P.
Technol
U.N.

Machinery.

ENGINEERING EDITION.

Index to Vol. XIV.

September, 1907, to August, 1908.

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Index to Vol. XIV.

MACHINERY, September, 1907.
Data Sheet No. 73.

MACHINERY
Contributions and data suitable for publication in these Data Sh...

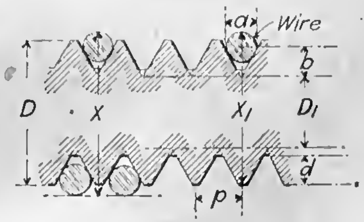
PUNCH PUNCH

CREASE HERE

MEASURING SCREW THREADS.—II.

Contributed by Walter Cantelo.

U.S STANDARD



n = number of threads per inch

p = pitch = $\frac{1}{\text{no. of threads per inch}}$

d = depth of thread = $0.6495p = \frac{0.6495}{n}$

D = diameter on top of threads

$D_1 = D - \frac{1.5155}{n}$

a = diameter of wire $\begin{cases}\text{maximum diam.} = 1.010p \\ \text{mininum diam.} = 0.505p\end{cases}$

$b = a$

$x = D_1 + 2b + a = D_1 + 3a$

$x_1 = \frac{D}{2} + \frac{D_1}{2} + b + \frac{a}{2} = \frac{D + D_1 + 3a}{2}$

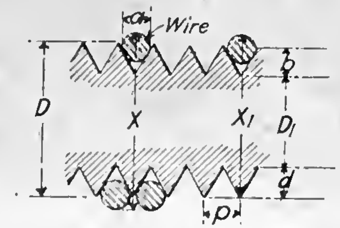
D	n	d	D_1	a and b	x	x_1
1/4"	20"	.0325"	.1742"	0.040"	.2942"	.2721"
5/16	18	.0361	.2283	"	.3483	.3304
3/8	16	.0406	.2803	"	.4003	.3876
7/16	14	.0464	.3292	"	.4492	.4433
1/2	13	.0500	.3834	0.060	.5634	.5317
9/16	12	.0541	.4362	"	.6162	.5893
5/8	11	.0590	.4872	"	.6672	.6460
11/16	11	.0590	.5497	"	.7297	.7086
3/4	10	.0649	.5984	"	.7784	.7643
13/16	10	.0649	.6610	"	.8410	.8267
7/8	9	.0722	.7066	0.100	1.0066	.9408
15/16	9	.0722	.7691	"	1.0690	1.0033
1	8	.0812	.8105	"	1.1105	1.0553
1 1/8	7	.0928	.9085	"	1.2085	1.1667
1 1/4	7	.0928	1.0335	"	1.3335	1.2917
1 3/8	6	.1082	1.1224	"	1.4224	1.3987
1 1/2	6	.1082	1.2474	"	1.5474	1.5237
1 5/8	5 1/2	.1180	1.3494	0.150	1.7994	1.7122
1 3/4	5	.1299	1.4470	"	1.8970	1.8234
1 7/8	5	.1299	1.5720	"	2.0220	1.9484
2	4 1/2	.1443	1.6632	"	2.1132	2.0566
2 1/8	4 1/2	.1443	1.7882	"	2.2382	2.1816
2 1/4	4 1/2	.1443	1.9132	"	2.3632	2.3066
2 3/8	4	.1624	1.9960	"	2.4460	2.4105
2 1/2	4	.1624	2.1210	"	2.5710	2.5355
2 3/4	4	.1624	2.3710	"	2.8210	2.7855
3	3 1/2	.1856	2.5670	0.200	3.1670	3.0835
3 1/4	3 1/2	.1856	2.8170	"	3.4170	3.3335
3 1/2	3 1/4	.2000	3.0337	"	3.6337	3.5668
3 3/4	3	.2165	3.2448	"	3.8448	3.7974
4	3	.2165	3.4948	"	4.0948	4.0474

CREASE HERE

MEASURING SCREW THREADS.—I.

Contributed by Walter Cantelo.

60° V THREAD



n = number of threads per inch

p = pitch = $\frac{1}{\text{no. of threads per inch}}$

d = depth of thread = $0.866p = \frac{0.866}{n}$

D = diameter of top of threads

D_1 = root diameter = $D - 2d$

a = diameter of wire $\begin{cases}\text{maximum diam.} = 1.155p \\ \text{minimum diam.} = 0.577p\end{cases}$

$b = a$

$x = D_1 + 2b + a = D_1 + 3a$

$x_1 = \frac{D}{2} + \frac{D_1}{2} + b + \frac{a}{2} = \frac{D + D_1 + 3a}{2}$

D	n	d	D_1	a and b	x	x_1
1/4"	20"	.0433"	.1634"	0.040"	.2834"	.2667"
5/16	18	.0481	.2163	"	.3363	.3244
3/8	16	.0541	.2667	"	.3867	.3808
7/16	14	.0617	.3138	0.060	.4938	.4656
1/2	12	.0722	.3557	"	.5357	.5178
9/16	12	.0722	.4182	"	.5982	.5803
5/8	11	.0787	.4676	"	.6476	.6363
11/16	11	.0787	.5300	"	.7100	.6987
3/4	10	.0866	.5768	0.100	.8768	.8134
13/16	10	.0866	.6393	"	.9393	.8759
7/8	9	.0962	.6826	"	.9826	.9288
15/16	9	.0962	.7450	"	1.0450	.9912
1	8	.1082	.7835	"	1.0835	1.0417
1 1/8	7	.1237	.8776	"	1.1776	1.1513
1 1/4	7	.1237	1.0026	"	1.3026	1.2763
1 3/8	6	.1443	1.0863	0.150	1.5363	1.4556
1 1/2	6	.1443	1.2113	"	1.6613	1.5806
1 5/8	5	.1732	1.2786	"	1.7286	1.6768
1 3/4	5	.1732	1.4036	"	1.8536	1.8018
1 7/8	4 1/2	.1924	1.4900	"	1.9400	1.9075
2	4 1/2	.1924	1.6150	"	2.0650	2.0325
2 1/8	4 1/2	.1924	1.7400	"	2.1900	2.1575
2 1/4	4 1/2	.1924	1.8650	"	2.3150	2.2825
2 3/8	4 1/2	.1924	1.9900	"	2.4400	2.4075
2 1/2	4	.2165	2.0670	0.200	2.6670	2.5835
2 3/4	4	.2165	2.3170	"	2.9170	2.8335
3	3 1/2	.2474	2.5050	"	3.1050	3.0525
3 1/4	3 1/2	.2474	2.7550	"	3.3550	3.3025
3 1/2	3 1/4	.2664	2.9670	"	3.5670	3.5335
3 3/4	3	.2886	3.1727	"	3.7727	3.7613
4	3	.2886	3.4227	"	4.0227	4.0113

This data sheet is made up so as to be readily bound. It may be cut sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

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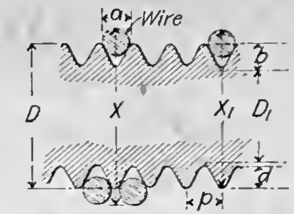
MEASURING SCREW THREADS.—III.

WHITWORTH THREAD



n = number of threads per inch

p = pitch = $\frac{1}{\text{no. of threads per inch}}$

d = depth of thread = $0.6403p = \frac{0.6403}{n}$

D = diameter on top of threads

$D_1 = D - \frac{1.6008}{n}$

a = diameter of wire $\begin{cases} \text{maximum diam.} = 0.840p \\ \text{mininum diam.} = 0.506p \end{cases}$

$b = 1.08205a$

$x = D_1 + 2b + a = D_1 + 3.1657a$

$x_1 = \frac{D}{2} + \frac{D_1}{2} + b + \frac{a}{2} = \frac{D + D_1 + 3.1657a}{2}$

D	n	d	D_1	a	b	x	x_1
1/4	20	.0320	.1699	0.040	.0433	.2965	.2733
5/16	18	.0356	.2235	"	"	.3501	.3313
3/8	16	.0400	.2749	"	"	.4015	.3883
7/16	14	.0457	.3231	"	"	.4497	.4436
1/2	12	.0534	.3666	"	"	.4932	.4966
9/16	12	.0534	.4291	0.060	.0649	.6190	.5907
5/8	11	.0582	.4794	"	"	.6693	.6372
11/16	11	.0582	.5420	"	"	.7319	.7097
3/4	10	.0640	.5899	"	"	.7798	.7649
13/16	10	.0640	.6524	"	"	.8423	.8274
7/8	9	.0711	.6971	"	"	.8870	.8810
15/16	9	.0711	.7596	"	"	.9495	.9435
1	8	.0800	.7999	0.100	.1084	1.1167	1.0583
1 1/8	7	.0915	.8963	"	"	1.2131	1.1690
1 1/4	7	.0915	1.0213	"	"	1.3381	1.2940
1 3/8	6	.1067	1.1082	"	"	1.4250	1.3999
1 1/2	6	.1067	1.2332	"	"	1.5500	1.5250
1 5/8	5	.1281	1.3048	0.150	.1624	1.7796	1.7023
1 3/4	5	.1281	1.4298	"	"	1.9046	1.8273
1 7/8	4 1/2	.1430	1.5193	"	"	1.9941	1.9345
2	4 1/2	.1430	1.6443	"	"	2.1191	2.0595
2 1/8	4 1/2	.1430	1.7693	"	"	2.2441	2.1845
2 1/4	4	.1601	1.8498	"	"	2.3246	2.2873
2 3/8	4	.1601	1.9750	"	"	2.4498	2.4123
2 1/2	4	.1601	2.1000	"	"	2.5748	2.5373
2 3/4	3 1/2	.1830	2.2926	0.200	.2157	2.9240	2.8370
3	3 1/2	.1830	2.5426	"	"	3.1740	3.0870
3 1/4	3 1/4	.1970	2.7574	"	"	3.3887	3.3194
3 1/2	3 1/4	.1970	3.0074	"	"	3.6387	3.5694
3 3/4	3	.2134	3.2164	"	"	3.8477	3.7990
4	3	.2134	3.4664	"	"	4.0977	4.0490

Contributed by Welter Cantelo.

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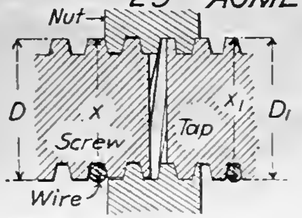
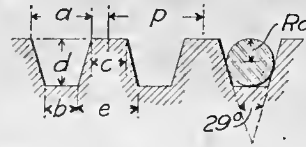
MEASURING SCREW THREADS.—IV.

29° ACME SCREW THREAD





SCREW THREAD

p - pitch = $\frac{1}{\text{no. of threads per inch}}$

d - depth of thread = $\frac{p}{2} + 0.010"$

a - space at top = $0.6293p$

b - space at bottom = $0.3707p - 0.0052"$

c - thickness at top = $0.3707p$

e - thickness at bottom = $0.6293p + 0.0052"$

D - diameter at top of thread

$x = D + 0.010"$

TAP THREAD

p = pitch = $\frac{1}{\text{no. of threads per inch}}$

d = depth of thread = $\frac{p}{2} + 0.020"$

a = space at top = $0.6293p + 0.0052"$

b = space at bottom = $0.3707p - 0.0052"$

c = thickness at top = $0.3707p - 0.0052"$

e = thickness at bottom = $0.6293p + 0.0052"$

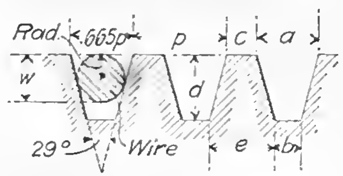
D_1 = diameter at top of thread = $D + 0.020"$

$x_1 = D_1 = D + 0.020"$

Threads per inch	p	d	Diameter of wire	Threads per inch	p	d	Diameter of wire
1/2	2.000	1.0100	0.9785	3	0.3333	0.1767	0.1664
3/4	1.500	0.7600	0.7349	4	0.2500	0.1350	0.1278
1	1.000	0.5100	0.4913	5	0.2000	0.1100	0.1014
1 1/3	0.750	0.3850	0.3694	6	0.1667	0.0933	0.0852
1 1/2	0.667	0.3433	0.3288	7	0.1429	0.0814	0.0736
1 3/4	0.571	0.2957	0.2824	8	0.1250	0.0725	0.0649
2	0.500	0.2600	0.2476	9	0.1111	0.0655	0.0581
2 1/2	0.400	0.2100	0.1989	10	0.1000	0.0600	0.0527

The wire used is of such diameter, that when laid in the thread groove of the tap, it will be flush with the top of the threads, and when laid in the thread groove of the screw, it will extend beyond the top of the threads 0.010."

THE BROWN AND SHARPE 29° WORM THREAD



p = pitch = $\frac{1}{\text{no. of threads per inch}}$

d = depth of thread = $0.6866p$

a = space at top = $0.665p$

b = space at bottom = $0.310p$

c = thickness at top = $0.335p$

e = thickness at bottom = $0.690p$

w = diam. of wire = $0.5149p$

Pitch	d	Wire Diam.	Pitch	d	Wire Diam.
2.000	1.3732	1.0298	.3333	.2288	.1716"
1.750	1.2015	.9010	.2500	.1716	.1287
1.500	1.0299	.7723	.2000	.1373	.1030
1.250	.8582	.6436	.1667	.1144	.0858
1.000	.6866	.5149	.1250	.0858	.0643
.750	.5150	.3862	.1111	.0763	.0582
.500	.3433	.2574	.1000	.0687	.0515

The wire used is of such diameter that it will be flush with the top of the thread when laid in the thread groove.

Contributed by Walter Cantelo.

No. 1. 28"

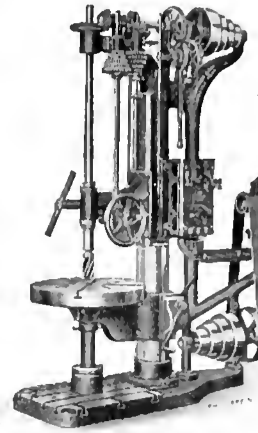
Snyder Celebrated Upright Drills

Are thoroughly well made, rigid and powerful, and are adapted to high grade work. They are furnished with Patented Tapping Attachment, Compound Table, Motor Drive, also Positive Gear Feed, which can be changed from the finest to the coarsest feed instantly, without stopping the machine. Have sufficient power for high speed drills, and are adapted to the most accurate work which can be done on a Drill Press. For twenty years our exclusive specialty has been "High Grade Upright Drilling Machines." By giving our undivided attention to this one line, we are enabled to produce a high grade machine at a reasonable price.

"NONE BETTER THAN THE SNYDER."

J. E. SNYDER & SON, Worcester, Mass.

Sizes 20-in., 23-in., 25-in., 28-in., 30-in. and 36-in.



No. 2 30"

MOTOR DRIVE

The Cheapest Elevator in the World

Because when installed you are done.
Yes sir, done bothering with elevators forever.
Done killing and hurting your men, too.
Done having your work upset by breakdowns.
Done paying repair bills.
Done living under the Elevator Curse.
And done cursing the elevator.

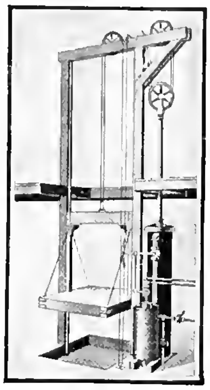
And if you are half as smart a manager as you would like the Powers-That-Be to think you are you will find out about a machine that claims as much as the Steam-Hydraulic elevator.

Of course you know we are putting them in the best plants everywhere. Just equipped the Bureau of Engraving and Printing at Washington with them, and are at work changing over the elevators of the Greatest Concerns in the land to the Steam-Hydraulic system.

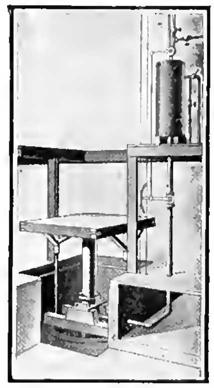
Why not let us refer you to somebody near you where you can go and see for yourself what a perfect hydraulic elevator is really like? If you want what is really the cheapest elevator in the world you will, like a great company of others,

Hook 'er to the Biler

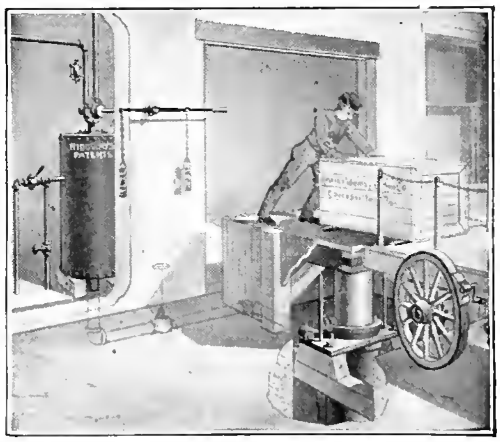
RIDGWAY & SON, Coatesville, Pa.



Double Geared Elevator



Direct Acting Elevator



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The Planer for All your Work

is the "Woodward & Powell," because its capacity ranges from the lightest work to the heaviest, and it is always accurate and very rapid.

WOODWARD & POWELL PLANER CO.

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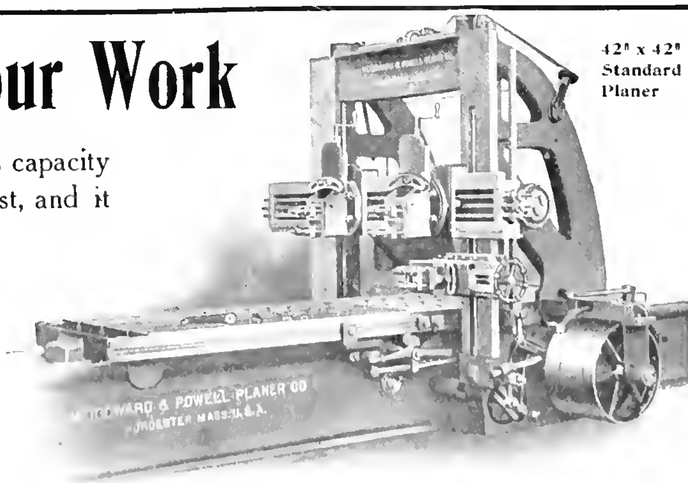
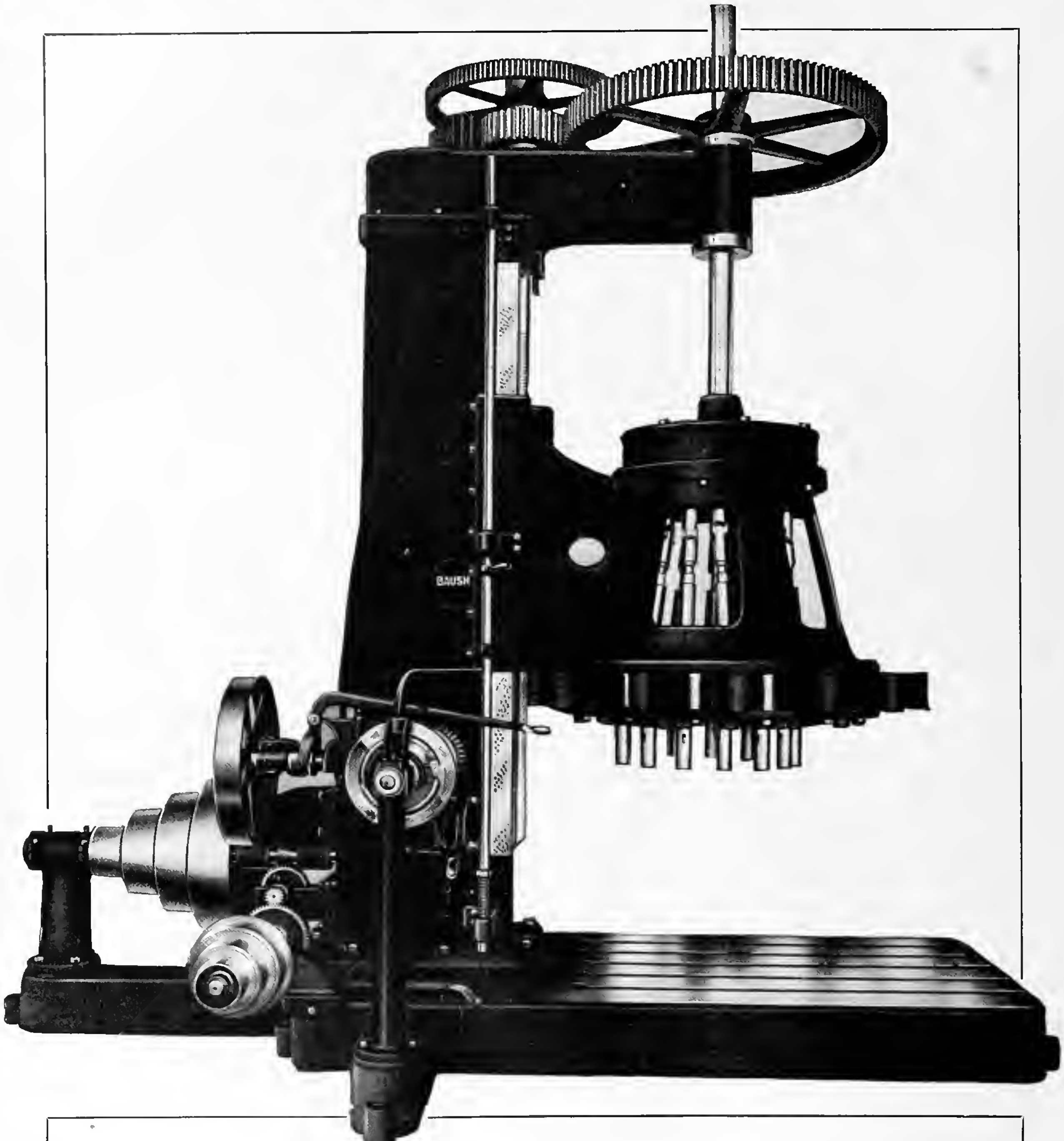
Manning, Maxwell & Moore, New York City, Philadelphia, Chicago, Ill., Pittsburg, Pa., Cleveland, Ohio, Boston, Mass., Birmingham, Ala., Mexico City, Mexico. Henshaw, Bulkley & Co., San Francisco, Cal. Takata & Co., Tokio, Japan.



42" x 42" Standard Planer



The Enormous Driving Power

of the No. 30 Screw Type High Speed Multiple Drill Covers the Problems of Heavy Drilling.

Spindles can be adjusted to cover any layout between a minimum drilling circle 10" in diameter and a maximum of 30".

The machine is especially designed for the use of high speed drills and equipped with 12 spindles; capacity up to 1 ½" holes in cast iron. Screw feed has ball bearings; spindles are adjustable vertically to allow for variations in drill length.

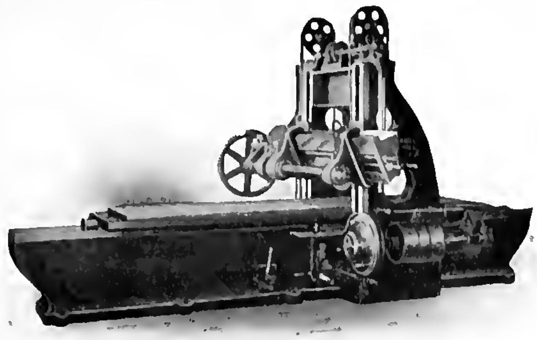
Furnished with 12, 14 or 16 spindles as desired.

Baush Machine Tool Company, Springfield, Mass., U.S.A.

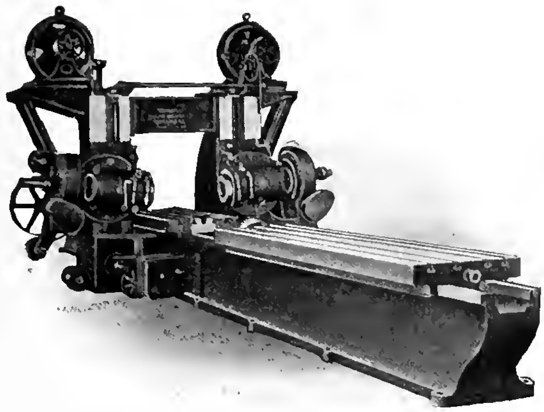
AGENTS—Manning, Maxwell & Moore, Inc., New York, Chicago, Cleveland, Philadelphia, Pittsburg, Boston, St. Louis
DeFries & Cie, Akt. Ges. Dusseldorf, Berlin. DeFries & Cia, Foro Bonaparte 54-56, Milan, Italy.
Selig, Sonnenthal & Co., London. Hugo Tillquist, Stockholm. Alfred H. Schutte, Brussels. Takata & Co., Japan.

Heavy Milling Machines Exclusively

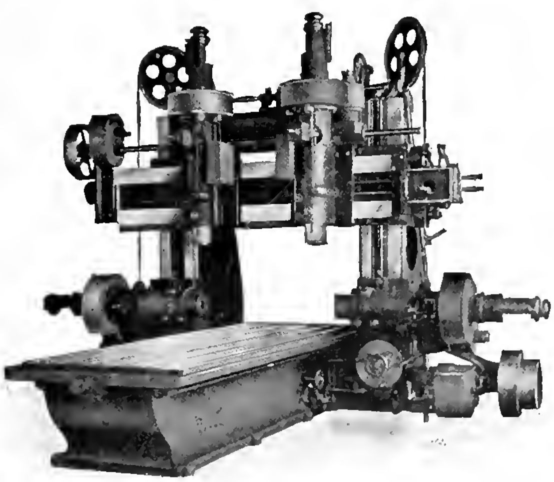
All Types



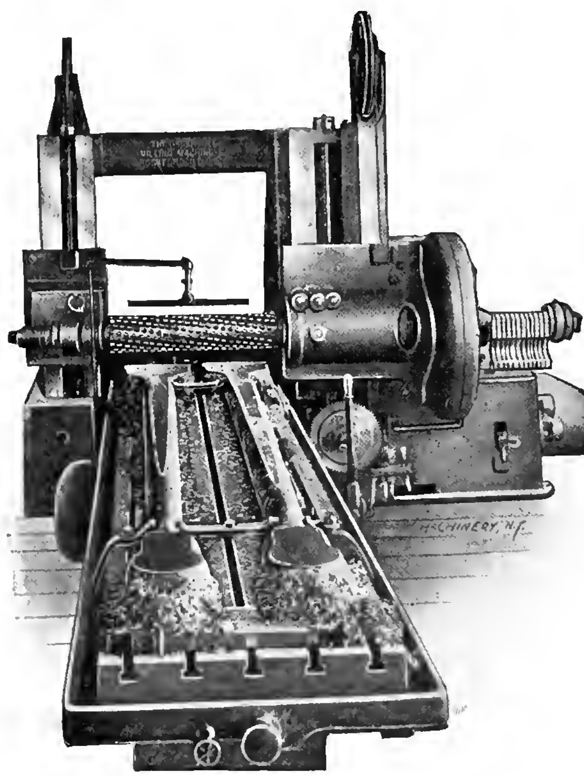
STANDARD HORIZONTAL SPINDLE MACHINE



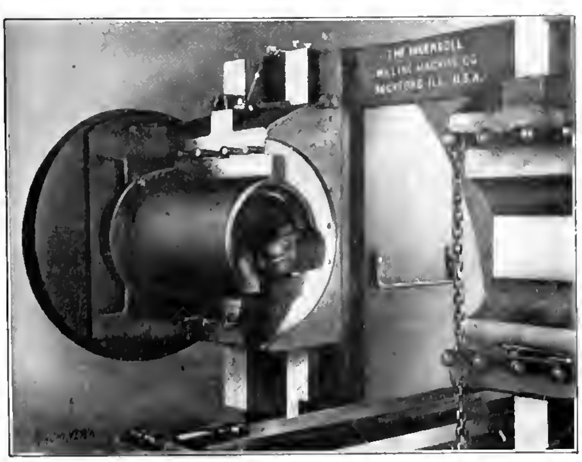
DUPLEX HORIZONTAL MACHINE
SWIVELING HEADS



FOUR HEAD TYPE



HEAVY TYPE MILLING MACHINE
MILLING CONNECTING RODS



SPINDLE BEARING OF ONE OF OUR LARGEST MACHINES

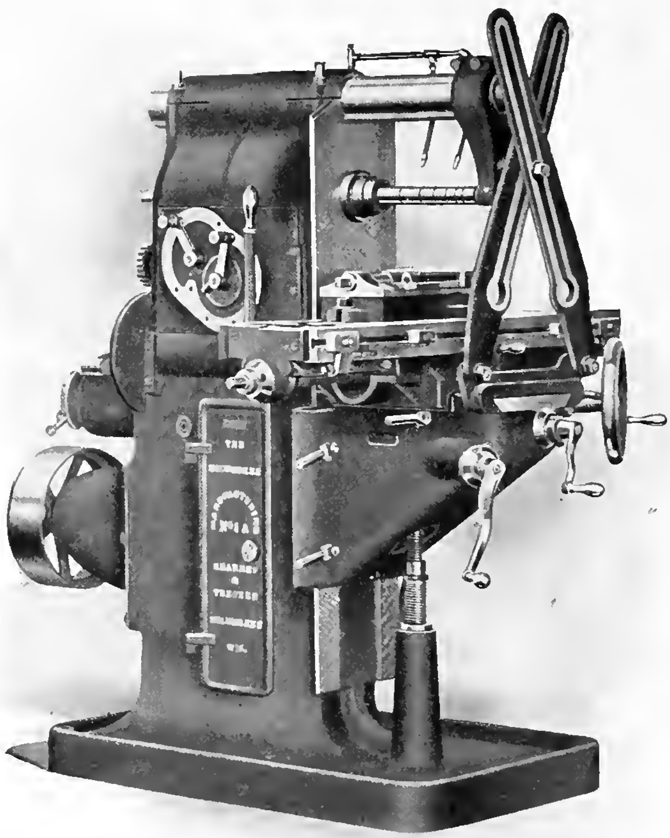
The Ingersoll Milling Machine Company,

Rockford, Ill., U. S. A.

Eastern Branch,
114 Liberty Street, New York,
Walter H. Foster, Mgr.

A MANUFACTURING MILLER

So called because it was designed to meet the requirements of quantity in large factories where piece work, High Speed Steel and chucking fixtures are the means employed to carry production to the maximum. There are no unnecessary parts or handles. Everything is boiled down to insure quick handling, and at the same time nothing is omitted, needed to make the machine complete for the purpose intended.



No. 1 A Manufacturing Miller.

There are no overhead belts or countershafts to interfere with the proper grouping of machines to secure the maximum plant on a given floor space. The power is taken direct from the line shaft without friction clutch, T and L pulley or other troublesome devices. Starting and stopping is effected by means of a lever on the machine itself. The machine is self contained and can be set up or shifted to a new position in a minimum of time.

If it ever becomes advisable to use electric drive the pulley bracket can be removed and the motor attached in half an hour.

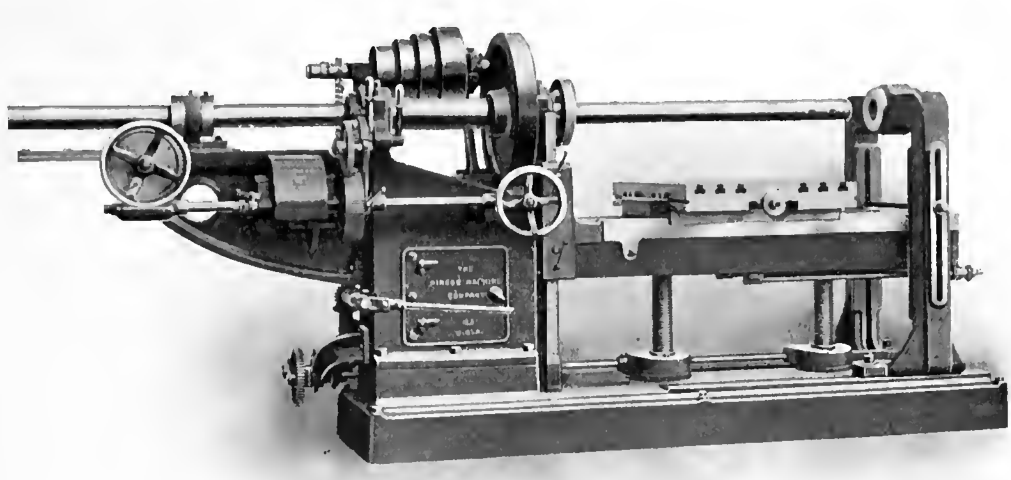
All shafts and gears have flooded lubrication. Every machine is equipped with pump for oiling cutters, and ample passages are provided to return the cutting lubricant to the reservoir.

They are given the preference by piece workers where there is a choice of Millers in the same factory.

We can refer you to users who have from one to a hundred in operation.

KEARNEY & TRECKER COMPANY

Manufacturers **MILWAUKEE, WIS., U. S. A.**



FOREIGN MACHINERY MERCHANTS.

BELGIUM.

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168, Rue de Brabant, Brussels.
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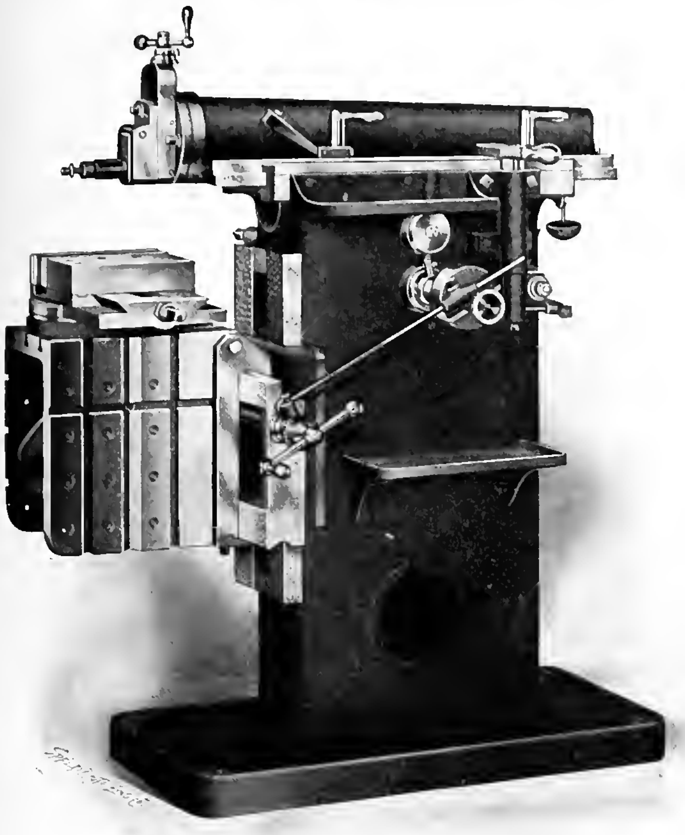
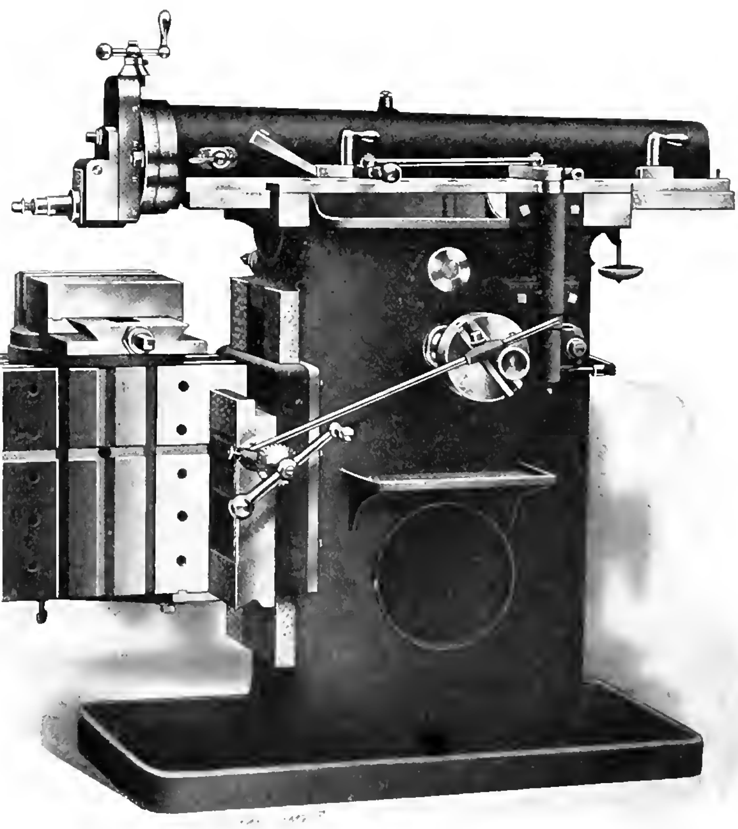


Will plane to a line.

Ram is driven by double train of gearing, giving **Constant Speed, Constant Power, Full Length of Stroke.**

Stroke of ram can be quickly changed to any length and position while in motion, simply by moving reversing dogs to necessary position on ram.



Micrometer adjustment on cutting stroke for fine variation in length of forward travel.

Made in 15″, 20″, 24″ and 28″ stroke.

24″ and 28″ shapers have power down feed.

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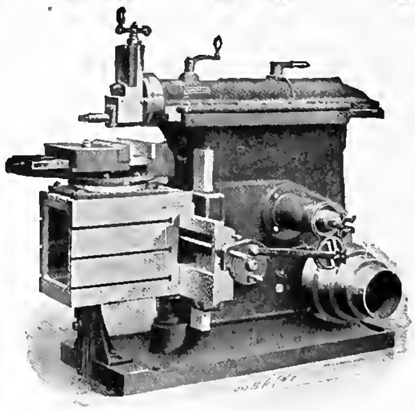
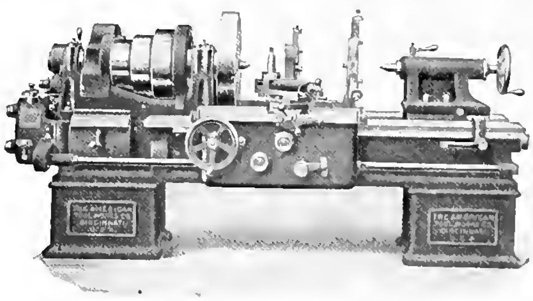
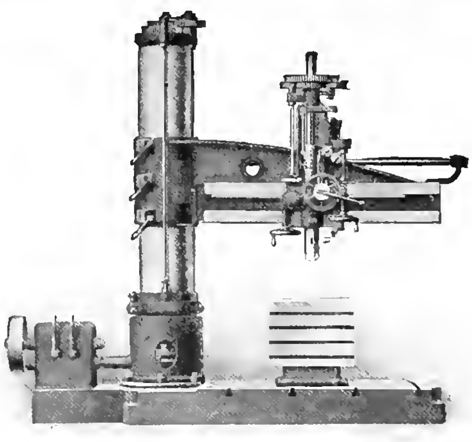
300 to 350 CULVERT STREET, CINCINNATI, OHIO, U. S. A.



Shapers--16" to 28" Stroke.



Double Back Geared Lathes--14" to 36" Swing.



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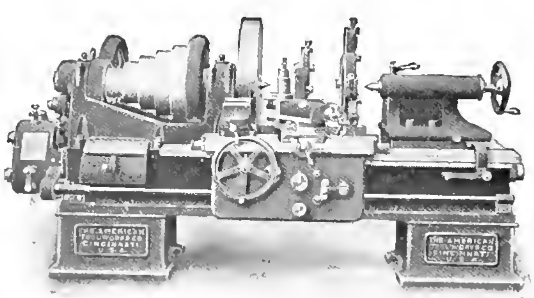

Cone Head Lathes--14" to 62" Swing.

INTELLIGENT SELECTION

(REGARDLESS OF FIRST COST)

of tools for your shop equipment

WILL RESULT IN

Maximum Output,
Lowest Shop Cost,
Best Quality of Work,
Satisfied Customers,
Increased Orders,
Greatest Profits.

"AMERICAN" TOOLS

REPRESENT THE

HIGHEST DEVELOPMENT

OF

MODERN DESIGN.

They are built for hard service and are **NOTED** for their

POWER, ACCURACY, SIMPLICITY, DURABILITY.

CATALOGUE "K" NOW READY.

NOTICE: To receive new catalog when issued, Machine Tool Users mail us postal card with company's name and mechanical officer in charge thereof.

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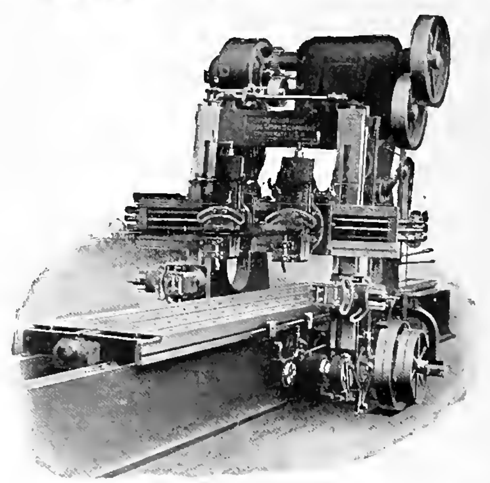

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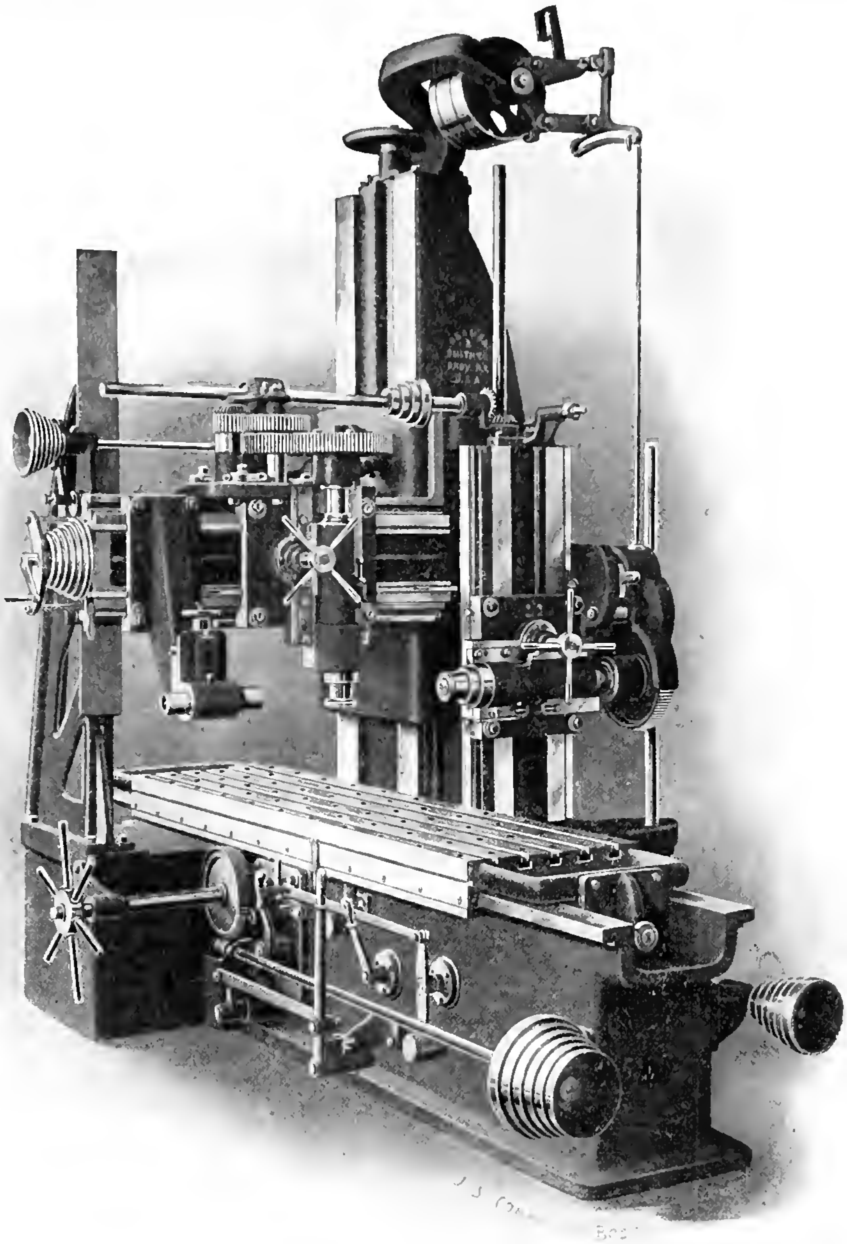

No. 2 Combined Vertical and Horizontal Spindle Milling Machine

We make a specialty of Milling and Boring Machines and build a line of these tools that covers the widest range of work.

Our Catalogue showing full line of machines is at your service.

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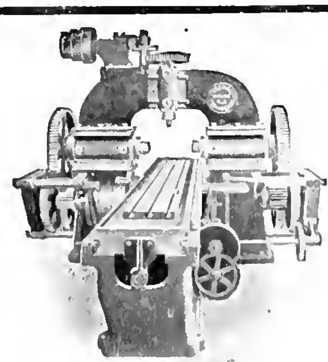

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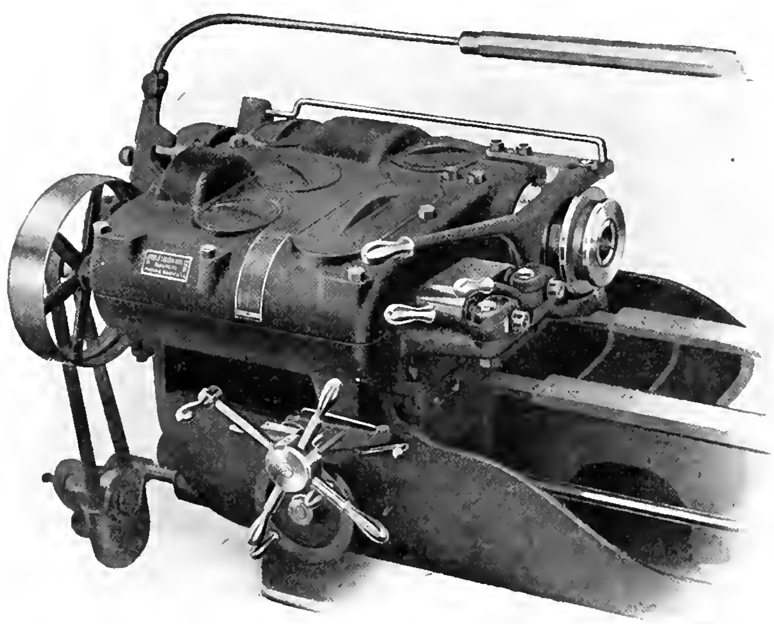
the Flat Turret Lathe will Appeal and Superintendent

6 or 8 pieces only are to be produced. The CROSS SLIDING HEAD is a distinctive point and a point of vantage. This head is securely gibbed to guideways running across the machine, giving the work carrying spindle a cross feed relative to the turret—or in other words, provides a cross feed for every tool, an arrangement which results in incalculable time saving not only for chuck work, but for many other kinds of work. The cross feed has ten stops and the turret twelve stops. Turret turns automatically to position required, skipping other positions. The single drive receives power at a constant speed in one direction and all necessary changes of speed are obtained by an arrangement of gears and clutches.



A WORD ABOUT SIZES:

The Flat Turret Lathe is now made in two sizes, 2 x 24 and 3 x 36, handling respectively bar work up to 24 inches and 36 inches, and chucked work to 12 inches and 14 inches. We shall be glad to estimate the saving possible on your work.

Machine Company, Queen Victoria St., London, E.C.

France and Spain, Ph. Bonvillain and E. Ronceray, 9 and 11 Rue des Envierges, Paris, France. Italy, Adler & Eisenschitz, Milan, Italy.

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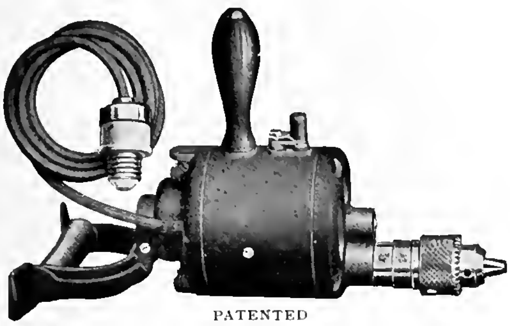
"Hisey" Portable Electrical Drills

Now up to 2" capacity



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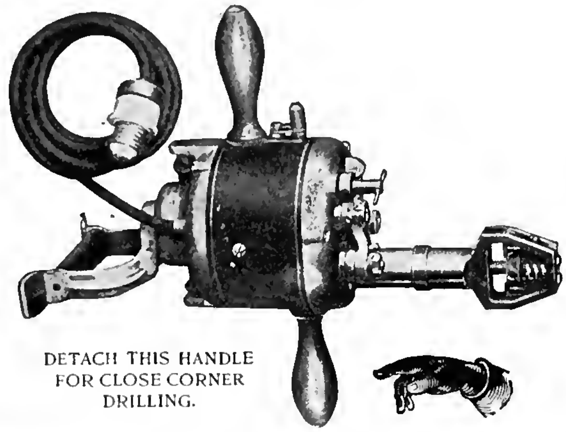
Made in 3 sizes, $\frac{1}{4}''$, $\frac{3}{8}''$, $\frac{1}{2}''$ capacities. Weights 8, 10, 15 lbs. respectively. Chuck offset for close corner drilling.



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Type K, 0 to $\frac{1}{2}''$ capacity. Weight 15 lbs. Two speeds. Fitted with screw feed if desired.

Capacities as given are for in steel.

Larger capacities for in softer material.

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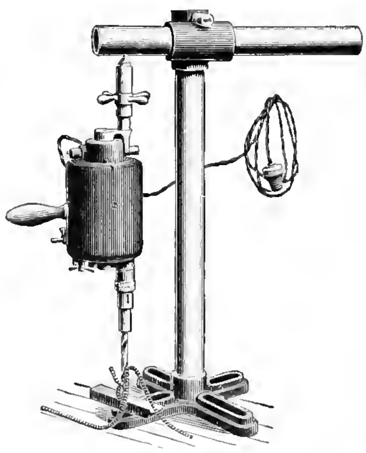

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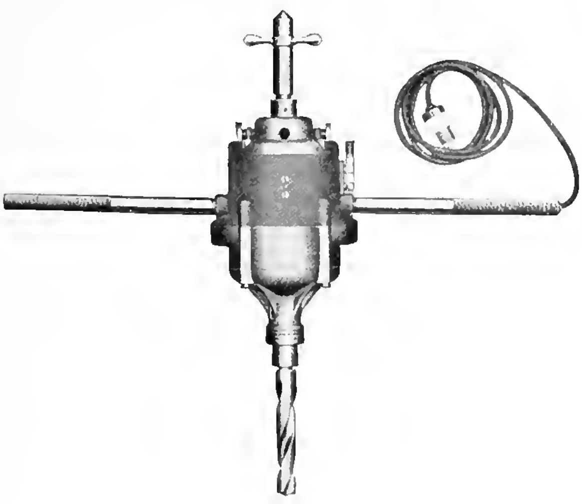
Type KK, 0 to $\frac{3}{4}''$ capacity. Weight 19 lbs. Two speeds. Fitted with screw feed and taper socket. Breast attachment included. "Old man" furnished as an extra.

ALSO FULL LINE OF

Tool Post Grinders,
Surface Grinders,
Internal Grinders.

Power from any lamp socket. Direct or alternating current.



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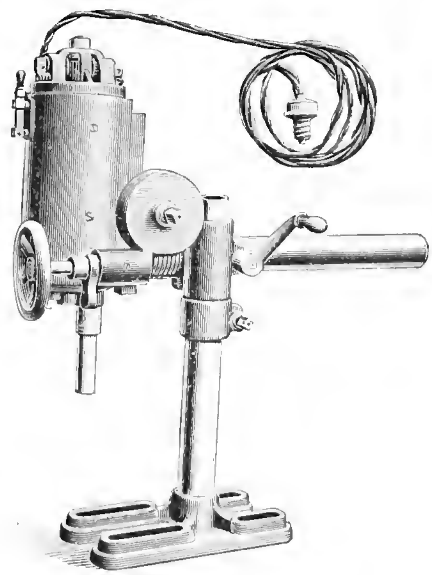
Center Drive Screw-feed Drill.

Made in 2 sizes, $\frac{7}{8}''$ capacity, weight 27 lbs., and $1\frac{1}{4}''$ capacity, weight 38 lbs. "Old man" furnished if desired. Carry them anywhere.

Our Catalogue No. 5-A illustrates fully.



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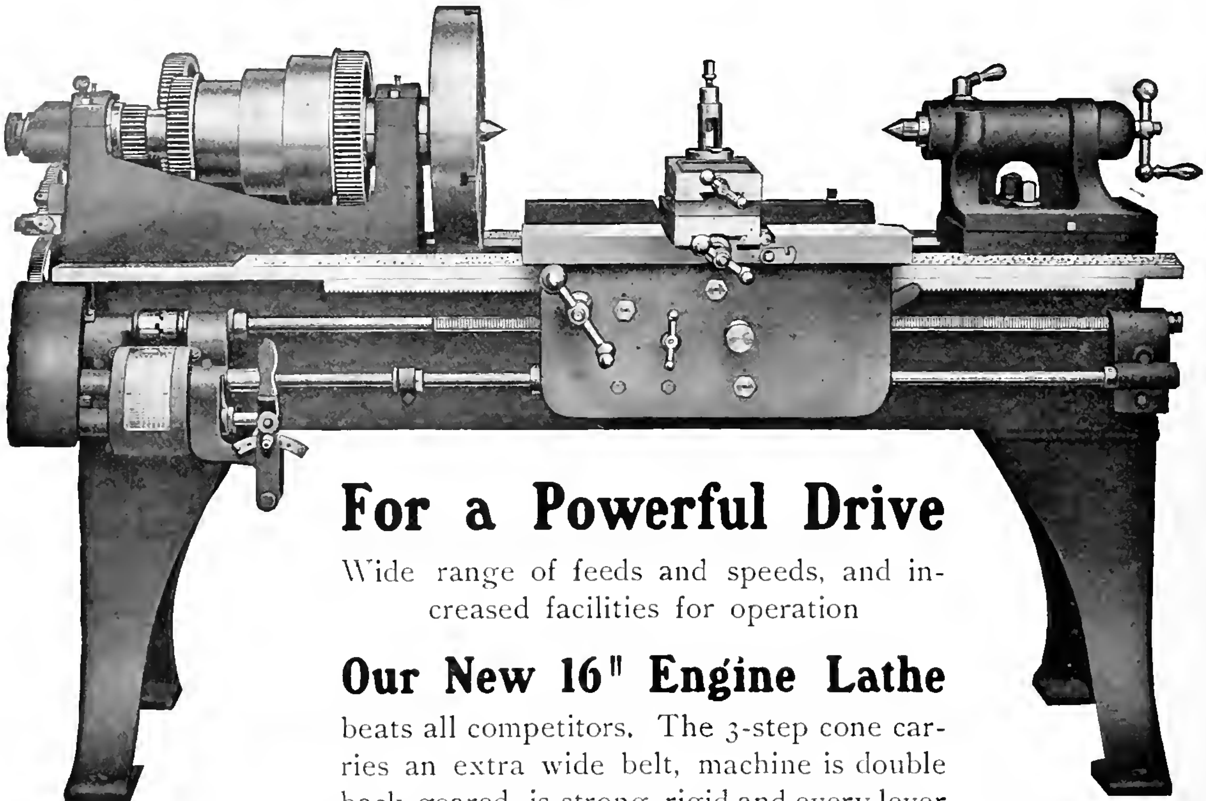
Made in 3 sizes, $\frac{7}{8}''$, $1\frac{1}{4}''$ and $2''$ capacities. 12" feed, 24" radius. Two speeds. Motor set at any angle. Will drill in any direction. Hand feed with quick return.

The Hisey-Wolf Machine Co.

New York Office: 150 Nassau Street **CINCINNATI, OHIO**

IN STOCK BY FOREIGN AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin, St. Petersburg, Vienna, Stockholm. Alfred H. Schutte, Cologne, Paris, Brussels, Bilbao, Milan, Liege. J. Lambercier & Co., Geneva, Switzerland.



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Wide range of feeds and speeds, and increased facilities for operation

Our New 16" Engine Lathe

beats all competitors. The 3-step cone carries an extra wide belt, machine is double back-geared, is strong, rigid and every lever is placed at the handiest point. We've a special circular of this tool at your disposal.

SAVE TIME, POWER AND NERVES

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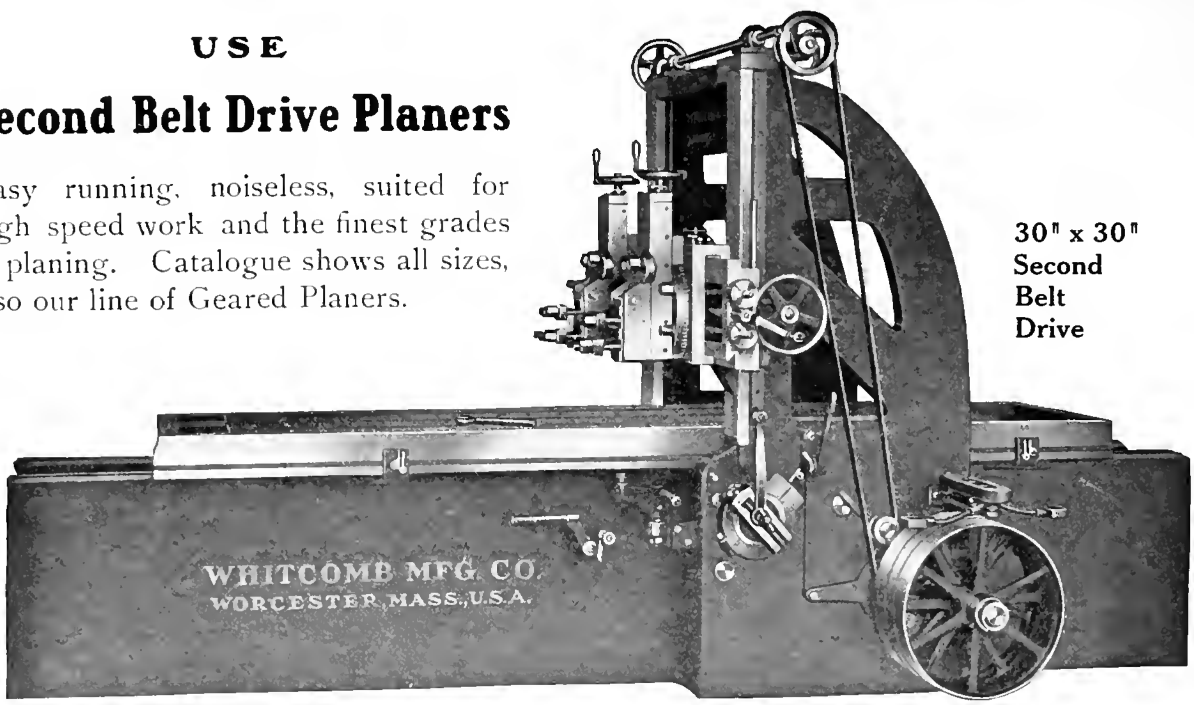
Second Belt Drive Planers

Easy running, noiseless, suited for high speed work and the finest grades of planing. Catalogue shows all sizes, also our line of Geared Planers.



30" x 30" Second Belt Drive

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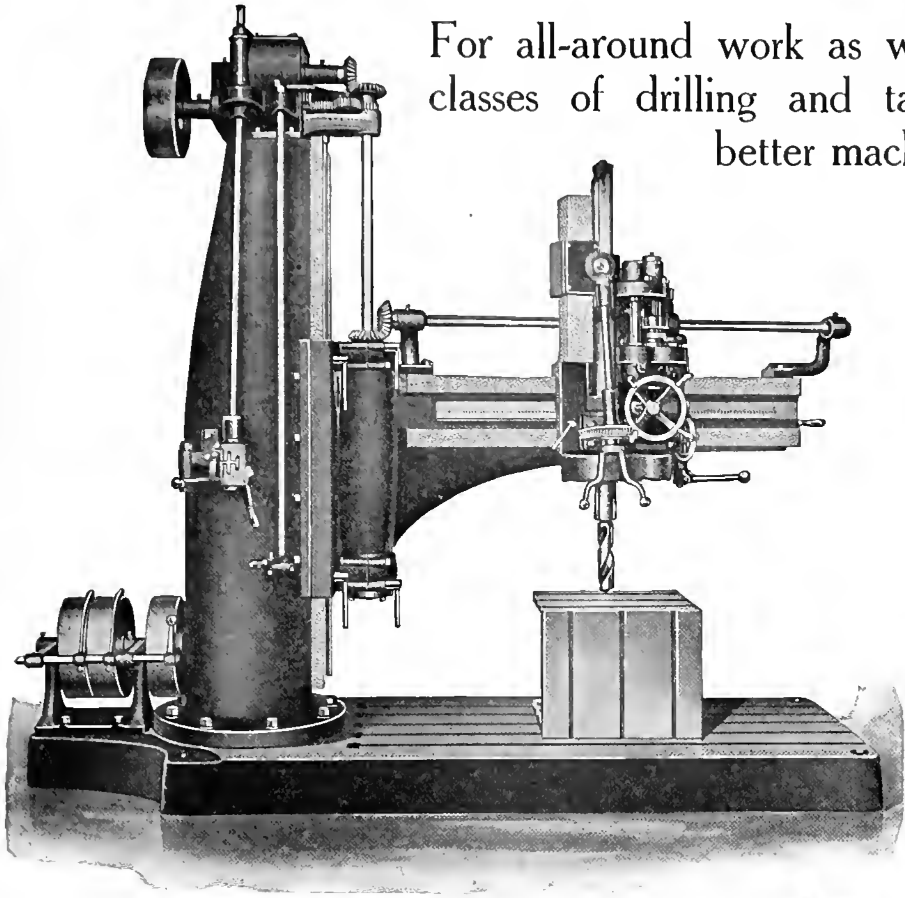
For all-around work as well as the heaviest classes of drilling and tapping there is no better machine than this



6-Foot Triple Geared Plain Radial Drill
Full Line of Sizes

6-ft. Western Triple Geared, Plain Radial Drill

High ratio of gearing.
Great range of speeds.
Power applied to lower end of spindle, close to the work.

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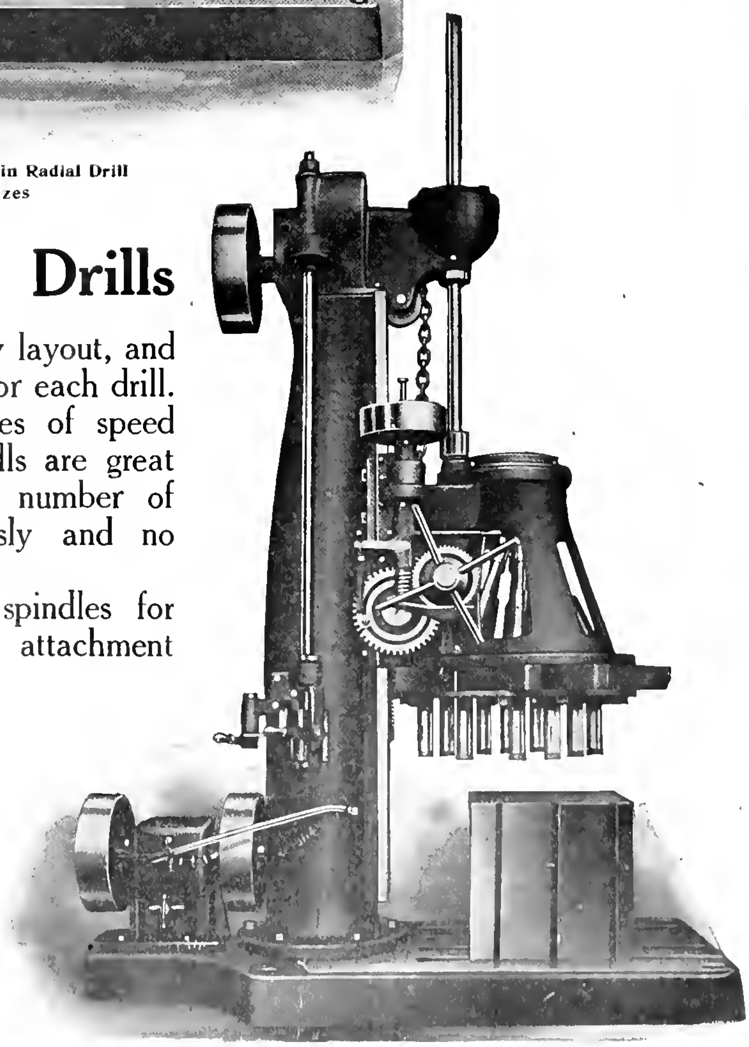
Western Multiple Drills

Spindles adjustable to almost any layout, and independent vertical adjustment for each drill. Gear drive, six or eight changes of speed instantly obtainable. These drills are great savers of time—permit a large number of holes to be drilled simultaneously and no need to move the work.
Arranged with any number of spindles for special requirements. Tapping attachment when desired.

FULL LINE OF SIZES



No. 2 Multiple Drill Belt or Motor Drive

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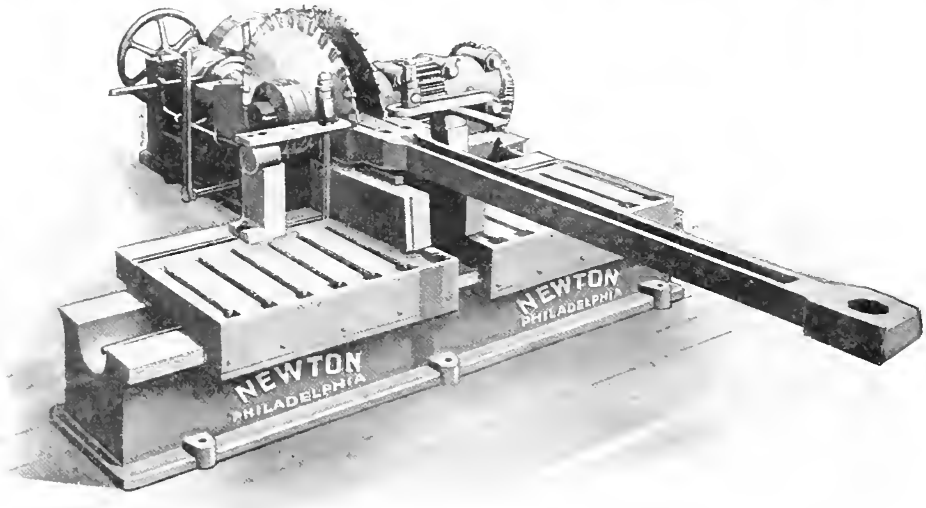

No. 3 CRANK SHAFT COLD SAWING MACHINE
Carrying inserted tooth blades making two cuts simultaneously $1\frac{1}{2}$-in. deep in a 5-in. thick rod in 17 minutes.

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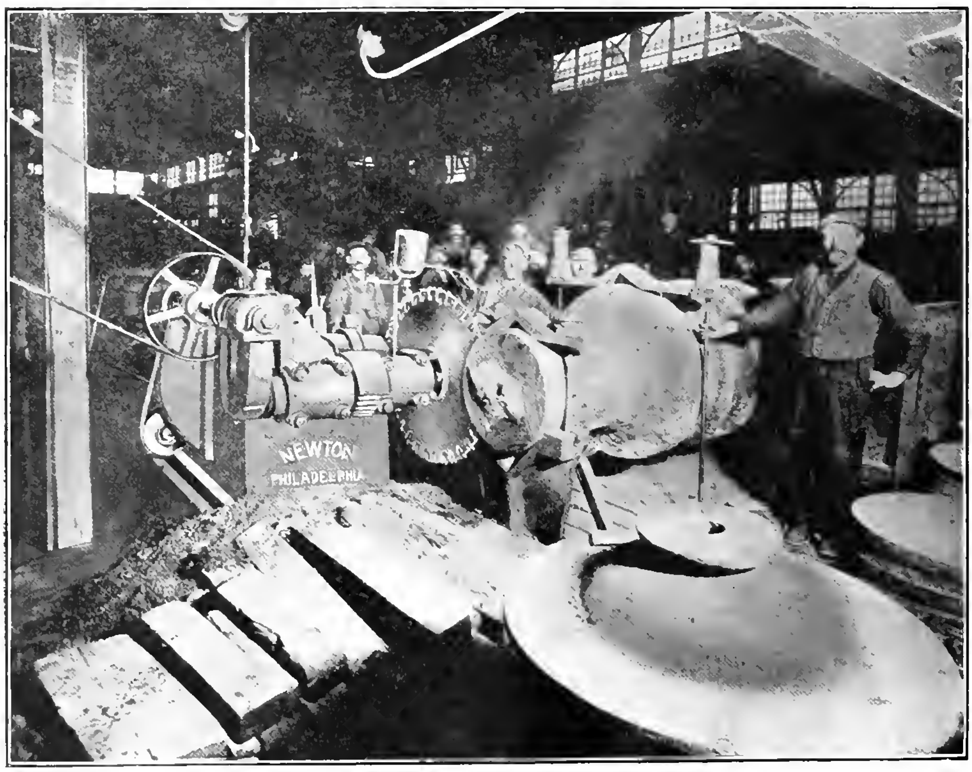
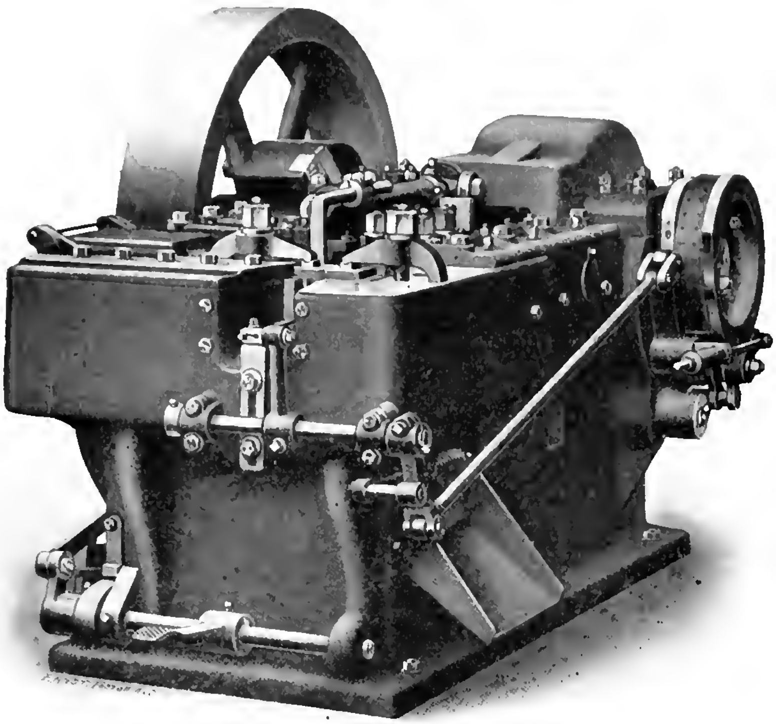


No. 1 STEEL FOUNDRY COLD SAW CUTTING OFF MACHINE

Newton Machine Tool Works, Inc.

Philadelphia, Pa., U. S. A.



The National New Wedge Grip Bolt and Rivet Header

has exceeded even our fondest expectations, and is worthy of the careful investigation of all bolt machine users.

The wedge prevents any "rocking" or springing open of the grip dies, and it is unnecessary to overgrip (hence batter) the dies to secure the required amount of gripping pressure. *As a result the dies will last from three to four times as long as in the regular toggle headers.*

Fins, also are practically eliminated, and this combined with the die saving makes the installation of this machine a plain business proposition.

One customer has ordered twenty-four.

We build complete equipment for Bolt and Nut Plants.

Our aim is to build our machines better, if anything, than need be. Hence we are in position to furnish only the best.

THE NATIONAL MACHINERY CO

TIFFIN, OHIO, U.S.A.

FOREIGN AGENTS

Buck & Hickman, Ltd., London, Birmingham, Manchester, Glasgow.

A. B. Horn, Havana, Cuba.

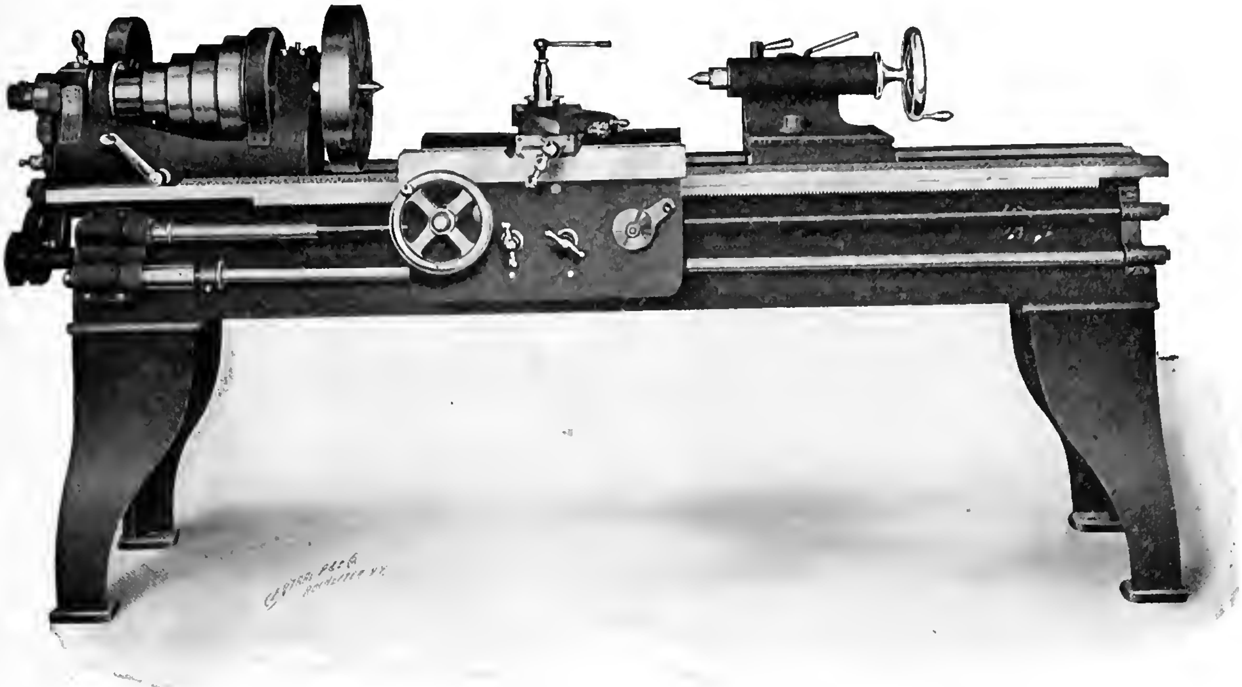
Takata & Co., Tokio, Japan.

Fenwick, Freres & Co., Paris, Liege, Brussels.

De Fries & Co., Dusseldorf, Berlin.

White, Child & Beney, Vienna, Austria.

ACCURATE MACHINE TOOLS



DAVIS 14, 16 and 18-inch ENGINE LATHES, with Quick Change Feed also Feed Provided with Automatic Stop.

The above cut represents our latest model of 14, 16 and 18-inch engine lathes. As will be noticed on the cut, ample provision has been made for strength in designing the bed.

The carriage has a long bearing on the Ways, and the tail stock is of improved type, by which the compound rest can be swung around at any angle when work is being finished with the tail stock. There is but one gear to change in cutting any thread, and a change can be made to cut any thread desired in from 20 to 30 seconds.

Our instantaneous feed change is arranged and operated by a lever in the front of the head stock. In bringing out these lathes we have been able to furnish a lathe with all the conveniences required for general use, and actual shop practice, at the same time we have eliminated a large amount of parts found in many of the so called quick change feed lathes.

We believe we are furnishing a tool that will meet all of the requirements of a first-class manufacturing establishment, and at the same time, furnish a tool that will stand up to hard continuous service for many years.

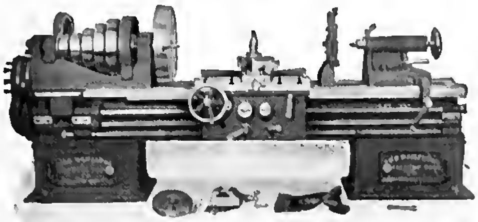
Orders can be sent to us direct or through leading machinery dealers in all large cities of the world.

For further particulars address

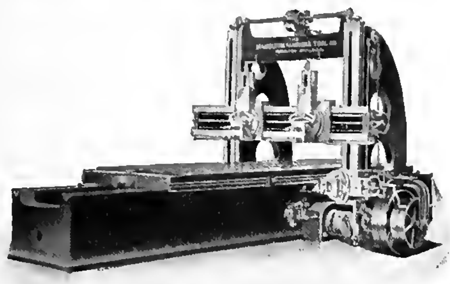
THE W. P. DAVIS MACHINE CO.,

ROCHESTER, N. Y., U. S. A.

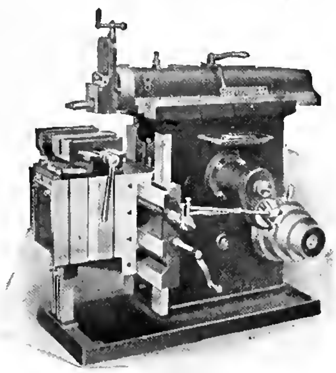
"HAMILTON" TOOLS ARE FAVORITES



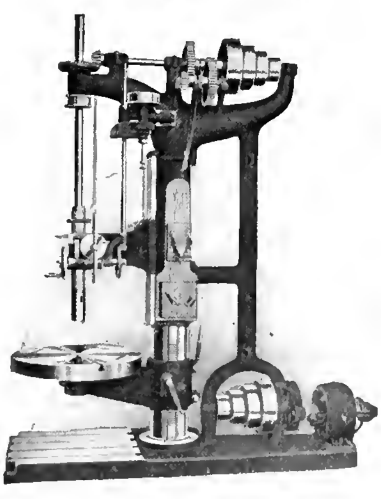
26" x 10' Style "A" Lathe



60" x 48" Planer, Widened Pattern



20" Back Geared Crank Shaper



36" Upright Drill Press, with Motor Drive

Among discriminating buyers, who realize the close relation between efficient equipment and satisfactory production. They are favorites, too, of the men in the shop, who know from daily experience the difference between high grade "HAMILTON" tools and the "just as good" kind.

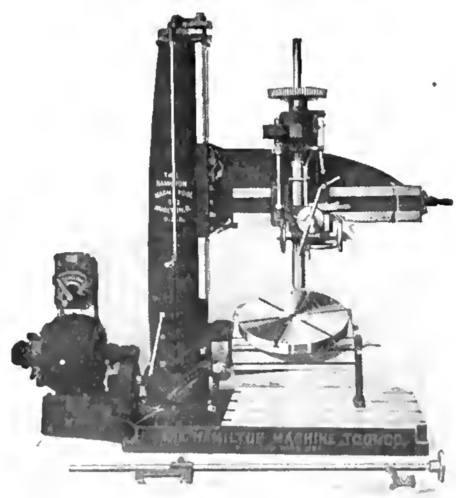
This is worth remembering when the question of

Lathes, Planers, Shapers, Upright and Radial Drills

is under consideration, also that the selection of "HAMILTON" tools forms the best possible answer.

In both design and construction these machines are unexcelled, and are sure to give a highly satisfactory account of themselves wherever installed. They are furnished in various sizes and styles, either belt or motor driven and with all usual attachments.

Let us send you descriptive matter and further particulars.

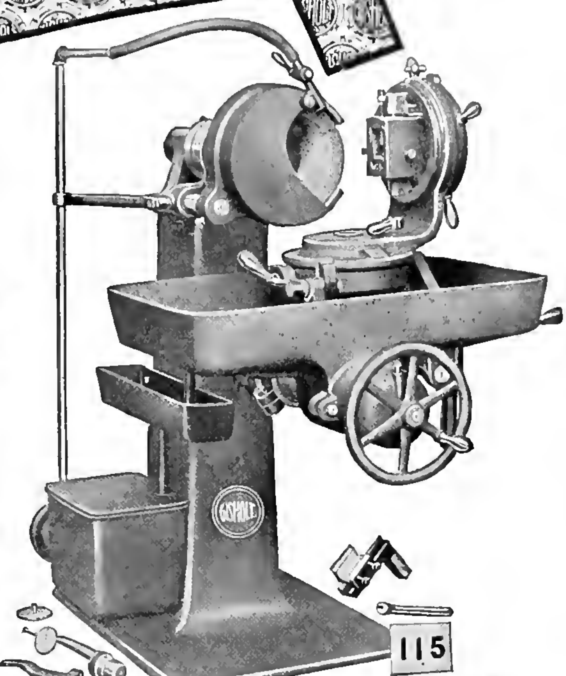


3½' Plain Radial Drill with Motor Drive

THE HAMILTON MACHINE TOOL COMPANY

HAMILTON, OHIO, U. S. A.

Philadelphia Store, 48-50 N. 6th St. Agents in the principal cities of the United States and Foreign Countries.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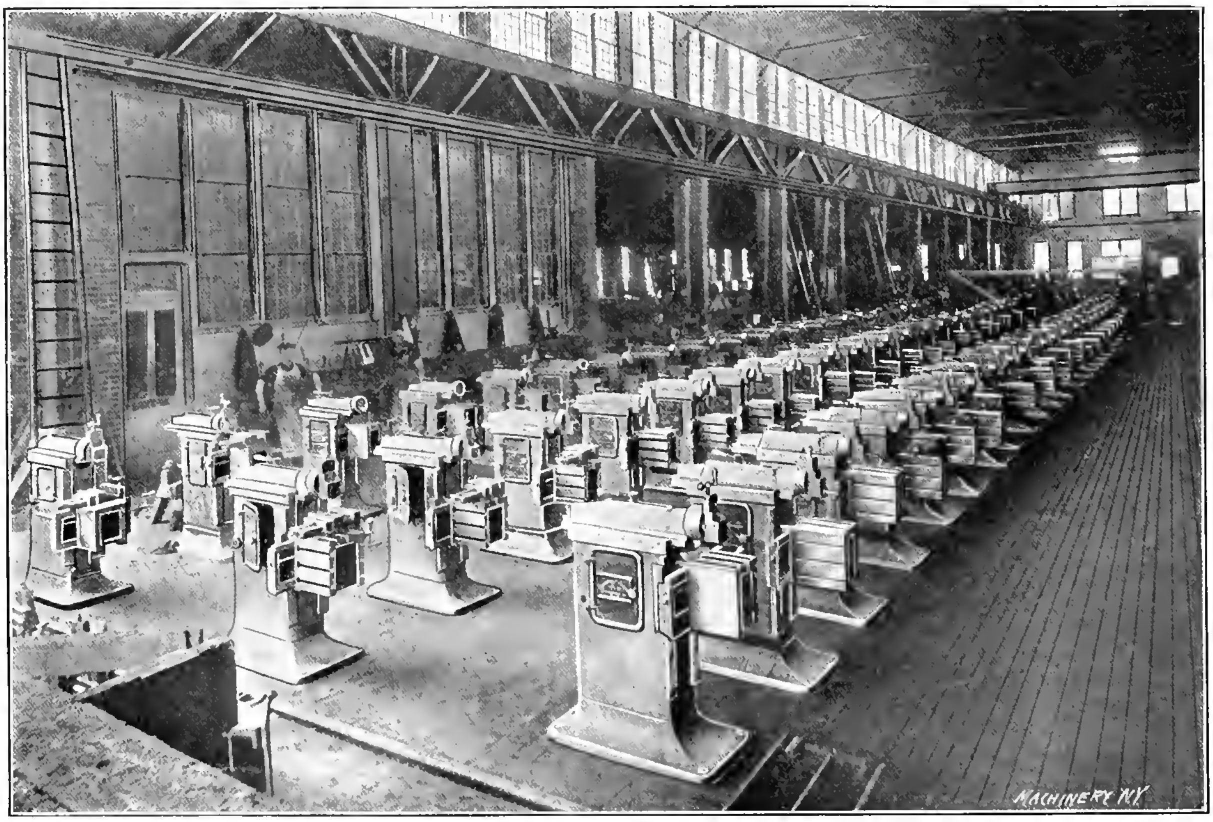
SPRINGFIELD
COST REDUCERS



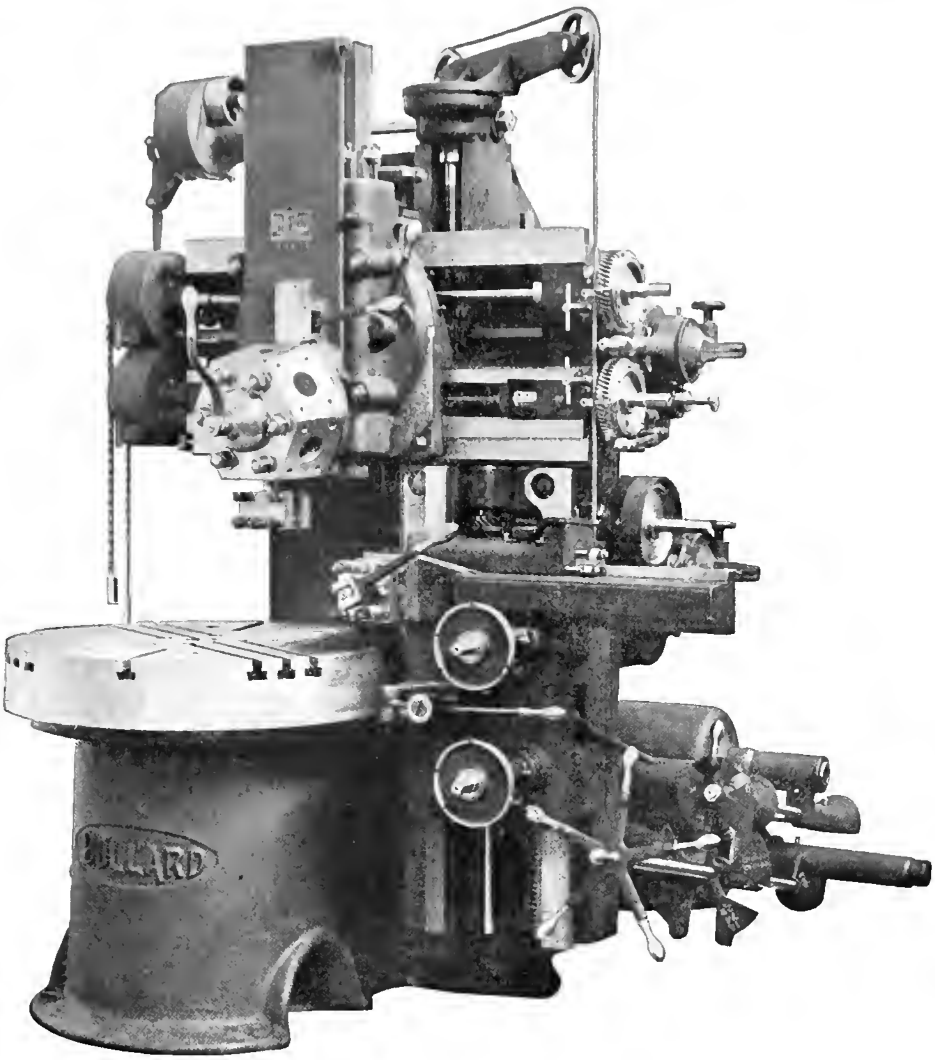
We manufacture Shapers in large lots. Above view shows sixty (60) 15-in. Crank Shapers on the erecting floor, ready for the painters and packers.

We make 12-in., 15-in. and 20-in. Crank Shapers and 16-in. and 25-in. Back Geared Shapers. Circulars 110, 111, 107 and 127.

SPRINGFIELD MACHINE TOOL CO.

SPRINGFIELD, OHIO, U. S. A.

Agents for Italy. Ing. Vaghi, Accornero & Co., Milan. Ludw. Loewe & Co., Berlin, Germany, Agents.



The Bullard Vertical Turret Lathe

It's a machine embodying the desirable features of the horizontal turret lathe and the vertical boring and turning mill. It will bore, turn and face any face-plate work that can be done on an engine lathe, horizontal turret lathe or boring and turning mill. It occupies but a third the floor space of a horizontal turret lathe of equal capacity, and requires only about a fifth the tool equipment.

BOOKLET M-602 DESCRIBES THIS MACHINE FULLY.

The Bullard Machine Tool Co.

531 BROAD ST.
BRIDGEPORT,
CONN., U. S. A.

AGENTS Marshall & Huschart Mchy Co., Chicago, Ill. The Motch & Merryweather Mchy. Co., Cleveland, Ohio. Chas. G Smith Co., Pittsburg, Pa., The C H. Wood Co., Syracuse, N. Y., Pacific Tool & Supply Co., San Francisco, Cal. Williams & Wilson, Montreal, P. Q. Chas. Churchill & Co., Ltd., London, E C., England Fenwick Freres & Co., Paris. Heinrich Dreyer, Berlin, Germany. Landre & Glinderman, Amsterdam, Holland.

Alphabetical Index of Advertisers.

Classified Index to Advertisements.

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Classified Index to Advts. (Continued).

For Alphabetical Index, see Page 36.

Classified Index to Advts. (Continued).

For Alphabetical Index, see Page 36.

The Power Behind the Superintendent

THE average shop man can run his lathe, follow his pattern, cut his die, or construct his particular piece of machinery just as well as his "boss"—yet he may plod along for years and never be a superintendent, or even a foreman. Why? Because he has not the ability to meet **difficult extraordinary** situations. He cannot direct, yet he can well do the work when directed. He has learned all he can in the shop, yet realizes he lacks something—but what? **Knowledge—the knowledge which cannot be obtained in the shop.**

¶ Theory must be combined with practice to insure the greatest results. It is this combination which distinguishes the superintendent and the foreman. They have developed their minds by acquainting themselves with the worked-out theories and hints of the leading mechanical experts of the world, and by studying the methods employed by thousands of other progressive concerns—*any man of ordinary ability has the same opportunity.*

CYCLOPEDIA of MODERN SHOP PRACTICE

¶ The greatest mechanical work ever published. Largest—handsomest—most complete. Everything explained in a plain and easy manner. Compiled from the most valuable instruction papers of the American School of Correspondence. **Consists of four massive volumes—each nearly one foot high—2,500 pages—2,000 full page plates. Large type—easy to read—bound in red morocco—marbled tops—gold stamped titles and edges.**

Half Price for 30 Days

SPECIAL PRICE, $12.00 REGULAR PRICE, $24.00

Sent express prepaid. If it meets your needs, send $2.00 within one week, and $2.00 a month for five months thereafter. We will send for the books at our expense if you do not care to keep them.

American School of Correspondence
CHICAGO

COUPON

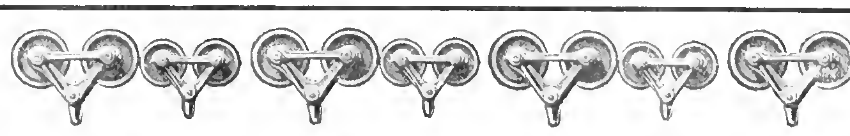
Machinery
9-07

Handbook describing over 60 of our regular Engineering Courses FREE on request.

Please send set Cyclopedia Modern Shop Practice for week's free examination. I will send $2 within a week and $2 a month until $12 is paid otherwise I will notify you to send for the books.

Name.......................................

Address.......................................



SHEPARD TROLLEYS

TYPIFY THE TROLLEY EXCELLENCES OF

Movability Adaptability Durability

Shipment from stock of 1, 3 and 5-ton sizes

The General Pneumatic Tool Company

General Office and Works, MONTOUR FALLS, N. Y.

NEW YORK, Singer Building. PITTSBURG, Machesney Building. PHILADELPHIA, Stephen Girard Building.

Classified Index to Advts. (Continued).

Engines, Gas, Gasoline and Oil.
Foos Gas Engine Co., Springfield, O.
Foss Gasoline Engine Co., Kalamazoo, Mich.
Otto Gas Engine Wks., Philadelphia, Pa.

Exhaust Heads.
B. F. Sturtevant Co., Hyde Park, Mass.

Factory Equipment.
Davis Mfg. Co., Milwaukee, Wis.
Federal Steel Fixture Co., Chicago, Ill.

Fans, Exhaust, Electric, Ventilating.
American Blower Co., Detroit, Mich.
Robbins & Myers Co., Springfield, O.
B. F. Sturtevant Co., Hyde Park, Mass.

Files.
American Swiss File & Tool Co., Elizabeth, N. J.
G. & H. Barnett Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Hayes File Co., Detroit, Mich.
Nicholson File Co., Providence, R. I.
Reichhelm, E. P. & Co., New York.

Filing Machines.
Cochrane-Bly Co., Rochester, N. Y.
Simplex Mfg. Co., New York.

Fillet Cutters.
Milwaukee Foundry Supply Co., Milwaukee, Wis.

Fillet (Leather).
Butler, A. G., New York.
S. Obermayer Co., Cincinnati, O.

Flasks.
S. Obermayer Co., Cincinnati, O.

Flexible Shafts.
Coates Clipper Mfg. Co., Worcester, Mass.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.

Forges.
Billings & Spencer Co., Hartford, Conn.
Buffalo Dental Mfg. Co., Buffalo, N. Y.
Burke Mchy. Co., Cleveland, O.
B. F. Sturtevant Co., Hyde Park, Mass.

Forgings, Drop.
Billings & Spencer Co., Hartford, Conn.
Hay-Budden Mfg. Co., Brooklyn, N. Y.
Keystone Drop Forge Wks., Chester, Pa.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
J. H. Williams & Co., Brooklyn, N. Y.
Wyman & Gordon, Worcester, Mass.

Forging Machines.
Acme Machinery Co., Cleveland, O.
National Mchy. Co., Tiffin, O.
Scranton & Co., New Haven, Conn.
Williams, White & Co., Moline, Ill.

Foundry Facings, Brushes, Barrows, Shovels, Bellows and Blowers.
S. Obermayer Co., Cincinnati, O.
Paxson, J. W., & Co., Philadelphia, Pa.
J. D. Smith Fdry. Sup. Co., Cleveland, O.

Foundry Supplies.
Goldschmidt Thermit Co., New York.
Milwaukee Foundry Supply Co., Milwaukee, Wis.
S. Obermayer Co., Cincinnati, O.
Paxson, J. W., & Co., Philadelphia, Pa.
J. D. Smith Fdry. Sup. Co., Cleveland, O.

Friction Cone Pulleys.
G. F. Evans, Newton Center, Mass.

Fuel Economizers.
B. F. Sturtevant Co., Hyde Park, Mass.

Furnaces, Coal Oil.
Burke Mchy. Co., Cleveland, O.

Furnaces, Gas.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Furnaces, Liquid Fuel.
Best, W. N., American Calorific Co., New York.

Gauges, Surface, Depth, etc.
Brown & Sharpe Mfg. Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
John M. Rogers Wks., Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
J. T. Slocomb Co., Providence, R. I.
E. G. Smith Co., Columbia, Pa.
L. S. Starrett Co., Athol, Mass.
Wells Bros. Co., Greenfield, Mass.
J. Wyke & Co., Boston, Mass.

Gears.
Arthur Co., New York.
Hugo Bilgram, Philadelphia, Pa.
Boston Gear Wks., Norfolk Downs, Mass.
F. H. Bultman & Co., Cleveland, O.
H. W. Caldwell & Son Co., Chicago, Ill.
Cullman Wheel Co., Chicago, Ill.
Eberhardt Bros. Mch. Co., Newark, N. J.
Foote Bros. Gear & Mch. Co., Chicago, Ill.
Wm. Ganschow Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Morse, Williams & Co., Philadelphia, Pa.
New Process Raw Hide Co., Syracuse, N. Y.
Philadelphia Gear Wks., Inc., Philadelphia, Pa.
Van Dorn & Dutton Co., Cleveland, O.
Werner & Pfleiderer, Saginaw, Mich.

Gear-Cutting Machines.
Becker-Brainard Milling Mch. Co., Hyde Park.
F. H. Bultman & Co., Cleveland, O.
Eberhardt Bros. Mch. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.
Van Dorn & Dutton Co., Cleveland, O.
D. E. Whiton Mch. Co., New London, Conn.

Gear Planers, Bevel.
Gleason Works, Rochester, N. Y.

Gear Shapers.
Fellows Gear Shaper Co., Springfield, Vt.

Generators.
Crocker-Wheeler Co., Ampere, N. J.
General Elec. Co., Schenectady, N. Y.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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Classified Index to Advts. (Continued).

Graphite.
Jos. Dixon Crucible Co., Jersey City, N. J.
S. Obermayer Co., Cincinnati, O.
Grinders, Portable Electrical Driven.
Chicago Pneu. Tool Co., Chicago, Ill.
Cincinnati Elec. Tool Co., Cincinnati, O.
Clark, Jas., Jr., & Co., Louisville, Ky.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mch. Co., Cincinnati, O.
United States Elec. Tool Co., Cincinnati, O.
Grinding Machinery.
B. F. Barnes Co., Rockford, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mch. Co., Hyde Park.
C. H. Besly & Co., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Diamond Mch. Co., Providence, R. I.
Gould & Eberhardt, Newark, N. J.
Graham Mfg. Co., Providence, R. I.
Hisey-Wolf Mch. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
Modern Tool Co., Erie, Pa.
Ney, R. W., Kingston, N. Y.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.
Saxon Mch. Co., Holyoke, Mass.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Star Corundum Wheel Co., Ltd., Detroit, Mich.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Walker, O. S., & Co., Worcester, Mass.
Whitney Mfg. Co., Hartford, Conn.
Grinding Machinery, Motor Driven.
Ransom Mfg. Co., Oshkosh, Wis.
Grinding Machines, Plain Universal.
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dayton Mch. & Tool Wks., Dayton, O.
Landis Tool Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Hammers, Power.
Beaudry & Co., Inc., Boston, Mass.
Niles-Bement-Pond Co., New York.
Scranton & Co., New Haven, Conn.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Williams, White & Co., Moline, Ill.
Hammers, Power, Steam and Drop.
Beaudry & Co., Inc., Boston, Mass.
Billings & Spencer Co., Hartford, Conn.
E. W. Bliss Co., Brooklyn, N. Y.
Bradley, C. C., & Son, Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Dienelt & Eisenhardt, Philadelphia, Pa.
Merrill Bros., Brooklyn, N. Y.
Niles-Bement-Pond Co., New York.
Parker Hoist & Mch. Co., Chicago, Ill.
Scranton & Co., New Haven, Conn.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Williams, White & Co., Moline, Ill.
Handles, Machine Tool.
Cincinnati Ball Crank Co., Cincinnati, O.
Hardening and Tempering.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Coes Wrench Co., Worcester, Mass.
Heading, Upsetting and Forging Machines.
Acme Machinery Co., Cleveland, O.
Ajax Mfg. Co., Cleveland, O.
Bliss, E. W., Co., Brooklyn, N. Y.
Brown, H. B., Co., East Hampton, Conn.
National Mchy. Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Williams, White & Co., Moline, Ill.
Heating and Ventilating, Dust Collecting Systems.
American Blower Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, O.
B. F. Sturtevant Co., Hyde Park, Mass.
Heating Machines.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Heaters.
American Blower Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, O.
B. F. Sturtevant Co., Hyde Park, Mass.
Heaters, Feed Water.
Stewart Heater Co., Buffalo, N. Y.
Hoists.
Volney W. Mason & Co., Providence, R. I.
Niles-Bement-Pond Co., New York.
J. D. Smith Fdry. Sup. Co., Cleveland, O.
Hoists, Chain.
Harrington, Edwin, & Son, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Hoists, Electric.
Box, Alfred, & Co., Philadelphia, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Wks., Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Yale & Towne Mfg. Co., New York.
Hoists, Pneumatic.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Northern Engineering Wks., Detroit, Mich.
Stow Flexible Shaft Co., Philadelphia, Pa.
Hydraulic Machinery.
Burroughs, Charles, Co., Newark, N. J.
Chambersburg Engineering Co., Chambersburg, Pa.
Niles-Bement-Pond Co., New York.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

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Classified Index to Advts. (Continued).

Hydraulic Tools.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.
Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Indicators.
Norton Grinding Co., Worcester, Mass.
L. S. Starrett Co., Athol, Mass.
R. Woodman Mfg. & Supply Co., Boston, Mass.

Injectors.
Jenkins Bros., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.

Jacks.
Dienelt & Eisenhardt, Philadelphia, Pa.
Watson-Stillman Co., New York.

Jigs.
B. P. Fortin Tool Co., Woonsocket, R. I.

Key-Seaters.
Baker Bros., Toledo, O.
Barnes, B. F., Co., Rockford, Ill.
John T. Burr & Sons, Brooklyn, N. Y.
W. P. Davis Mch. Co., Rochester, N. Y.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles-Bement Pond Co., New York.

Lathes.
American Tool Works Co., Cincinnati, O.
Automatic Mch. Co., Bridgeport, Conn.
B. F. Barnes Co., Rockford, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Machine Tool Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mch. Tool Co., Bridgeport, Conn.
Champion Tool Works Co., Cincinnati, O.
W. P. Davis Mch. Co., Rochester, N. Y.
Detrick & Harvey Mch. Co., Baltimore, Md.
Fay & Scott, Dexter, Me.
Fitchburg Mch. Wks., Fitchburg, Mass.
Flather & Co., Nashua, N. H.
Garvin Mch. Co., New York.
Gisholt Mch. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Greaves, Klusman & Co., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O.
Hendey Mch. Co., Torrington, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
F. E. Reed Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Brighton, Mass.
Robbins Mch. Co., Worcester, Mass.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincinnati, O.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.
Springfield Mch. Tool Co., Springfield, O.
Stark Tool Co., Waltham, Mass.
Von Wyck Mch. Tool Co., Cincinnati, O.
Walcott & Wood Mch. Tool Co., Jackson, Mich.
Waltham Mch. Wks., Waltham, Mass.
Warner & Swasey Co., Cleveland, O.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.

Lathe and Planer Tools.
Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, O.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Lifting Magnets.
Browning Eng'r'g Co., Cleveland, O.
Cutler-Hammer Clutch Co., Milwaukee, Wis.
Elec. Cont. & Supply Co., Cleveland, O.

Lockers.
Federal Steel Fixture Co., Chicago, Ill.
Hart & Cooley Co., New Britain, Conn.

Lubricants.
C. H. Besly & Co., Chicago, Ill.
Joseph Dixon Crucible Co., Jersey City, N. J.

Machine Keys.
Morton Mfg. Co., Muskegon Heights, Mich.
Olney & Warrin, New York.
Standard Gauge Steel Co., Beaver Falls, Pa.

Machine Shop Furniture.
Federal Steel Fixture Co., Chicago, Ill.
Mfg. Equip. & Eng'rg Co., Boston, Mass.

Machinery Dealers, Domestic.
Frevert Mchy. Co., New York.
J. J. McCabe, New York.
Motch & Merryweather Mchy. Co., Cleveland, O.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Vandyck Churchill Co., New York.

Machinists' Small Tools.
Athol Mch. Co., Athol, Mass.
C. H. Besly & Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., New York.
Pratt & Whitney Co., Hartford, Conn.
John M. Rogers Works, Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
J. T. Slocomb Co., Providence, R. I.
E. G. Smith Co., Columbia, Pa.
Standard Tool Co., Cleveland, O.
L. S. Starrett Co., Athol, Mass.
Syracuse Twist Drill Co., Syracuse, N. Y.
Wells Bros. Co., Greenfield, Mass.
J. Wyke & Co., Boston, Mass.

Mandrels.
Cleveland Twist Drill Co., Cleveland, O.
W. H. Nicholson & Co., Wilkesbarre, Pa.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Western Tool & Mfg. Co., Springfield, O.

For Alphabetical Index, see Page 36.

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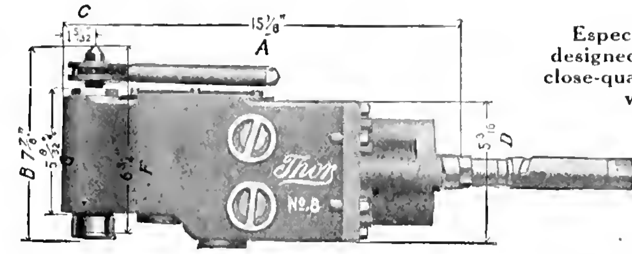

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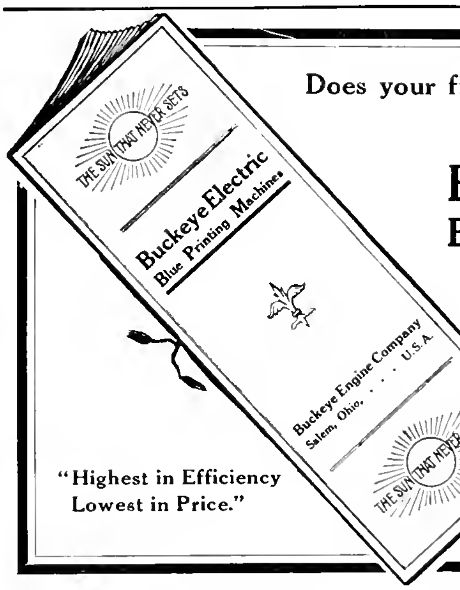

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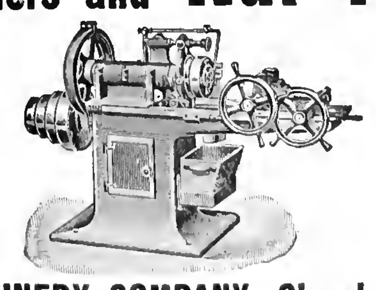

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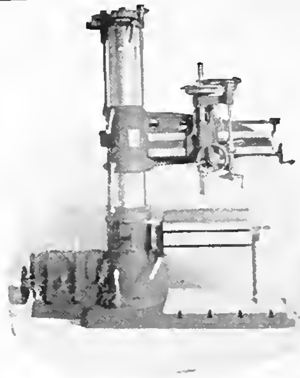

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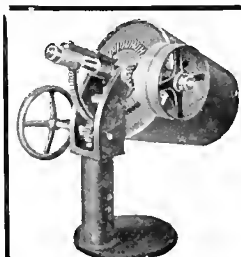

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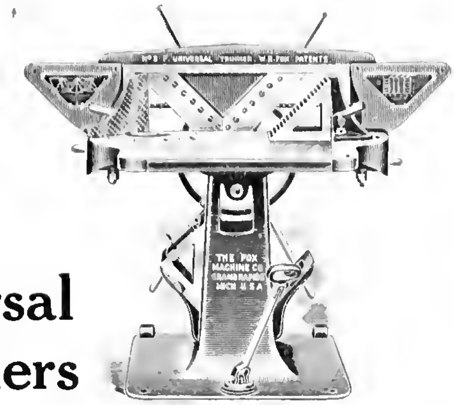

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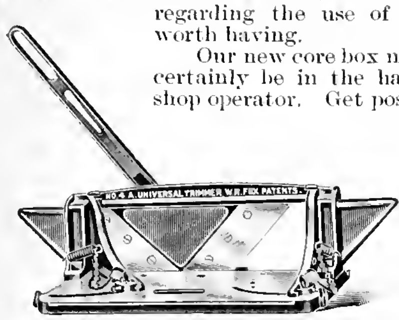

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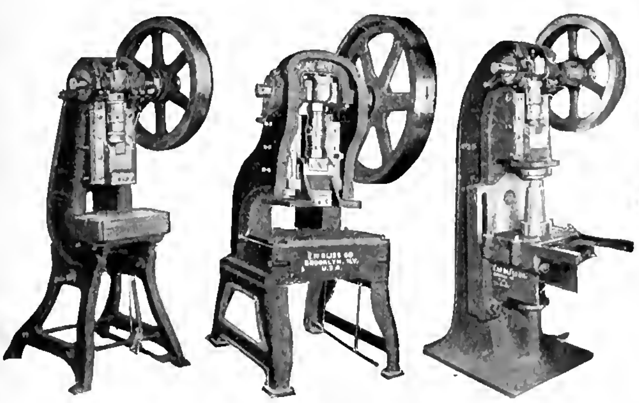

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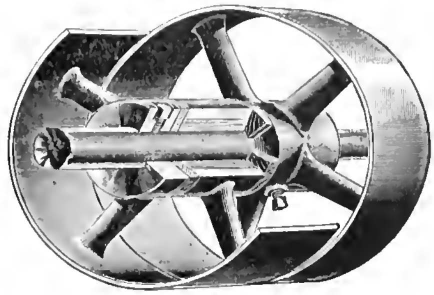

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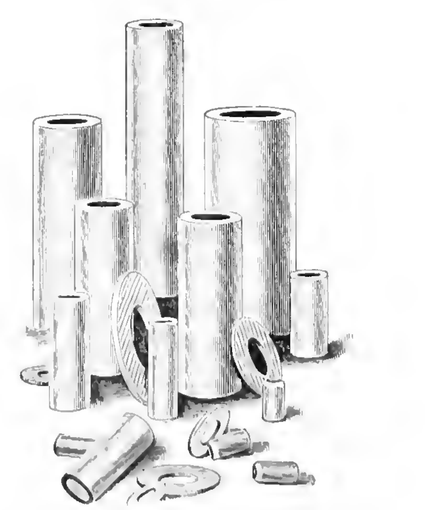

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MACHINERY.

September, 1907.

THE HEATING AND VENTILATION OF MACHINE SHOPS.*

CHAS. L. HUBBARD.†

IN the previous articles, published in the October, November and December, 1905, and the March, 1907, issue, fans and heaters have been treated in some detail without reference to their specific uses in connection with any particular class of buildings. It is now proposed to take up the methods of air distribution, and show the application of hot-blast heating to machine shops and other buildings of similar construction. In order to make the present article complete in itself, some of the data already published will be repeated in condensed form. This is especially for the benefit of those who may not have the articles above mentioned on file.

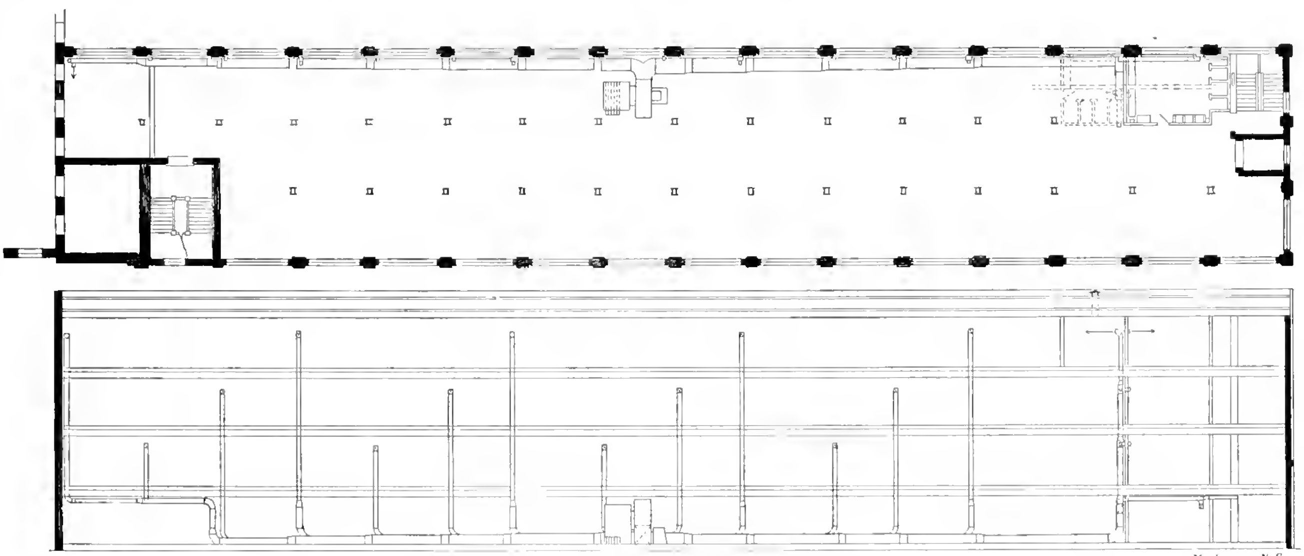
Methods of Heating.

The older method of heating a shop was by means of steam coils, either run along the walls under the windows, or supported overhead as most convenient. This arrangement necessitates a large amount of heating surface together with an extended system of supply and return piping, thus greatly increasing the liability to leaks and freezing. This method provides no fresh air for ventilation, and the distribution of heat is not of the best. When the coils are placed along the walls, under benches, it is uncomfortably warm for those working near them, and if supported overhead, the heat rises directly to the ceiling or roof, thus leaving the lower portion of the room too cold.

The most satisfactory arrangement is where the heating is done by hot air properly distributed through suitable ducts and flues. The heating surface in this case is very compact, only about one-fifth of that required for direct heating being necessary; and as the surface is grouped in a single heater, even in buildings of large size, long runs of piping are avoided. In the largest plants, or where the buildings are more or less detached, it becomes necessary to increase the number of units, but even then the pipe runs are simple compared with those necessary for direct heating. A better distribution of heat is obtained, resulting in a more uniform temperature throughout the rooms. As heating systems of this kind are usually arranged for taking a portion of their air supply from out of doors, it is possible to secure any degree of ventilation required.

General Arrangement.

The location of the fan and heater and the general arrangement of the distributing ducts will depend largely upon the construction and plan of the building. One of the simplest arrangements for a building of small size is that shown in Fig. 2. In this case a single galvanized iron uptake is carried from the mouth of the fan directly upward through the different stories of the building. At each floor the requisite number of outlets are provided at or near the ceiling level, and the air discharged toward the outer walls. In the case of a larger building it would be necessary to extend the distributing ducts horizontally from the main uptake, as shown in Fig. 3.



Machinery, N.Y.

Fig. 1. Heating and Ventilating System of the Ashcroft Manufacturing Company, Bridgeport, Conn.

Another typical arrangement is that shown in Fig. 1, which represents the plan and elevation of the heating and ventilating system installed in the shops of the Ashcroft Manufacturing Company, of Bridgeport, Conn. In this arrangement the fan and heater are centrally located in the basement near one of the side walls. Main distributing ducts are carried in both directions near the floor, and from these, vertical risers are taken off at frequent intervals and carried up to the different stories. The air is discharged into the rooms horizontally at an elevation of about eight feet from the floor. Regulating dampers are provided in each uptake for proportioning the air flow through each outlet.

Fig. 8 shows a plan and elevation of the fan and heater. The fan is of the centrifugal type, with bottom horizontal discharge. The wheel is 6½ feet in diameter, and is driven by a 7-inch by 7-inch vertical direct-connected engine. The heater is made of 1-inch pipe, twenty-two rows deep. The sections are 6½ feet wide by 8 feet high. The building is warmed by air-rotation, no connection being made with the outside air.

Figs. 5 and 6 show plan and sectional elevation of a different arrangement, as installed in the shops of the Houston, Stanwood & Gamble Co., at Covington, Ky. In this case the fan and heater are placed in one corner of the building, and the air carried across one end in an underground concrete

* The following articles on the subject of heating and ventilation have previously appeared in MACHINERY: Boiler Horse-Power for Heating and Power, February, 1903; Notes on Forced Blast Heating Systems, June, 1903; Fans, October, November and December, 1905; Heaters for Hot Blast and Ventilation, March, 1907.

† Address: 551 Boylston St., Boston, Mass.

duct. Two uptakes connect with this, running up beside columns supporting the roof; horizontal branches are then carried the entire length of the building, one on each side, passing through the roof trusses as shown. The air is discharged through short mouthpieces set at an angle to give it a downward direction, and arranged to deliver it both to the central portion and the side aisles or bays. This particular arrangement of the distributing ducts is made necessary on account of the traveling cranes which pass through the entire length of the building in each of the three sections as indicated by tracks at the sides in Fig. 5. This is a typi-

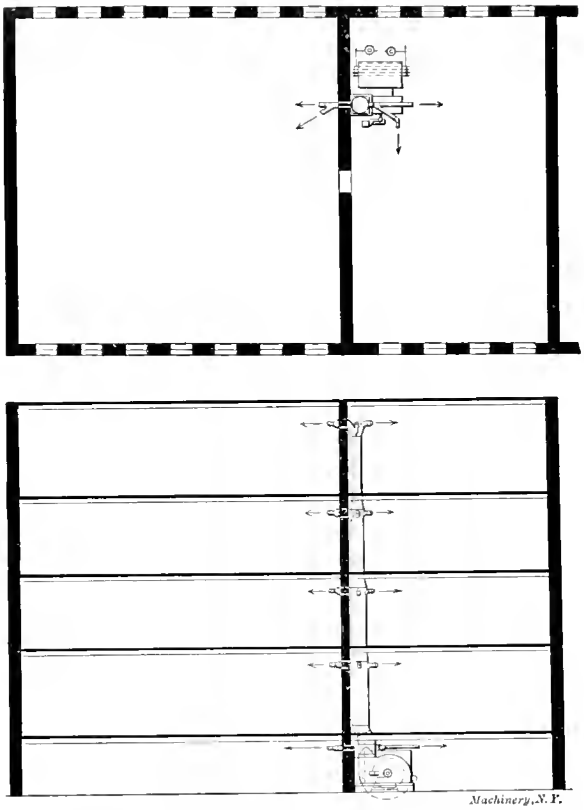


Fig. 2. Simple Arrangement of Heating Installation of a Small Building.

cal illustration of an overhead distribution, the air being discharged at an elevation of about 18 feet above the floor. The apparatus in this case also takes its air supply from the building, leakage being depended upon for ventilation.

Fig. 9 shows a plan and elevation of the fan and heater. The fan is of the three-quarter housed type, with a bottom horizontal discharge connecting with the underground duct. The wheel is 9 feet in diameter. The heater is made up of two groups, with a supply and return header at each side. It is 20 pipes deep, and has an exposed front 8 feet high by 12½ feet wide.

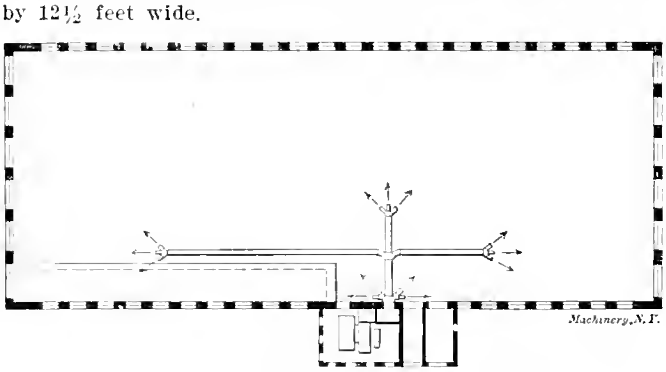


Fig. 3. Heating Installation in a Building of Larger Size than the one shown in Fig. 2.

Fig. 7 illustrates a somewhat similar arrangement, although in this case two overhead units are used, each made up of two fans and a heater, and the air is carried downward to a point about 8 feet from the floor before being discharged. The system is installed in the machine and erecting shops of the Pennsylvania Railroad Company at Trenton, N. J. All parts of the system are symmetrically arranged, which gives practically an equal resistance to the flow of air in each of the four main distributing ducts.

A plan and elevation of the fan and heater of one of the units is shown in Fig. 4. Two double inlet fans are used, with wheels 8½ feet in diameter attached to a common shaft and driven by a belted motor. The heater is made up with a double header, as in the previous layout. It is 20 pipes deep, 13½ feet wide and 10 feet high. The air is taken from

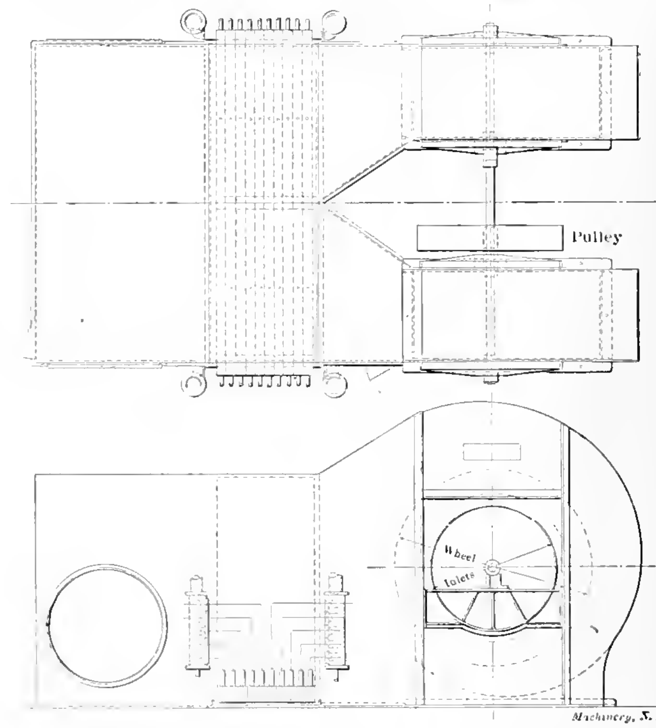


Fig. 4. Fan and Heater of Installation shown in Fig. 7.

the building, but is forced through the heater instead of being drawn through by suction, as in the other arrangements shown.

These five buildings illustrate the more common methods of arranging the distributing systems in the heating of machine shops of modern construction. They were designed and installed by the B. F. Sturtevant Co., of Boston. Having shown examples illustrating the general layout of a system for shop heating, let us now take up some of the details of design.

Material used for Ducts and Flues.

The airways are either constructed of brick or galvanized iron. In brick buildings where the heating system is planned

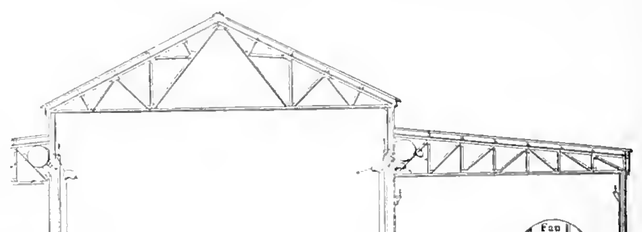


Fig. 5. End Elevation of Installation shown in Fig. 6.

before the building is constructed the flues may be most readily and economically built in the walls as the building is erected. When this is done, care should be taken to give them as smooth an interior as possible by removing all projecting mortar from between the bricks.

Underground ducts are built either of brick or concrete for the larger sizes, and generally of glazed tile for the branches. In buildings of wooden construction, and also those of brick when erected before the heating system is laid out, it is customary to use galvanized iron. This is easily worked into the required form, is light in weight, and takes up a minimum of space for a given area.

Construction of Ducts and Flues.

Great care should be taken in the design and construction of a system of ducts and flues. When a change in the di-

rection of flow is necessary, a gracious curve should be provided. For 90-degree turns, the elbow should be made with at least five pieces, and the radius of the inner side of the elbow should not be less than the diameter of the pipe. This relation between the radius of curvature and the size of pipe should hold in the case of rectangular ducts as well.

When a branch is taken off from a straight run of pipe, it should be given an angle of 45 degrees at the point of connection, and the remaining change in direction made by an easy turn. The main run of pipe is commonly reduced at each branch or take-off by an easy taper, about 28 inches in length, which can be made from a sheet of iron of standard width, which is 30 inches. Whenever the duct or pipe branches, the construction should be such as to divide the air volume into the required proportions, giving to each branch an easy change in direction, when possible. While due regard should be given to the proper proportioning of the pipe areas, it is not possible to get a sufficiently accurate distribution of air without the use of dampers and deflectors. In the case of a large number of small outlets from a main duct, the best results are usually obtained by the use of adjustable dampers in each outlet. Where there are several branches of considerable size leading from the main, it is well to place adjustable deflectors at the junction of the ducts, so that the air volume can be deflected into the branches in such quantities as may be desired. In the case of brick or concrete underground ducts, the same points relating to curves, dampers, etc., should be observed as described above for galvanized iron.

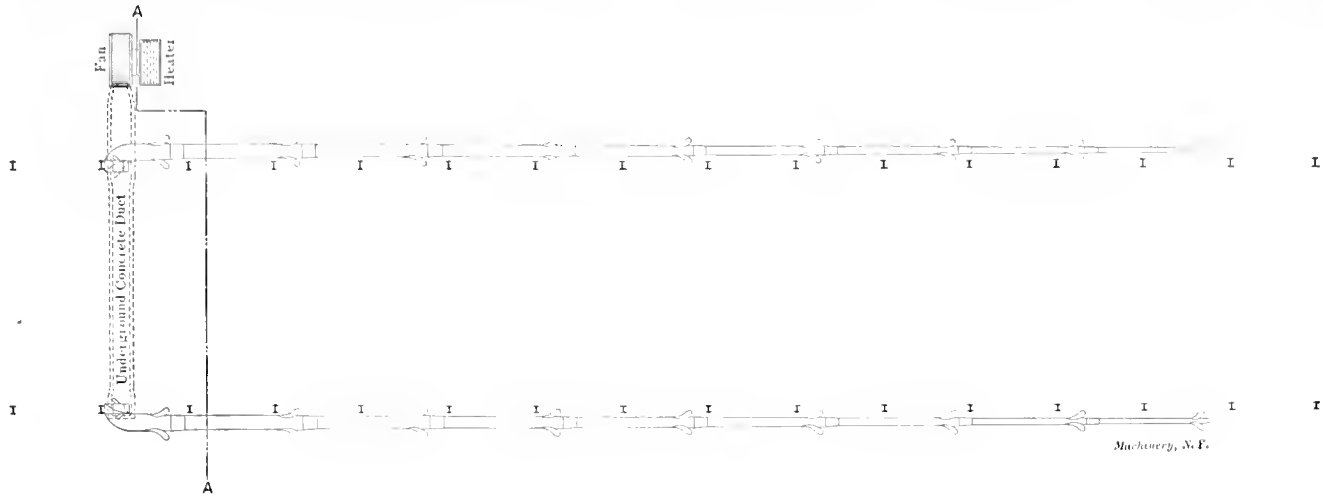
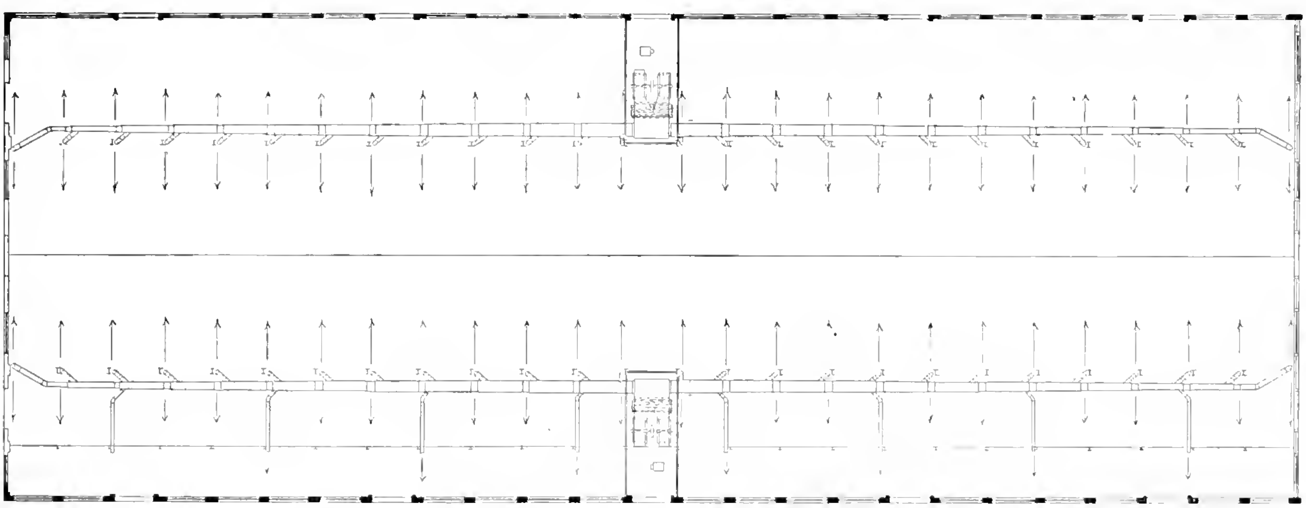


Fig. 6. Plan of Heating and Ventilating System of the Houston, Stanwood & Gamble Co., Covington, Kentucky.

Size of Ducts and Flues.

The sectional area of the ducts and flues is based upon the velocity of the air flow through them. It is a well-known fact that the frictional resistance to the flow of air through pipes increases as the square of the velocity, hence if the power required for driving the fan was an important factor, very low velocities would be required. As a matter of fact, this is generally neglected in practice, and velocities are based upon the most desirable speed of fan for this class of work, which is about 5,000 linear feet per minute tip velocity. This results in a velocity through the fan outlet of about 3,500 feet per minute. The size of the main duct is made such that the velocity commonly runs from 2,000 to 3,000 feet per minute, although some engineers make a practice of starting with a duct the same size as the fan outlet, but making a small increase in the size of the branches, so that their aggregate area shall be from 30 to 40 per cent greater than the area of fan outlet, thus bringing the velocity down to from 2,500 to 2,800 feet per minute.



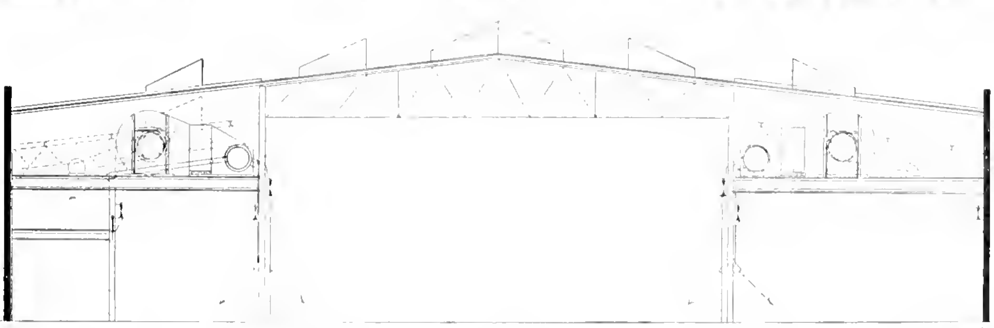


Fig. 7. Heating System of Pennsylvania Railroad Company's Machine Shop at Trenton, N. J.

It is frequently possible in shop practice to secure satisfactory circulation of the air with a limited extent of ducts by discharging it at a high velocity, as noted above, thus compelling it to continue its direction of movement for a consider-

able distance without the use of conducting pipes. It is not uncommon in such cases to force the air 100 feet or more from the outlets at a velocity of 2,000 to 3,000 feet per minute.

Weight of Iron Used.

Table I gives the gage of iron commonly used for pipes of different diameter. All sizes above 60 inches are made of No. 16 gage. If the pipe is made much lighter, particularly in the larger sizes, it will not keep its shape when supported horizontally, which results in loosening the joints and also decreasing the area of the pipe. The common practice is to make rectangular pipes of the same gage as round pipes having the same sectional area, but under certain conditions, as in the case of a thin, flat pipe, bracing is necessary to prevent sagging, even with heavy gages. When braces are used, lighter iron may be used than given in the table.

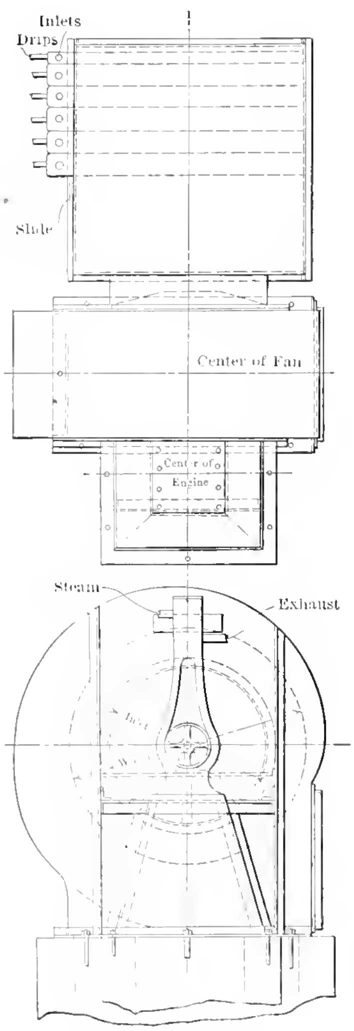


Fig. 8. Fan and Heater of Installation shown in Fig. 1.

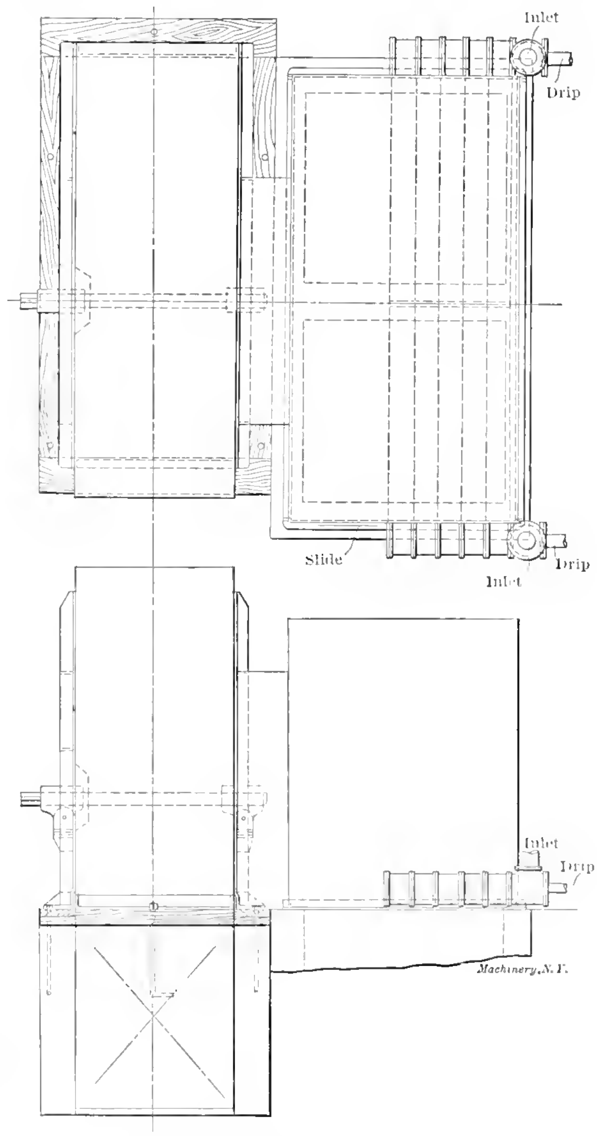


Fig. 9. Fan and Heater of Installation shown in Figs. 5 and 6.

Heaters.

The subject of heaters for shop heating was quite thoroughly discussed in MACHINERY for March, 1907. A few of the results noted there will be given in the present article together with some special reference to heating by air rotation. In shop practice, the amount of heating surface is generally expressed in linear feet of one-inch pipe for a given space to be heated. This, for average conditions, may be taken as follows. With all of the air taken from out of doors, there is generally allowed 100 cubic feet of space for one foot of pipe when exhaust or low-pressure steam is used, and 150 cubic feet with steam at 80 pounds pressure. When the building is heated by air rotation, the above figures may be raised to about 140 and 200 for low-pressure and high-pressure steam, respectively. The heater is generally made about twenty pipes deep under ordinary conditions. Heaters of this type have an efficiency of about 1,300 heat units per square foot of surface for steam at 5 pounds pressure, and an efficiency of 1,600 for 60 pounds pressure.

TABLE I.

Diameter of Pipe.	Gage of Iron
Less than 9 inch	28
9 inch to 14 inch	26
15 inch to 20 inch	25
21 inch to 26 inch	24
27 inch to 35 inch	22
36 inch to 46 inch	20
47 inch to 60 inch	18
61 inch and above	16

Volume of Air Required.

When the air is taken from out of doors for the purpose of ventilation, it may be based upon the number of occupants or upon a given number of air changes per hour. Usually the cubic contents is large per occupant and may vary considerably in different shops, so that under ordinary conditions it is best to use the former method. The air supply per occupant may be taken as about 25 or 30 cubic feet per minute, unless the building is very openly constructed, in which case the air volume may be reduced and leakage depended upon to a considerable extent. In many shops the heating is done entirely by air rotation, and leakage is depended upon entirely for ventilation. This is made possible because of the large enclosed space in proportion to the number of occupants and to the thorough mixture of the inleaking air with that which is in rotation. When this method of heating is used, the air simply becomes the medium for transferring the heat to the different parts of the building, and the volume required will depend upon the amount of heat to be transferred and the temperature to which the air is raised.

Suppose the air is returned to the heater at a temperature of 60 degrees and delivered at a temperature of 140 degrees, the total rise being 80 degrees. In cooling one degree, one cubic foot of air gives out 1/55 of a heat unit, or in cooling 80 degrees will give out $1/55 \times 80 = 80/55$, or 1.4 heat unit. Therefore, if we divide the total amount of heat to be supplied in a given time, expressed in heat units, by 1.4, it will give the volume of air to be rotated in that time, assuming, of course, that it is cooled through 80 degrees during its passage through the room.

The heat loss from the building may be computed by any of the common methods in use, or the size of the heater may first be computed by the method already given, and the heat given off taken as the equivalent of the heat lost. Referring to Table II in MACHINERY for March, 1907, we find that a heater twenty pipes deep with steam at 5 pounds pressure will raise the temperature of air from 0 to 140 degrees, and has an efficiency of 1,300 heat units. Steam at 5 pounds pressure has a temperature of 227 degrees. The average temperature of the air passing through the heater is $\frac{0 + 140}{2} =$ 70 degrees, hence the difference in temperature between the steam and air is $227 - 70 = 157$ degrees. In case the air is rotated, its average temperature is $\frac{60 + 140}{2} = 100$ degrees,

and the difference between the steam and air is 227 — 100 = 127 degrees. The efficiency of a heater varies directly as the difference between the temperature of the steam and air; hence, in the second case, with the air rotated, the efficiency would be 157 : 127 = 1,300 : x, and x, the efficiency in this case, would be approximately 1,100 heat units. Then the square feet of surface in the heater multiplied by 1,100 will be the heat given off per hour, and this divided by 1.1 will give the cubic feet of air to be moved per hour by the fan.

Size of Fan.

The required size of fan for moving any given volume of air may be taken from Table II, which also gives the approximate speed and the horse-power required for driving the fan.

TABLE II.

Nominal Size of Fan, Height of Housing in Inches.	Diameter of Fan Wheel in Inches.	Width of Housing in Inches.	Ordinary Speed Giving ½ Ounce Pressure.	Cubic Feet of Air Delivered per Minute.	Horse-power of Engine to Drive the Fan.
30	18	9	870	1000	½
40	24	12	580	1600	1
50	30	15	465	2600	1
60	36	18	390	4500	2
70	42	21	333	6000	2½
80	48	24	293	8000	2½
90	54	28	260	11000	4
100	60	32	233	12500	4
120	72	43	195	21500	7
140	84	48	167	28600	9
160	96	48	147	31800	10
	108	54	130	40400	13
	120	60	117	51000	16

The speeds given in the table are for ½ ounce pressure; should it be desired to deliver the air under a higher pressure, in order to force it a long distance from the outlets, it would be necessary to increase the speed of the fan somewhat, depending upon local conditions.

* * *

NOVEL HIGH COMPRESSION OIL ENGINE.*

ALFRED GRADENWITZ.†

In oil engines of the injection type, the liquid fuel, as is well known, is injected in an atomized condition immediately into the combustion chamber, where an immediate ignition and combustion takes place owing to the heat from the previous compression of the air. Now the main difficulty met with in the construction of these motors has been to conveniently atomize the fuel, and to produce the highly compressed injection air which is indispensable for the process. This air must be raised to a pressure superior to the terminal compression in the clearance space, in order to pick up the oil and spray it in a finely subdivided state into the combustion chamber.

In the Trinkler motor, recently brought out by Messrs. Körting, Ltd., this is neatly and efficiently effected by the aid of a small auxiliary "injection" piston, which, towards the end of the compression, separates a certain amount of compressed air from the clearance space, driving it with the necessary injection pressure through the injection nozzle, along with the oil contained in the latter, into the combustion chamber. The construction of this motor will be understood by reference to Figs. 1 and 2, and the accompanying description.

The Trinkler engine is a single-action four-cycle motor, with a working stroke on every alternate rotation, the working process being as follows: The piston A, on the out stroke, draws in through the inlet valve pure air, which it compresses on the return stroke to a pressure of from 28 to 30 atmospheres. At the same time the compartment D, situated in front of the injection piston C, will be filled with compressed air from the cylinder through a compensating channel E, which connects this compartment with the clearance space. Through channel G, at the same time, the compressed air flows into injection nozzle F, which permanently communicates with the compression chamber through a relatively small injection aperture. A charge of liquid fuel is stored in the chamber of the injection nozzle F, being supplied to it through a valve I from a fuel pump, connected with the valve through the conduit K.

Toward the end of the compression stroke, the injection piston C (owing to the difference in pressure on the front surface turned toward the compression compartment and the annular surface formed by the piston rod of the injection piston) will be rapidly moved outward, sliding across the channel E, and separating the air in compartment D from that in the cylinder. With the further motion to the left of piston C, this amount of air is forced from the chamber D through conduit G and injection nozzle F back into the combustion chamber again. As the mouth H of the nozzle is relatively narrow, while the motion of the piston C is extremely rapid, the injection air will be highly compressed, and will traverse the injection nozzle F of the fuel-storing compartment with a

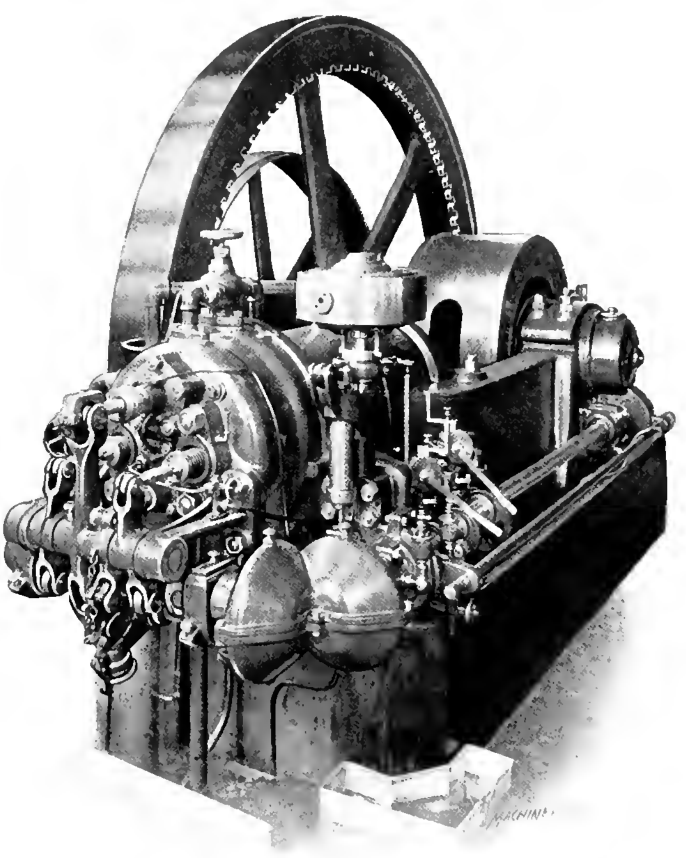


Fig. 1. The Trinkler Oil Engine.

high speed, so as to carry along the fuel and to throw it in a state of finely atomized spray into the combustion chamber, in which, owing to the high temperature of the compression, the fuel will be ignited, whereupon piston A will be thrown forward, transferring the impulse to the crank. Shortly before the end of the working stroke, the outlet valve will be opened by the valve gear, and the products of combustion will be exhausted on the return stroke of the piston. During the subsequent advance of the piston, the suction and further working processes will be repeated as above described.

The motor is started by means of compressed air, supplied to the engine through a mechanically controlled valve N. The compressed air reservoir used for this is charged from the compression space of the engine itself through a charging valve (not shown) cooled by the jacket water.

The high thermal efficiency of oil injection engines is generally known. As regards the other features of these motors, the absence of any igniting or heating apparatus should be noted, as well as the perfect elimination of soot and smell, due to the perfect combustion of the fuel. As regards their ease of operation, and the safety and elasticity of the service, these engines may be said to equal those using gas fuel, while

* For further information on internal combustion engines, see the following articles previously published in Machinery: The Oil Engine, September 1898; The Commercial Advantage of the Oil Engine, June, 1899; An Interesting Engine, May, 1899 Internal Combustion Engines and the Diesel Principle, September, 1901 Patents in their Relation to the Gas Engine and the Automobile, January, March, and May, 1906; Oil Engines, August, 1907; The Johnston Crude Oil Engine, August, 1907.

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far excelling from the former point of view the steam engine. One of the main special advantages of the Trinkler motor is the simplicity of the injection apparatus, which is free from any valves and special pressure reservoirs. The motor, thus, is free from any part requiring to be packed permanently against high pressure. As the fuel pump has not to work against high pressure, the ease of regulation of this motor is especially remarkable.

The most valuable feature of this novel engine is its extremely low fuel consumption, both with full and partial loads. According to tests made by Prof. E. Meyer, of the Charlottenburg Technical Institute, a 12-horse-power motor of this type showed in permanent operation a consumption of 0.4863 pound Russian crude naphtha per hour and effective (metric) horse-power. The minimum heating value of the crude oil in question was found to be 9,863 thermal units per kilogramme. The engine thus used up 2,180 thermal units per effective horse-power hour, corresponding to a thermal fuel efficiency of 29.2 per cent. This is the more remarkable, as the consumption of fuel with half load was found to be only 7½ per cent higher than with full load, that is to say, 0.524 pound per hour.

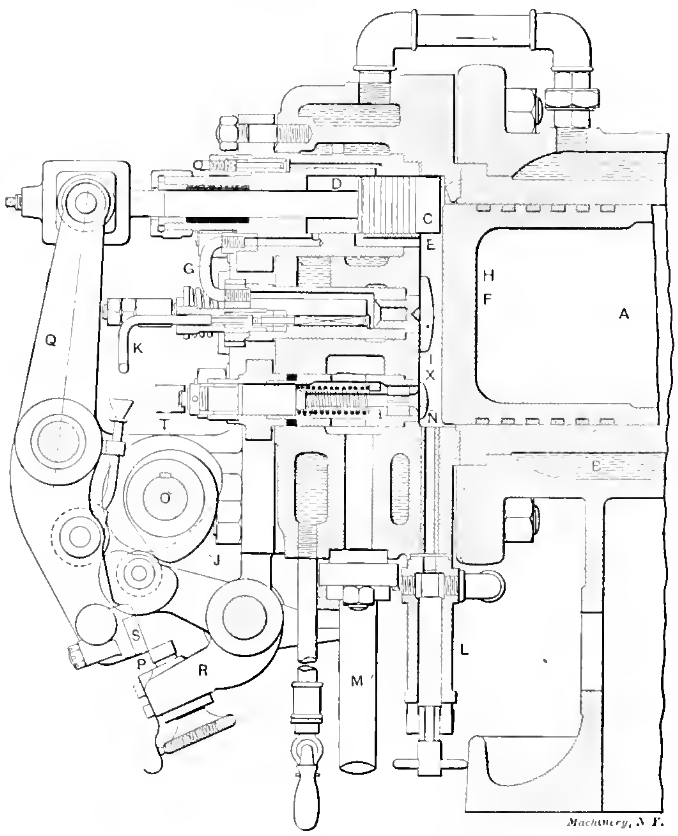


Fig. 2. Cross Section through Oil Injection Mechanism.

[Two or three other points of interest besides those mentioned by Dr. Gradenwitz, may be noted from a survey of the cuts. The auxiliary piston *C* is evidently moved to the right positively, by arm *Q* and cam *T*. It is then held in this position by the engagement of latch *P* against the hardened block *S* at the lower end of lever *Q*. As piston *A* approaches the end of the compression stroke, at the proper moment cam *J* presses down lever *R* and latch *P*, releasing lever *Q*, and allowing piston *C* to move to the left as described, under the influence of the pressure in the compression space *X*. On the release of lever *Q*, the spraying of the fuel and its consequent ignition take place almost immediately. Owing to this, the time of ignition can be regulated by changing the time of release of the lever *Q*. This is done by making latch *P* adjustable by the knurled thumb screw shown. The speed of the engine is regulated by the action of the governor on the fuel pump, which is thus made to furnish a greater or less charge to the nozzle, as may be required.—Editor.]

* * *

A brass much used in marine vessel construction, because of its excellent resistance to the corrosive action of sea water, is 1 part tin, 39 parts zinc, and 60 parts copper.

EDUCATION FOR INDUSTRIAL WORKERS.*

A PLEA FOR A MACHINE TRADE SCHOOL.

ARTHUR D. DEAN.†

There are several movements now on foot for the establishment of trade schools. One is that initiated by the schoolmaster. He states that boys do not remain in school long enough, and that some scheme of education must be devised whereby they will remain after the legal limit imposed by the compulsory attendance laws. He claims that they leave school at 14 and waste two years drifting along lines of work which do not give them an economic hold on the industrial life. I regret that the schoolmaster advocates for these boys only manual training when I believe that he should propose trade training for them. I regret that he impresses upon the public that the public school does not and will not teach a trade. He states that the shop work in the schools is to teach only the mechanical principles underlying the trades, and these merely for their educational value. Only 6 per cent of 2,500 graduates of our manual training high schools have become mechanics.

Need of a New Type of Trade School.

This result may justify the existence of the manual training high school, and at the same time it strongly points to the need of another type of school which will teach the youth of our land to become *first-class mechanics.* I believe it is the proper function of the school official to advocate a type of school which in its purpose frankly and openly states that it can and will fit a boy for a good workman at a chosen trade. Our head workers must come from the ranks if we are to get the best work out of these workers. To eliminate the chances for promotion which give a worthy purpose for ambition and foresight by taking into our industrial system foremen and superintendents outside of the ranks is to crush the workers, and eventually kill the industrial system. The phrase "room at the top" must not lose its significance through closing the entering door by taking into the industrial system too many men trained outside the industrial ranks.

Among the objections to trade schools is that they cannot teach a trade, and that the only place to learn a trade is in the shop. I believe that this statement is unfair, as the few trade schools which exist have demonstrated that a trade can be taught as a part of an educational system, and the graduates have gone into the shops and made good. I do not claim that they can learn all that concerns a trade in any school. Neither do they learn all there is to a trade in a shop. It is a self-evident truth that no man learns all that there is to a trade or profession, no matter where he receives his training nor how long he practices it. It seems to me that definite organized instruction in the use of various tools and machines in a trade school will turn out workers superior to those who, like Topsy, simply "grew up" in such manufacturing establishments, which take no pains to give systematic instruction to their young workers.

Why an Ideal Trade School can Develop Better Mechanics than the Shop.

Let us consider some of the reasons why a trade school can render better service than the average shop in developing skilled mechanics.

1. The school can help make a profitable workman in a shorter time by giving him, under instruction, legitimate shop practice in the work of the trade. Definite practice in the work of the trade from the very beginning in a school is a far different proposition from sweeping, piling castings or running errands for several weeks or months in the shop.

2. The school can give a series of graded lessons, general and fundamental, upon which other work may be based, and future efficiency more certainly developed. The lack of sequence in the ordinary shop work becomes for the average boy merely routine work, and he flounders around.

* The subject of industrial education and kindred subjects has been treated previously in the following articles in Machinery: Technical Education, January, 1901; Technical Education, December, 1903; Contemporary Technical Education, January, 1905; Factory Education, December, 1905; An Experiment in Industrial Education, January, 1906; An Experiment in Industrial Training, September, 1906; A Step Toward Increased Facilities for Industrial Education, December, 1906; Vital Needs of Evening Schools for Industrial Workers, January, 1907; Apprenticeship Education, February, 1907; Unique Experiment in Technical Education, March, 1907; Promoting Industrial Education, May, 1907.

† Address: 167 Tremont St., Boston, Mass.

3. The school can give the opportunity to do a task over and over again until it is done right, the opportunity to study each problem closely and deliberately. In a shop there is little chance to try again. The work must be thrown away. A "call down" in a shop can never take the place of *definite instruction* in a school.

4. The school can give a broader, more intelligent idea of the relation of the parts to the whole. The beginner learns the dependence of one part on another. The tendency to keep a cheap grade of labor doing one thing may make a first-class operator, but if we expect our bright boys to respond to an unusual problem, they must have a chance to practice all the usual operations of production.

5. In the school the instruction is direct and personal, given by one who is selected not only because of his superior qualities as a workman, but because of his ability to teach. The instruction in the average shop is haphazard and accidental, given by a foreman who is already harrassed by a multiplicity of details.

6. The school comes nearer to taking the place of the shop as it approaches the commercial standards of the shop. The incentive of the commercial demands of the shop will emphasize the value of time. A clear conception of how a piece of work should be done is necessary at the outset to avoid a waste of time.

Municipal Authorities Slow to Respond.

To hope that municipal authorities will take the initiative with reference to trade schools is expecting too much, for unfortunately some politicians only see the popular mind of the people through the eye of the labor leader, and labor leaders are opposed to trade schools. There will also be difficulty in disposing of the finished products of these schools if they are under municipal auspices. In order that the work may be of a thorough, practical sort, it must illustrate actual trade conditions. The parts must be assembled into a complete machine in order to illustrate all the commercial processes. When these machines are complete, they must be disposed of in the market. If we bear in mind the past experience of some state reform schools which have attempted to dispose of their products and have been prevented from so doing, and finally have given up their industrial and trade work, one can readily see that the disposition of the finished product becomes a real and serious problem.

Private Trade Schools Needed for Purpose of Illustration.

We need a few trade schools to serve as practical illustrations of what they are capable of doing. We need schools which can practically answer the statements that a trade can be learned in a school, and that trade schools are a benefit to the working man. We must show what a trade school is like. I believe that these schools must pass through the same experience which was undergone when cooking, manual training, and kindergarten schools were established. They were introduced at first under private auspices, and demonstrated their value before they were accepted by the mass of the people. I am a believer in the theory that *private initiative creates public enterprise*, and that no better service can be done than to educate through private trade schools the public conscience to the point where it will see some practical examples of their value. In the preliminary development the trade school movement will go forward only when it is a private enterprise. These schools must have the interest of the manufacturer. They must have his suggestions. He has been the largest factor in industrial development. He recognizes that the trade school can substitute definite systematic instruction for the haphazard, uneconomic training in those shops where no special effort is made to train industrial workers. Practical men know that special education for a trade, accompanied by training in mechanics, mathematics, science, and precepts of clean living, will serve as a basis for stable equilibrium for the industrial world, now so often upset through industrial strife.

The two points to keep in mind in all this discussion of trade schools are first, the American boy who is desirous of an opportunity to learn a trade, and second, the establishment of a school which will give him such training.

Naturally you want to know what sort of a definite proposition I can present, and so, as an illustration, I offer the following suggested outline for a trade school preparing students for the machine trades.

Should have no Other Name but Trade School.

In regard to its nomenclature it must be called a trade school. It must not be called an industrial school or a preparatory school for the trades. Its name should not cover up the character of the work which it intends to do. It should in its very name define the nature of its proposed work. There should be no hesitation in calling it just what it is.

Schools not to Create Class Distinction.

Naturally the question arises, what class of students will be taken into the school. The students should be recruited from any class wherein an individual feels that a knowledge of a trade will be of value to him. In all probability the great majority of recruits would come from the rank and file of workers, and the whole atmosphere of the school should be such as to make them feel that its work was for their benefit. It must be a school which will instil in the minds of the boys the idea that they are going to become workmen, and good workmen at that, and that if they are good workmen they may become superintendents and foremen. It must avoid starting them out with the idea that they are to be superintendents and foremen immediately upon graduation. It should awaken in them a desire to be *good workmen*.

School Schedule Same as Shop Schedule.

The school should run eleven months in the year, fifty hours a week, or in other words should imitate the hours and holidays of the factory. The hours and working days being practically the same as those in the shop would teach the students habits of regularity which they must learn in actual employment. I would suggest that the month of August be taken as a shut-down period. This does not imply a vacation, but rather an opportunity for making necessary repairs for next year's work. Boys in the school who need money should be hired to do this repair work.

Should be Open both Day and Evening.

The school should be open both day and evening, although whether such a school could be run successfully for two kinds of work depends entirely upon its organization. To run it successfully both day and evening would require practically a double force of instructors. This, however, is a detail in organization. The day class should be composed of boys who have been secured with a great deal of care as regards mental and physical fitness for the future work which they are to do. They should be taken into the school for a trial period of three months. They should be set at work the very first thing on a job which will test their ability to do mechanical work. Sweeping floors may demonstrate a boy's ability to sweep, but it will not point out to the school managers his ability to make a good mechanic.

The school should be open evenings for young men who wish to advance themselves in their trade. Few, however, will care to spend their evenings in the same class of work in which they are engaged during the day. This departure will reach fellows of a different caliber, whose qualities of mind and mechanical ability cannot be judged by written entrance examinations. Their fitness to enter the school can be determined by a practical examination in one or two pieces of shop work and a five minute interview in order to size up their characteristics.

Kernel of Instruction should be Shop Practice.

The kernel of instruction should be shop practice and book learning which fits in with the machine trades. This means that the major subject will be machine shop practice. It also means that there must be some mechanical drawing, pattern making and molding. The course of instruction will not be complete unless there is academic work in English, business forms, mechanics, arithmetic and physical science. The instruction in all this work must be carried on expressly to meet the needs of the machine trades. It must not be taken from elaborate text-books in general arithmetic, general English, etc., but rather from courses which have been carefully worked out by practical men who know what topics are of vital importance to a boy who is to be engaged in a machine trade. Incidentally, there should be inculcated in the minds of the students a power to reason on social and economic

problems along lines which will give them tnat proper point of view so necessary in these days of the relation of their individual responsibility and life's responsibility. To so teach boys that they may earn good wages at a trade, and at the same time neglect to give them that training wnich will enable them to live wisely while earning that money, is a false position for any school to take. However, I should not have social and economic work incorporated as a set course. It is rather a point to be considered as entering into all the instruction.

Tuition Fee should be Charged.

There should be a tuition fee both for the day and evening work. It is the experience of most of us, not only in school work, but in all concerns of life, that what we pay for, we value, and that what we get free is not always appreciated. Provision should be made for those applicants who cannot pay the necessary fee by some scheme of scholarship fund, provided for by those patrons of the school who are enough interested in boys to take care of them financially while in school. When the boy goes to work the loan can be returned to the scholarship fund or to the one who lends the money.

Work Must be Done in a Commercial Manner to Command Respect.

In order that the trade school shall command respect, it must do work in a commercial manner, which is another way of saying that it must do commercial work, and if it does this, it will be possible to pay wages to the boys. The boys should be paid wages after the trial period, and these wages should be increased regularly according to the ability which each boy shows. It may seem strange to propose a tuition fee and at the same time return it in the form of wages. The tuition fee is a guarantee of business earnestness of the boy, his parent, guardian, or patron. Paying boys a small wage on a rising scale is done simply because we must recognize the moral value which accrues to a young man when he finds that his advancement in his trade is appreciated. It puts a practical aspect on the school's methods, and affords immense satisfaction to the young man when he receives definite compensation for his labor through an advancing scale of wages due to increased efficiency.

There is no one who ought to be more qualified to teach these young mechanics than a competent, practical man. That there would be some difficulty in obtaining such a teacher I will acknowledge, and in itself it forms an argument for the need of trade schools when we are obliged to acknowledge that not even a few men can be founa who are competent to be teachers in a trade school. A successful instructor for a school of this character must be a man of exceptional ability. He not only would be required to know his trade fully, but would have to combine with that knowledge ability as a teacher, tact and diplomacy, which perhaps would fit him for positions paying far higher salaries than would be given to the instructor of a trade school. At all events the instructors will determine the success or failure of these schools.

As the school is to be a trade school and is to teach machine trades, it must for the very sake of this aim make the work of practical character, or, in other words, must make work of a commercial character, of the sort which will take a boy into real commercial life. This involves the turning out of products which will satisfy in points of accuracy and skill the demands of the industry. It means the doing of things according to commercial processes. It means that time and material consumed must be considered. In fact the school must imitate schemes of "works management" in order that the graduate may immediately fit into the economics of shop life. Throughout all the work the students must be taught the economy of material, tool-room methods, shop kinks and cost accounts. Frequent excursions should be made to the neighboring manufacturing establishments.

Lines of Work that a Trade School Can Do.

In order that the school may best illustrate commercial methods it should make things to sell. It is understood that these things are not made merely to sell for the sake of financial return, but to illustrate completely the commercial requirements of a trade. The school can do the following lines of work.

1. The making of some regular line of machinery like a bench grinder, speed lathe, bench lathe, arbor press, etc., which will illustrate to the boys how jigs and fixtures can be used in modern manufacture when a number of machines are turned out at one time. This procedure should serve to keep the shops going at all times regardless of the other lines of order work which might be on hand.

2. The school should also take repair work for small concerns. It can buy up second-hand machinery and repair it. This sort of work gives a splendid opportunity to turn out all-round workmen. It will serve to illustrate re-babbitting, re-surfacing, making of patterns from broken parts, making of castings directly from the iron form, etc.

3. Doing order work in the making of jigs and fixtures for various manufacturing concerns. This special order work can be done by older and brighter boys who understand the reading of drawings and the laying out of the work. It will give them an opportunity to use their ingenuity in discriminating between that work on the jig which must be done very accurately and that which can be slighted without damage to the commercial efficiency of the jig. It will teach the boys how to figure on the cost of jobs, etc.

4. The making of patterns and castings for special orders of outside firms.

There is not a city of any size having machine trade industries which cannot have such a school, providing there are enough resident manufacturers who have an interest in the American boy as well as an interest in the future of American industry, and providing these manufacturers and public spirited men will put their hands down into their pockets and give the money necessary to start the school.

Can such a School be Made Self-supporting?

I suppose the school can never be completely self-supporting, although some men who think they know what they are talking about (and two of them have tried it) say that it can be made self-supporting. Personally, I think it would be well to allow considerable financial leeway. It is not necessary to wait until these interested men can gather up money enough for a fine building. All that is necessary is to lease for a term of years a building suited to the purpose. There are manufacturers of iron working machinery in the country who will be glad to contribute liberally to the equipment. It is not necessary to have a power plant in the building, and thus the cost of an expensive portion of ordinary school equipment can be saved. Purchased electric power will suffice for the first few years. I have estimated that a yearly expense of $20,000 will give instruction to 200 boys in the day school and 275 boys in the night school. This sum includes administrative and teaching force, rent, heat and light, and materials.

Certain features of this school probably prohibit it being, at its inception, a part of the public school system, but some such plan as I have presented can open the way for larger public enterprise.

* * *

A CURIOUS RESULT OF HIGH TARIFF.

A curions aud amusing illustration of the effects of protection, says the *Mechanical Engineer* (London), was afforded a few days ago by a deputation of American watch dealers which waited upon the president of the Board of Trade. It appears, from their statements, that the four great watch manufacturing companies of America are banded together with a view to keep up prices. This, of course, is possible in the United States, with its tariff wall, but in the British market, where the trust has to meet Continental competition, the goods are supplied at much lower prices than those which rule in the United States. As a consequence of this, American retailers have been in the habit of purchasing their supplies of American watches in the British market at an increase of 5 per cent on the invoiced price, and then reshipping them to the United States, where, being of American manufacture, they are not liable to duty. In this way the trust finds itself undercut in its own market by its own goods; and it would appear from the statements of the deputation that the trust is making desperate efforts to prevent this undercutting. British traders are informed that they can only be supplied on condition that they undertake to forfeit £5 if they allow a watch to get into the hands of an American dealer. But it is difficult to see how such efforts can prove effective, or why American dealers should seek assistance in this country (England)!

MAKING SWISS FILES IN AMERICA.—1.*

The plant of the American Swiss File and Tool Co. of Elizabethport, N. J., was described in MACHINERY, April, 1905. In that article the processes used at the time were quite fully described and illustrated. Since then the business has grown rapidly, manufacturing methods have been improved, and a new and enlarged factory has been built. These changes have offered so much new material of interest and value that it has seemed decidedly worth while to describe the plant again, touching lightly on the points fully treated in the previous article, and going more into details on other points.

Most of the tools a machinist or tool-maker uses have nothing of great difficulty or mystery connected with their making. Any good tool-maker, if necessity demands, would feel competent to make for himself a twist drill or a micrometer caliper, even though these tools are seldom made for personal use, but are almost invariably purchased. There is a different feeling in the case of files, however. A good file is treasured by the man who owns it. He looks upon it with friendliness, and respect as well, for while he can buy files by the thousand (good, bad and indifferent) from people who make a business of making them, he would not be able to make one himself. The matter of cutting those fine teeth, so well formed and regular, and yet so delicate as to be in the finer sizes almost invisible, and afterwards the hardening of the tool to the proper degree without injuring the sharpness of these multitudes of little teeth, he feels to be beyond the range of his ability. File makers, in general, have rather catered to this idea of mystery. Their shops are surrounded by high fences and the visitor gets no further than the office. Their catalogues are full of little hints and suggestions of the complicated special machinery used, and the secret and mysterious formulas and processes followed in the annealing and hardening departments.

* The following articles dealing with file manufacture and machinery have previously appeared in MACHINERY: File Cutting Machine, October, 1903, engineering edition; The Making of Fine Toolmakers' Files by American Methods, April, 1905.

In the face of all this mystery, Mr. E. P. Reichhelm determined to embark in the manufacture of files, and not merely in the making of ordinary hand machinists' tools of the coarser grades, but those of finest and most delicate shapes, in which the Swiss makers had hitherto held undisputed preeminence. We have had occasion before now to refer to cases where men have resolutely embarked in work of this mysterious nature with not much more than determination and common sense, and nothing in the way of tradition and prejudice, to guide them. This is still another case in point. While it is not to be supposed that Mr. Reichhelm developed his methods of manufacture full-fledged from the start, and that there is no further improvement possible in his methods, yet he has already succeeded in building up a business which is limited in extent only by his ability to get good workmen, and he is to-day turning out a product which at least equals the best that is produced abroad.

As stated in the previous article, Mr. Reichhelm was led to undertake this business from his previous experience in the hardening and annealing of steel. He is the moving spirit of the American Gas Furnace Co. which has made a specialty of that work for many years, so his experience is a most valuable one. The one point of superiority of European hand-cut files over American machine-cut ones, is in the matter of uniformity in size and sharpness of the teeth; the advantage of the hand-cut file is not due, as many have supposed, to a quite different condition—the irregularity of the spacing. The reason why it is possible, usually, to obtain more regular shaped teeth from hand cutting done by skilled workmen is that, until now, the best methods of annealing with the best and most uniform tool steels produced uneven results. In the machine, whenever the chisel comes to a hard spot, a shallower cut is made; when it comes to a softer spot the cut is deeper, and the tooth sharper. In cutting a file by hand, however, the workman can follow the effect of his chisel, striking it harder in the hard spots, and lighter where the metal is soft. With these conditions understood, it is evident that uniform annealing is the prime requirement for

Fig. 1. Plant of the American Swiss File and Tool Co., Elizabethport, New Jersey.

producing a first-class file of the high grade required by tool-makers and watch-makers. On his skill and experience along this line Mr. Reichhelm based his confidence. The present extent of the business, and the rate at which it is growing, tend to show that his confidence was not misplaced.

The Buildings.

The plant is located on an irregular tract in Elizabethport, N. J., bounded by streets on three sides. The place was specially selected on this account with the idea of having it always open to light and air. As shown in Fig. 1, the main building is two stories in height. Back of this is a one-story building, with a power plant at the eastern end. The lay-out of the departments is shown in Fig. 2. The rough stock is received at the shipping door at the front of the main building, whence it is carried through into the stock and cutting-off rooms in the one-story extension. From here the cut stock is taken to the blacksmith shop, thence to the annealing room, the grinding department, the stripping department and the blank storage, all as indicated in the cut. The teeth are formed by either of the two processes of cutting or etching, as will be described later. The cutting is done downstairs at the north end of the building, while the blanks which are to be etched are taken to the room directly above the cutting department on the second floor. After cutting, they go to the hardening room near the center of the main building, and from there are taken to the packing room directly above. It will be seen from this that there is a complete circuit with no loops or backward movements, from the receiving of the raw material to the delivery of the finished goods. All the rooms are of ample size for an equipment of three times the present capacity, so this increase can be made without disturbing the arrangement shown. Having the general plan of the works thus before us we can follow the process from step to step.

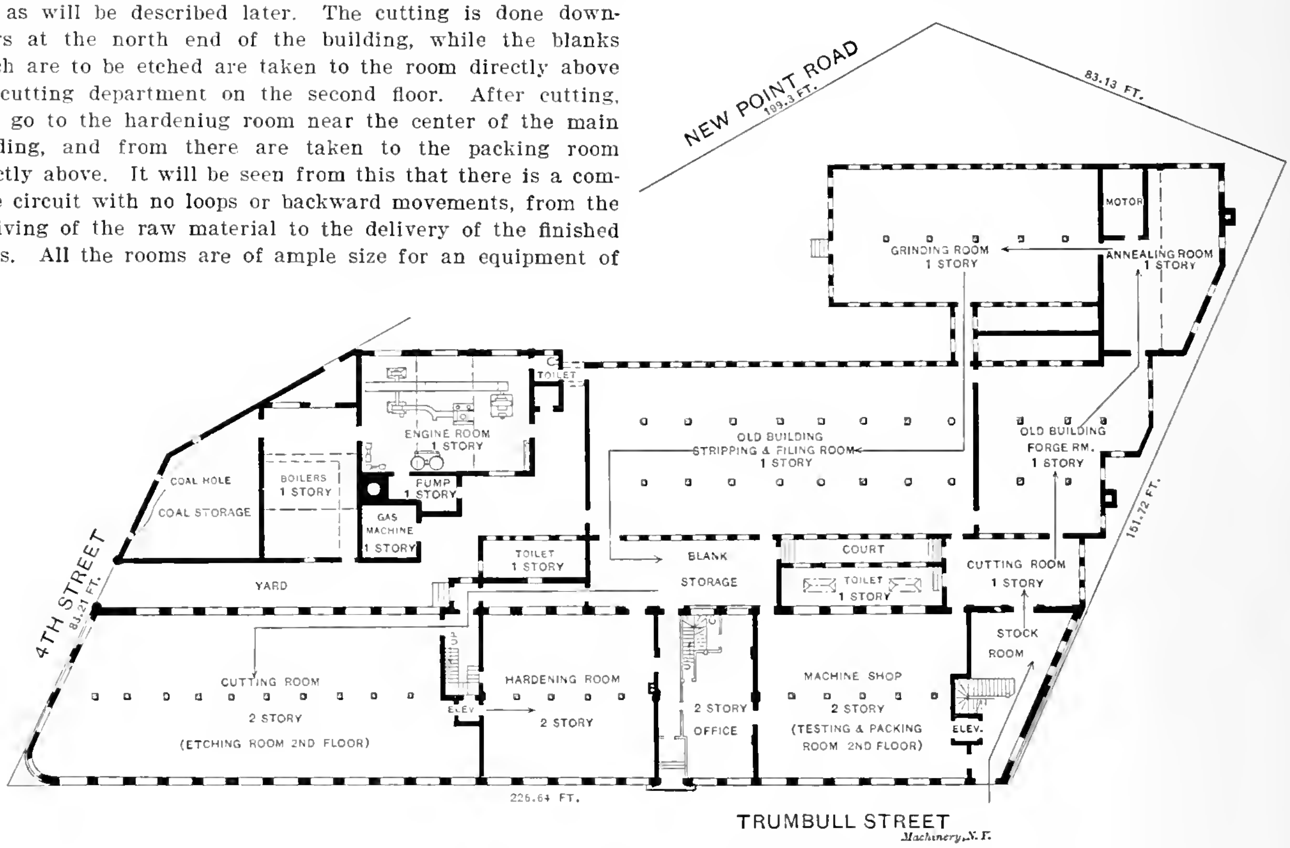


Fig. 2. Plan of the Shops of the American Swiss File and Tool Co., showing Route of the Work.

Blanking and Forging.

The raw material received comes in various forms, generally of the exact shape of the "amid-ships" section of the file. In a few cases sheet stock is used for thin flat files of various forms and uniform thickness. These are punched in blanking dies under a punch press. For half-round, round, square, barrette and other styles, stock of appropriate shape is cut in the shears to the proper length. From here it is taken to the forging department. In this room, aside from the noise which is unescapable where power hammers are used, the thing which first strikes the visitor is the clearness and comparative coolness of the air. There is none of the dust and smoke usually associated with the operation of forges. This, of course, is due to the use of gas furnaces with their smokeless, dustless fuel in the place of the coal forges ordinarily found. A furnace stands at the side of each smith, and a very small and inconspicuous affair it is. A fire-brick lining in an iron casing with four legs to stand on, with piping and burners for gas and air, is all there appears to be to the apparatus. The furnaces are quite small, being only just wide enough for the length of the files being heated. The uniformity of the temperature throughout the whole area of the furnace is remarkable, there being no difference visible to the eye in color anywhere within the heated area. The first operation is the forming of the tang. Then the blanks are reheated, and worked to the proper shape under dies. The face of each die is made in three sections. That on one side of the die is used for breaking down the stock, that on the other side for bringing the edge of the stock to approximately the right dimension, while the central section is used in forming the sides or faces of the blank. The workmen handle these with great rapidity and dexterity, changing the work quickly from one side to the other, and back again to the middle, turning and re-turning the blank until it is formed to the shape determined by the dies. It is impossible to form some shapes correctly under the power hammer. The barrette, and the point of the half round, for instance, have to be finished by drop forging. The former shape of file is struck up from a round blank. The amount of scale found around the hammers and drop presses is very small—an indication of the non-oxidizing quality of the flame in the gas furnace. Each workman has a private supply of cool air from the pressure service which he can direct on himself in whatever way best suits his convenience and comfort.

Annealing.

As stated in the beginning, Mr. Reichhelm considers that the secret of fine file making lies primarily in the matter of annealing. This is the next operation after the forging. One might expect from the importance of this part of the work to find elaborate precautions taken. One would suppose that the blanks would be packed with charcoal in cases having covers luted with fire-clay; such precautions are generally considered necessary to get even heat and freedom from oxidation. Nothing of this kind is seen in Fig. 3, which shows a general view of the annealing room. There are here, as shown, a number of gas furnaces of various sizes. The big ones are for big files, and the little ones, for little files. The blanks are packed in the furnaces, unprotected, exposed to the direct action of the flame. The precaution of packing them with the tangs outward and the points inward is taken, but otherwise the metal is not shielded in any way. The flame is lighted and kept going at a temperature of 1,500

degrees Fahrenheit, for about four hours, ordinarily; then (the doors being carefully closed) the work is allowed to remain over two nights and one day, until it is perfectly cool. There is a very slight, thin scale resulting from this heat treatment, but no pitting or corrosion. What little scale there is comes from air which leaks in during the cooling process, the flame itself being absolutely non-oxidizing. It would be difficult to find a better commercial test of the excellence of the fuel gas process used, than this.

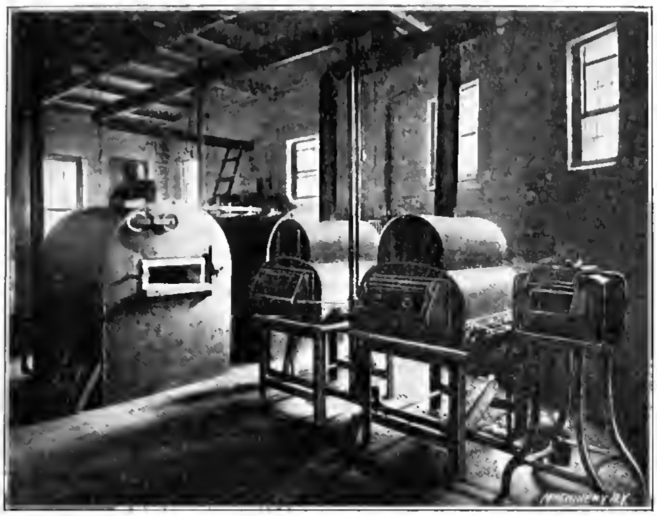


Fig. 3. A View of the Annealing Room.

The uniformity of annealing obtained is the result of the fulfillment of several simple conditions. There must be a constant quality pressure and amount of gas, and a constant pressure and volume of the air mixed with it. With these mixtures determined, the nature of the flame and the temperature will be constant. Too much cannot be said about the composition of the flame. The vaporized naphtha used is free from injurious elements, such as sulphur, and is provided with a slight under supply of oxygen, so that there is no danger of any of that element combining with the metal. The furnace must be so built that the heat is evenly distributed throughout the whole of the interior. The file on the bottom of the pile must be heated under the same conditions as the one at the top. The ends and sides of the furnace must each be subject to exactly the same degree of heat. With these points carefully looked out for, and with the matter of time of exposure to the heat attended to, it only remains to provide the proper steel to be able to get the same results day in and day out, in the annealing of file blanks. For the finest work, Mr. Reichhelm has been unable, sad to say, to find an American steel which will give good results. The best that can be obtained varies in composition and resulting hardness from one bar to another, and from point to point in the same bar. The necessity for uniform hardness in the annealed blank involves in this case the necessity of patronizing a foreign firm instead of a home industry.

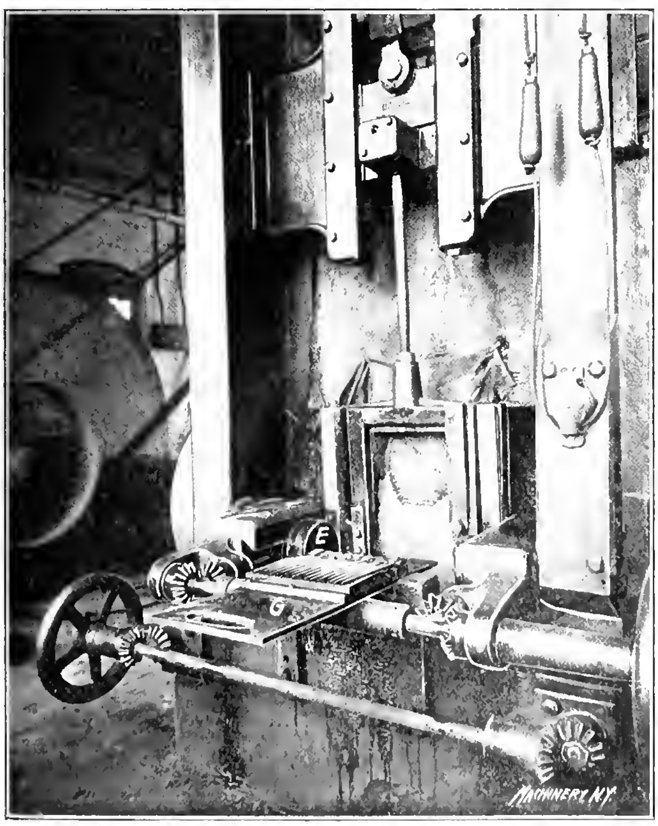


Fig. 4 Machine for Grinding Flat Files.

Grinding and Stripping.

In order to form sharp teeth of uniform height, it is necessary to provide a smooth, even surface to start with. To produce this surface the blanks are first ground and then draw filed or "stripped." The files with flat cutting surfaces have them ground on automatic machines. A near view of one of these machines is shown in Fig. 4. At *B* is a grindstone of large diameter, revolved at suitable speed and traversed slowly back and forth by a cam, to equalize the work across its face. The files, shown at *A*, are ranged in a row, with suitable backing and supports, on the flat plate or holder *G*. This frame or holder is dropped in a vertical position in slide *D*, and pressed up against the face of the revolving grindstone *B* by the rollers *E* and the adjusting screws operating them. The mechanism which reciprocates slide *D* up and down, so that the blanks are ground from one end to the other, is then started. In the machine shown this motion is operated by an adjustable crank at the top of the machine, connected to crosshead *C*. The matter of grinding a frame full of blanks is one of a few strokes and a few seconds only. The wheels used are five or six feet in diameter, and means are provided in the machine for keeping them constantly trued.

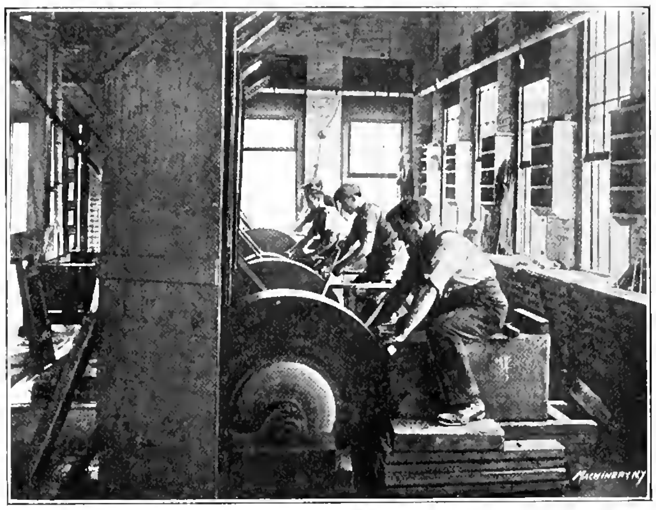


Fig. 5. Grinding Round File Surfaces by Hand.

This machine grinding is done on flat surfaces only. On round surfaces the grinding is done by hand. In Fig. 5 may be seen workmen engaged in this operation. Most of them are working on half-round files. As may be seen, they are sitting on wooden blocks in front of large grindstones, all except the man in the foreground, being astride of a board with a steel hook or holder on the end of it, which holds the work down to the wheel. The weight of the workman thus furnishes the pressure needed for grinding. The smallest and finest files, whether flat or round, are ground by hand on carefully trued wet emery wheels.

The surface produced by this grinding is not quite good enough for the purpose desired, so the finishing touches are given by draw filing or "stripping." Both flat and round surfaces are finished in this way, and all burrs are removed from edges and corners. The men work at benches, with the blanks supported by their ends in wooden blocks. For stripping flat surfaces, a new machine has recently been introduced. One of these is shown in Fig. 6. The blanks, *B*, are held in suitable holders. These holders are pressed upward

by levers and weights against the cutting files E in slide D. This slide is moved in and out for the stroke, being carried by saddle G, which slides along ways on the under side of overhanging arms $H H$. It is also traversed back and forth to distribute the action over the full length of the cutting files by a drunken screw at F. The work is relieved from contact with the files on the back stroke. It might be expected that it would be a matter of some difficulty to avoid "pinning" in a case of this sort. This is not often met with, however. In the first place the files are made specially for the purpose, with plenty of clearance. Besides this, the pressure on the work is unvariable, being determined by the weights and levers mentioned. A workman, even though expert, might momentarily use more pressure than he ought to on his file, so as to cause it to tear the steel and get the broken particles wedged or "pinned" in the teeth. With a machine, having once found the conditions necessary to avoid this trouble, these conditions may be preserved indefinitely, and the trouble practically avoided. When it does occur, perhaps once a day, the blank thus injured has to be reground and refiled.

Flat files are ground and stripped on all of their cutting surfaces before going to the cutting department. On files having sharp edges, however, such as half-round, barrette, and other shapes, this course is not followed. On a half-round file,

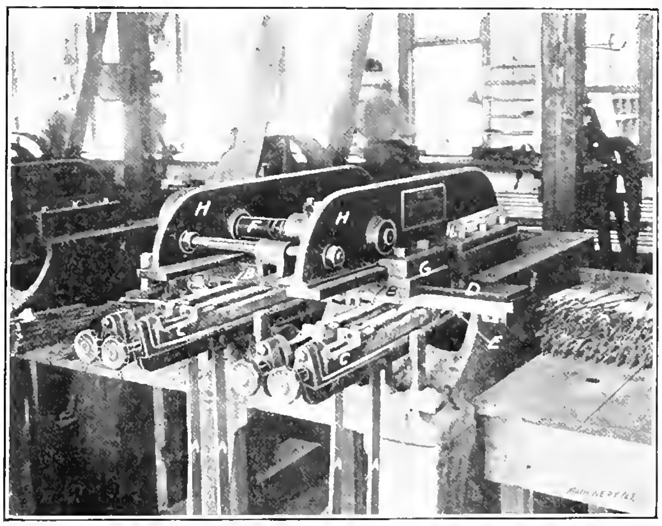


Fig. 6. Stripping Machine for Draw Filing the Blanks.

for instance, the flat surface is stripped; then the first cut is taken over it, and it is returned to the stripping room to have the round surface finished, which then, in turn, is treated with the first cutting; after this the second cut is given to the flat side, and then to the round side. This working first on one side and then on the other, on a blank having sharp edges, is necessary to keep the teeth perfect in shape clear out to the edge. If one side were finished completely before the other was touched, the edges would be turned over, away from the surface last finished, making a sharp burr on the side which was cut first.

After the blanks have been stripped, they are taken to the blank storage, awaiting their turn at the cutting machines. The cutting of the teeth and the hardening of the file will be described in a succeeding installment of this article.

* * *

USING A CANNON FOR DISSOCIATING A SHRINK FIT.

A contributor to the *National Engineer* of May, 1907, describes a device which is well known and much used in railroad shops. Machinists in other lines, however, are probably not so familiar with it. This device is a cannon which is used as a sort of desperate remedy, when everything else has failed, for knocking out crank-pins, axles, and other shrunk and rusted joints. It is somewhat dangerous to use, so should not be ordinarily employed.

The writer referred to says in substance: "On a recent visit to the plant of the Kittaning Iron & Steel Co., I witnessed a novel method for removing broken crank-pins from crank disks. A crank-pin 8 inches in diameter had broken off close to the crank disk, and several men had spent considerable time in a futile effort to drive out the remaining part of the broken pin. Finally the chief engineer ordered one of the men to bring in the cannon. It was made, as shown in Fig. 1, of a piece of steel with a 2-inch hole bored in it longitudinally. A ¼-inch hole for the fuse and a 2-inch hole for the escape of the gases of combustion after they had completed their work, were drilled in from the sides as shown, to meet the center hole of the device.

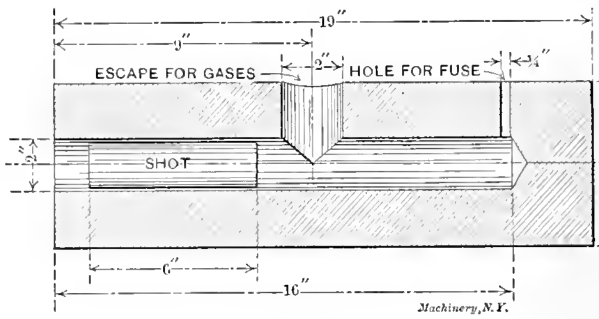


Fig. 1. Cannon for Machine Shop Use.

"The cannon was loaded with about ½ pound of giant powder. A piece of 2-inch case-hardened steel called the 'shot' was inserted in the opening, and all was firmly chained to the disk, as shown in Fig. 2, with the opening of the cannon directly over the crank-pin. A fuse was inserted in the small opening, and ignited. All hands then sought places of safety. A heavy explosion soon followed, after which an examination showed that the pin was still intact in the disk, notwithstanding that the shot had embedded itself in the pin ¼ inch. The cannon was again loaded, fastened in position, and fired, which loosened the pin so that a few blows from a heavy hammer drove it out of the disk.

"When the cannon was fired, the smoke and flame caused by the explosion followed the shot until the latter passed the 2-inch opening on top, through which they escaped to the atmosphere.

"The engineer informed the writer that the cannon had been in use over a year, and that during that time it had been used over sixty times for removing keys, pins, etc., without an accident, except on one occasion. On this occasion the fuse hole was by mistake turned toward a window, and the resulting concussion destroyed the glass and sash of the latter.

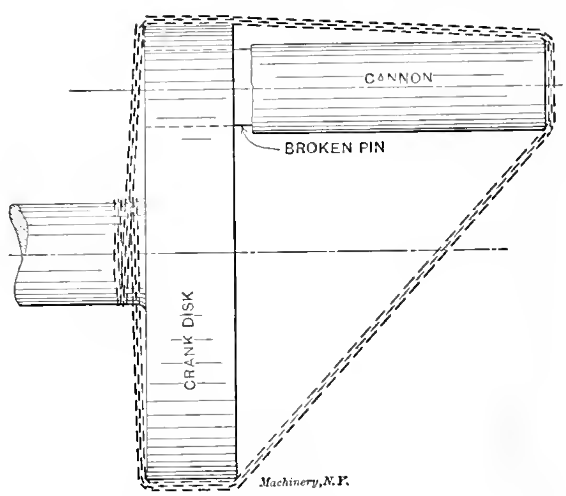


Fig. 2. Cannon Charged and Aimed, ready for Firing.

When the shot was first made, it was only hardened for about two inches of its length. The result was that the impact of its striking the object to be removed, enlarged its diameter so that it stuck in the bore of the cannon and had to be bored out."

* * *

One of the causes of a serious less in the transmission of compressed air is pumping the air of the engine room rather than air drawn from a cooler place. This loss amounts to from 2 to 10 per cent.

METHODS OF DELICATE TURNING.

There are some kinds of work that do not come up in the ordinary run of business, but which are met with occasionally, and are liable to give considerable concern when they do appear. It is not often, for instance, that one has to turn a 3/16 inch steel rod 26 inches long down to a diameter of 1/16 of an inch. This delicate operation may be performed easily when called for, if it is gone about in the right way. *Engineering*, of London, in the June 7, 1907 issue, contains a description of the way in which an Englishman, Mr. Henry Lea, of Birmingham, performed this operation. The stock, which is of mild steel 3/16 inch diameter as stated, was placed in a $5\frac{1}{2}$-inch (11-inch swing) lathe, one end being caught in a chuck on the spindle, and the other supported by the tail-center. It is necessary of course to use a follow-rest to do turning of any kind with such slender work. The follow-rest used is shown in Fig. 1. It is composed of a bracket *A* fastened to the rear of the carriage. This bracket carries a vertical slider *B*, which again carries a horizontal slider or steady plate *C*, which is hardened and has notches in the four corners, of sizes to suit rods of different diameters. The bolt *D* locks plates *B* and *C* to the bracket. *E* is an arm pivoted at *F*, and provided with a coiled spring *G*, the effect of which is to press the nose *H* against the under side of the revolving rod in a slightly inclined direction, as shown by the arrow, thus keeping the revolving rod in contact with the two sides of the notch in plate *C*.

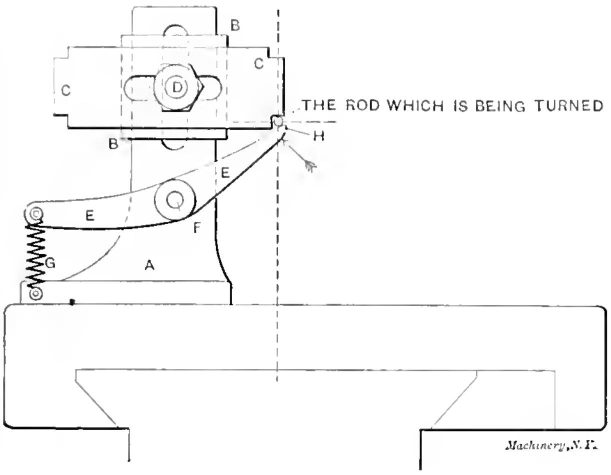


Fig. 1. Follow-rest for Delicate Turning.

A portion of the rod next the chuck was turned true, and the steady was adjusted to it. The turning tool (Fig. 2) is a very keen side-tool, facing away from the chuck, and its cutting edge was normal to the axis of the rod, so that the tool had no tendency either to force the rod inwards or to draw it outwards. The point of the tool was set about 0.02 inch in advance of the steady plate. The speed and feed were about 250 revolutions per minute and 180 turns per inch of travel. Oil was kept dropping on the point of the tool. The first few cuts were about 0.002 inch deep; the final cuts were 0.0005 inch each.

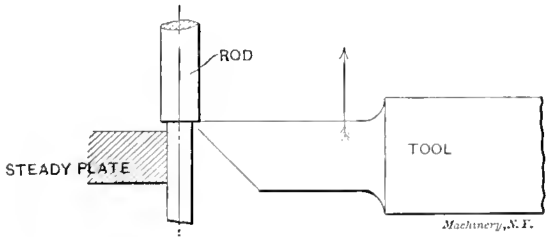
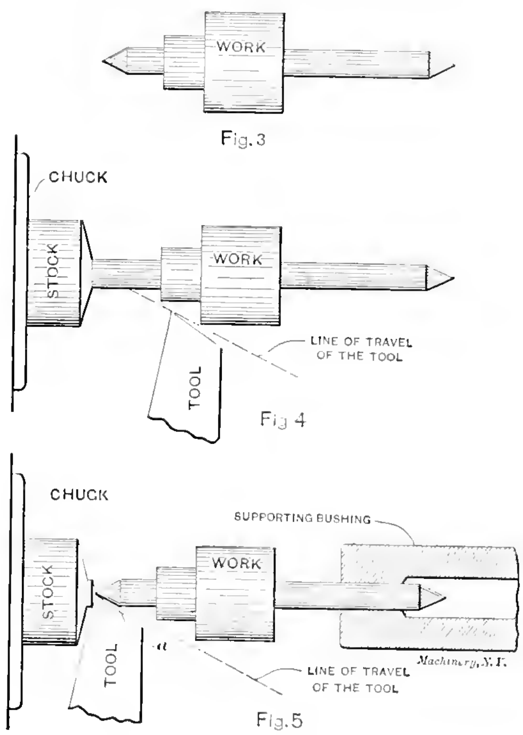


Fig. 2. Setting of Tool and Steady Plate.

It is most important in work of this kind that the cut should be taken in a direction away from the chuck, and that the pressure of the tail-center be so light as not to bend the rod by end compression. As the work proceeds, the rod becomes so slender that the steadying effect of the tail-center is practically nil, and two loose wooden supports standing on the lathe-bed were used instead, having V-notches for the rod to revolve in. As the saddle receded from the chuck, one, and then both, of the supports were transferred to the left-hand side of the saddle, so as to support the portion already turned. The time required for each cut was $12\frac{1}{2}$ minutes. The first one or two cuts removing the skin left the rod rather crooked, but it became more and more straight after each succeeding cut, and the last cut left it practically straight.

There is another delicate lathe operation of a different kind which is well known to clock and watch tool-makers, though perhaps not to machinists engaged in heavier work. Supposing it were required to finish complete from the bar in one chucking a small pinion blank, such as shown in Fig. 3. It is apparent, after looking the piece over, that the only difficulty in making it thus, lies in getting a sharp point where the bearings are, on each end of the piece. It will at once be seen that the end next to the solid bar from which the piece is formed will break off, under the pressure of the cut used in forming and separating this end, a considerable time before the tool point has reached the center, thus leaving a blunt, ragged pivot where a sharp, smoothly finished one is desired.

The way in which this operation is performed is shown in Figs. 4 and 5. The work is cut off, and the point shaped in such a way that the entire pressure of the cut comes on the bar of stock held in the chuck, and none of it on the work. The outer end of the work is held in a supporting bushing in the lathe or screw machine in which the work is being done. A tool of the shape shown is used for severing the work from the bar. This tool, it will be noticed, is not fed straight in, but is moved in on an angle that will form the pivot to the right shape. Face *a* is beveled so that it clears the work entirely. The point is quite sharp. The cutting action is thus entirely on the face of the stock, and the work is not subject to any pressure whatsoever. Being supported by the bushing in the rear, even the weight of the piece has no tendency to sever it before it is cut away by the tool, and when it is finally separated it is still supported in the same position as before the separation took place. This method of doing the work saves the separate operation which would otherwise be necessary for pointing the pivot at the end where it was severed from the bar.



Figs. 3, 4 and 5. Finishing a Pivot at the End where it is Cut from the Bar.

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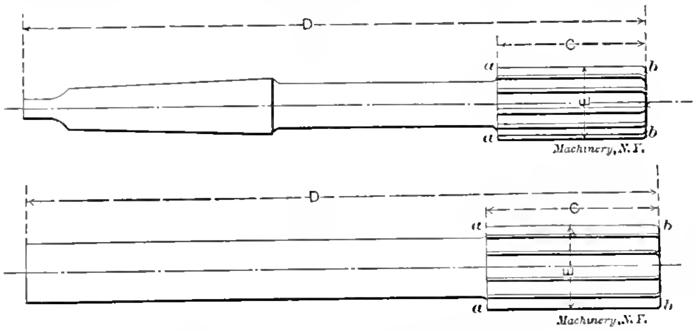
The *Brass World* calls attention to the fact that too much phosphorus in a phosphor-bronze bearing causes the tin to liquidate in the form of "tin-spots," which are nearly as hard as steel. Such "tin-spots" cut the axle and cause the bearing to heat.

REAMERS.—2.

ERIK OBERG.

Fluted Chucking Reamers.

Fluted chucking reamers are used in machines for enlarging holes as well as for finishing them smooth and true to size. These reamers are usually provided with either straight or standard taper shanks, as shown in Figs. 6 and 7. They are not intended for removing a large amount of stock, 0.005 to 0.010 inch being all that should be required. The cutting edges are along the lines *a b*. At the front end of the reamer there is a slight round as shown at *b*. It is a well known occurrence that reamers held rigidly at the end of the shank are liable to cut holes somewhat larger in diameter than their own size. In cases where a very accurate hole is desired, reamers used for chucking purposes should therefore be somewhat smaller than the final size of the hole to be reamed, be



Figs. 6 and 7. Fluted Chucking Reamers.

held in a floating reamer holder, and after having reamed the hole by a chucking reamer, it should be finished by a hand reamer.

Number of Flutes.

The number of flutes with which fluted chucking reamers should be provided is given in Table IV. It will be noticed that the pitch of the cutting edges, or the distance from cutting edge to cutting edge, is in some cases a trifle smaller than in the case of hand reamers. The same fluting cutters as are used for hand reamers are used for fluted chucking reamers also. The radii of the small rounded corners at the end of the flutes at *b*, Figs. 6 and 7, should be 1/32 inch for sizes up to and including ¾ inch diameter, and 1/16 inch for larger sizes.

TABLE IV. NUMBER OF FLUTES IN FLUTED CHUCKING REAMERS.

Size of Reamer.	Number of Flutes.	Size of Reamer.	Number of Flutes.	Size of Reamer.	Number of Flutes.
1/8	6	7/8	8	1 3/4	12
1/4	6	1	8	2	12
3/8	6	1 1/8	10	2 1/4	14
1/2	6	1 1/4	10	2 1/2	14
5/8	8	1 3/8	10	2 3/4	16
3/4	8	1 1/2	10	3	16

TABLE V. NUMBER OF MORSE TAPER SHANKS FOR FLUTED CHUCKING REAMERS.

No of Morse Taper Shank.	Sizes of Reamers, inches.	No. of Morse Taper Shank.	Sizes of Reamers, inches.
1	1/8 — 1/2	4	1 9/32 — 1 3/4
2	17/32 — 7/8	5	1 25/32 — 3
3	29/32 — 1 1/4	..	....

Dimensions of Fluted Chucking Reamers.

The principal dimensions of consequence are the over-all length and the length of the cutting portion of the reamer, denoted *C* and *D*, respectively, in Figs. 6 and 7. The over-all length of the straight shank and the tapered shank chucking reamer are usually made the same. The Morse standard taper shank is nearly always used on this class of reamer. The sizes of reamers and the corresponding Morse taper shanks with which they are provided are given in Table V.

The length of the cutting edges *C* and the total length *D* may be determined from the formulas

$$C = E + \tfrac{3}{4} \text{ inch, and}$$
$$D = 4E + 4 \text{ inches,}$$

in which formulas *E* denotes the diameter of the reamer. Dimensions figured from these formulas are given in Table VI.

The diameter of the neck between the fluted part of the reamer and the taper shank, Fig. 7, should be about 1/32 inch smaller than either the diameter of the reamer, or the diameter at the large end of the shank, depending upon which of these two diameters is the smaller, so that the grinding wheel will clear the necked portion both when the reamer part and the shank part are ground.

The diameter of the straight shank should be from 1/16 to ¼ inch below the size of the reamer for sizes up to 1½ inch diameter. For larger sizes the shank may be proportionally smaller, so that the shank for a 2-inch reamer is 1½ inch, and for a 3-inch reamer, 1¾ inch.

Rose Chucking Reamers.

The rose chucking reamer is not intended for finishing holes smoothly or true to size, but is merely used for enlarging cored holes, and is so constructed as to enable the removal of a considerable amount of stock. As shown in Fig. 8, the cutting edges are beveled to a 45-degree angle at the end of the reamer. The teeth are cut on the end only, so as to give a cutting edge to this 45-degree bevel. At every other cutting tooth there is a groove cut the full length of the reamer body. This groove serves the purpose of providing a way for the chips to escape, and forms a channel for lubricants to reach the cutting edges. The groove, however, does not provide for any cutting edge on the cylindrical part of the reamer.

Formerly rose reamers were often made without these

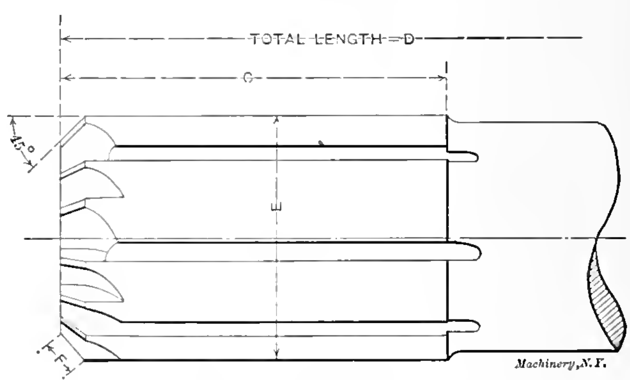


Fig. 8. Rose Chucking Reamer.

grooves; the body of the reamer was solid with the exception of the cuts made to form the teeth at the end, but this construction caused a great deal of trouble on account of the reamer binding in the hole to be reamed. The binding effect is overcome by cutting the grooves for every other tooth, as mentioned. In fact, there is no reason why this groove should not be cut for every tooth, excepting that it would increase the cost of making the tool, and not being imperative, this cost is, of course, properly avoided.

Rose chucking reamers are slightly back tapered on the cylindrical body, that is, the diameter at the point with the beveled cutting edges is slightly larger than the body where it joins the shank. This provision also aids to prevent the tool from binding, in the hole being reamed. The back taper ought properly not to exceed 0.0005 inch per one inch, although it is usual in the manufacture of these reamers to make this taper as much as 0.001 inch per inch.

The length of the beveled edge *F*, Fig. 8, should increase with the diameter of the reamer. The length of this bevel for different sizes of reamers is given in Table VII.

The rose chucking reamer will produce holes slightly larger in diameter than the actual size of the reamer, and for this reason this tool should always be made from 0.005 to 0.010 inch smaller in diameter than the finished size, and should be followed, when in use, by a fluted reamer for finishing. For enlarging cored holes, however, these reamers are of great advantage, firstly, because they are able to take a heavy cut, and secondly because they will cut a hole that is more nearly parallel or straight than will a fluted reamer, particularly if there are blow-holes or hard spots in the walls of the surface being worked upon.

Fluting Rose Reamers.

The grooves with which rose reamers are provided along their cylindrical surface, not being intended to produce cutting edges, are not of the same shape as those cut in fluted reamers. A convex cutter, having a width equal to from one-fifth to one-fourth the diameter of the rose reamer itself, should be used for cutting the groove. The depth of the groove should be from one-eighth to one-sixth the diameter of the reamer. The cylindrical part of the reamer between the grooves should not be relieved, but should be left circular.

TABLE VI. DIMENSIONS OF FLUTED CHUCKING REAMERS.

Diameter of Reamer.	Length of Flute.	Total Length.	Diameter of Reamer.	Length of Flute.	Total Length.
E	C	D	E	C	D
$\frac{1}{4}$	1	6	$1\frac{3}{8}$	$2\frac{1}{8}$	$10\frac{1}{2}$
$\frac{5}{16}$	$1\frac{1}{16}$	$6\frac{1}{4}$	$1\frac{1}{2}$	$2\frac{1}{4}$	11
$\frac{3}{8}$	$1\frac{1}{8}$	$6\frac{1}{2}$	$1\frac{5}{8}$	$2\frac{3}{8}$	$11\frac{1}{2}$
$\frac{7}{16}$	$1\frac{3}{16}$	$6\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{1}{2}$	12
$\frac{1}{2}$	$1\frac{1}{4}$	7	$1\frac{7}{8}$	$2\frac{5}{8}$	$12\frac{1}{2}$
$\frac{9}{16}$	$1\frac{5}{16}$	$7\frac{1}{4}$	2	$2\frac{3}{4}$	13
$\frac{5}{8}$	$1\frac{3}{8}$	$7\frac{1}{2}$	$2\frac{1}{8}$	$2\frac{7}{8}$	$13\frac{1}{2}$
$\frac{11}{16}$	$1\frac{7}{16}$	$7\frac{3}{4}$	$2\frac{1}{4}$	3	14
$\frac{3}{4}$	$1\frac{1}{2}$	8	$2\frac{3}{8}$	$3\frac{1}{8}$	$14\frac{1}{2}$
$\frac{7}{8}$	$1\frac{5}{8}$	$8\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{4}$	15
1	$1\frac{3}{4}$	9	$2\frac{3}{4}$	$3\frac{1}{2}$	16
$1\frac{1}{8}$	$1\frac{7}{8}$	$9\frac{1}{2}$	3	$3\frac{3}{4}$	17
$1\frac{1}{4}$	2	10	..	..	..

Rose reamers smaller than ¼ inch in diameter may be made without grooves, but in such a case they should have only three teeth on the end, and fairly deep cuts between the teeth to take care of the chips. The best practice is, however, to provide rose reamers of all sizes with grooves on the cylindrical part.

The number of cutting edges on the 45-degree beveled end of the reamer are made according to the figures given in Table VIII. The number of grooves is evidently equal to half tne number of cutting edges, there being one groove on the cylindrical part for every second cut at the end. The cuts at the end are milled with a 75-degree angular cutter. The width of the land at the cutting edge should be about one-fifth the distance from tooth to tooth. If an angular cutter is preferred, rather than a convex, for cutting the grooves on the cylindrical surface, because of the higher cutting speed permissible when milling the grooves, an 80-degree angular cutter, with a slight round at the point, may be used.

TABLE VII. LENGTH OF BEVELED CUTTING EDGE OF ROSE CHUCKING REAMERS.

Size of Reamer.	Length of Beveled Cutting Edge.	Size of Reamer.	Length of Beveled Cutting Edge.	Size of Reamer.	Length of Beveled Cutting Edge.
$\frac{1}{4}$	$\frac{1}{32}$	$\frac{7}{8}$	$\frac{1}{16}$	2	$\frac{1}{8}$
$\frac{5}{16}$	$\frac{1}{32}$	1	$\frac{5}{64}$	$2\frac{1}{4}$	$\frac{5}{32}$
$\frac{3}{8}$	$\frac{1}{32}$	$1\frac{1}{8}$	$\frac{5}{64}$	$2\frac{1}{2}$	$\frac{3}{16}$
$\frac{7}{16}$	$\frac{3}{64}$	$1\frac{1}{4}$	$\frac{3}{32}$	$2\frac{3}{4}$	$\frac{3}{16}$
$\frac{1}{2}$	$\frac{3}{64}$	$1\frac{3}{8}$	$\frac{3}{32}$	3	$\frac{7}{32}$
$\frac{9}{16}$	$\frac{3}{64}$	$1\frac{1}{2}$	$\frac{7}{64}$	$3\frac{1}{4}$	$\frac{1}{4}$
$\frac{5}{8}$	$\frac{1}{16}$	$1\frac{5}{8}$	$\frac{7}{64}$	$3\frac{1}{2}$	$\frac{1}{4}$
$\frac{11}{16}$	$\frac{1}{16}$	$1\frac{3}{4}$	$\frac{1}{8}$	$3\frac{3}{4}$	$\frac{5}{16}$
$\frac{3}{4}$	$\frac{1}{16}$	$1\frac{7}{8}$	$\frac{1}{8}$	4	$\frac{5}{16}$

TABLE VIII. NUMBER OF CUTTING EDGES ON BEVELED END OF ROSE CHUCKING REAMERS.

Size of Reamer.	No. of Cutting Edges.	Size of Reamer.	No. of Cutting Edges	Size of Reamer.	No. of Cutting Edges.
$\frac{1}{8}$	6	$\frac{7}{8}$	8	$1\frac{3}{4}$	12
$\frac{1}{4}$	6	1	8	2	12
$\frac{3}{8}$	6	$1\frac{1}{8}$	10	$2\frac{1}{4}$	14
$\frac{1}{2}$	6	$1\frac{1}{4}$	10	$2\frac{1}{2}$	14
$\frac{5}{8}$	8	$1\frac{3}{8}$	10	$2\frac{3}{4}$	16
$\frac{3}{4}$	8	$1\frac{1}{2}$	10	3	16

Dimensions.

Rose chucking reamers are, like fluted chucking reamers, made with both straight and taper shanks. The same dimensions for the total length as were given for the fluted reamers apply to the rose reamers also, but the length of the grooved portion of the reamer, or the body, is longer. If E is the diameter of the reamer, and C the length of the grooved part (see Fig. 8), then

$$C = \frac{3E}{2} + 1\frac{1}{8} \text{ inch.}$$

In Table IX are given the dimensions for rose chucking reamers in accordance with this formula. What was said in regard to the straight and taper shank of these reamers, and the diameter of the neck in the latter class, in connection with fluted chucking reamers, applies to rose reamers also.

Principles of Grinding Reamers.

When grinding reamers, whether they be given an eccentric or flat relief, it is necessary to rest the face of the tooth being ground against a guide finger which can be adjusted to give any desired amount of clearance.

TABLE IX. DIMENSIONS OF ROSE CHUCKING REAMERS.

Diameter of Reamer.	Length of Body.	Diameter of Reamer.	Length of Body.	Diameter of Reamer.	Length of Body.
E	C	E	C	E	C
$\frac{1}{4}$	$1\frac{1}{2}$	$\frac{7}{8}$	$2\frac{7}{16}$	2	$4\frac{1}{8}$
$\frac{5}{16}$	$1\frac{5}{8}$	1	$2\frac{5}{8}$	$2\frac{1}{8}$	$4\frac{5}{16}$
$\frac{3}{8}$	$1\frac{11}{16}$	$1\frac{1}{8}$	$2\frac{13}{16}$	$2\frac{1}{4}$	$4\frac{1}{2}$
$\frac{7}{16}$	$1\frac{3}{4}$	$1\frac{1}{4}$	3	$2\frac{3}{8}$	$4\frac{11}{16}$
$\frac{1}{2}$	$1\frac{7}{8}$	$1\frac{3}{8}$	$3\frac{3}{16}$	$2\frac{1}{2}$	$4\frac{7}{8}$
$\frac{9}{16}$	2	$1\frac{1}{2}$	$3\frac{3}{8}$	$2\frac{5}{8}$	$5\frac{1}{16}$
$\frac{5}{8}$	$2\frac{1}{16}$	$1\frac{5}{8}$	$3\frac{9}{16}$	$2\frac{3}{4}$	$5\frac{1}{4}$
$\frac{11}{16}$	$2\frac{1}{8}$	$1\frac{3}{4}$	$3\frac{3}{4}$	$2\frac{7}{8}$	$5\frac{7}{16}$
$\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{7}{8}$	$3\frac{15}{16}$	3	$5\frac{5}{8}$

Fig. 9 shows an end view of a reamer being ground. A represents the emery wheel, which should run in the direction of the arrow, so that the tooth of the reamer may be pressed down on the finger B. If the wheel were running in the opposite direction, it would have a tendency to pull the tooth of the reamer away from the guide finger; the cutting edge of the tooth would then be ground away, and the reamer would be spoiled. It is claimed that when using a dry grinder, that is, one where water is not used on the emery wheel, the danger of heating the tooth and drawing the temper is greater when the wheel is run in the direction shown in Fig. 9; but if the face of the wheel is kept free from glaze, and ordinary care is exercised, there is little danger of drawing the temper, provided a cutting wheel that is not too fine is used. In order to give the tooth the proper clearance, the guide finger is adjusted to bring the cutting edge below the center line. It should not be attempted to remove too great an amount of stock at one cut; it is better to take a number of successive cuts, going around the reamer several times.

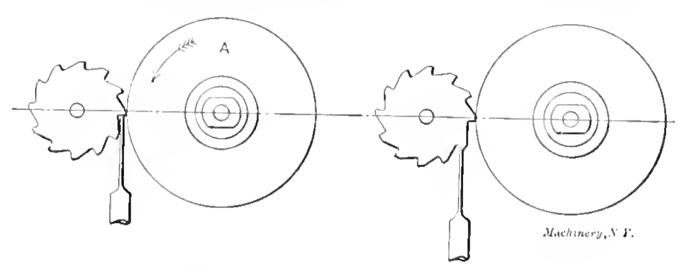


Fig. 9. Fig. 10.

When grinding reamers it is absolutely necessary to rest the face of the tooth being ground on the guide finger, otherwise the teeth, particularly when irregularly spaced, would not be ground with an equal amount of clearance, nor would all the cutting edges be at an equal distance from the center line of the reamer, and some of the teeth, consequently, would not cut when such reamers were used. Figs. 9 and 10 show, respectively, the correct and incorrect way of applying the guide finger, it being, in Fig. 10 applied to the tooth nearest below the cutting edge being ground.

Care should be taken not to give the cutting edge of a reamer any more clearance than is necessary to permit it to cut freely. Too much clearance produces a weak edge which is liable to chatter, and the reamer soon loses its size.

CREAM SEPARATOR BOWL BALANCING.*

YANKEE.

The balancing of cream separator bowls is the art of poising the rotating part or bowl so that it will run to full speed or beyond without producing any perceptible vibration in any part of the machine at any period of acceleration or falling off of speed. It is usually done by means of weights soldered in place on the bowl, or on the skimming device, and suitably distributed. A perfectly balanced bowl is one that answers the above definition, but practically slight vibrations are expected, and whatever the balancer is unable to overcome, is taken care of by using a spring bearing directly underneath the bowl. One design of this bearing is shown at the right, upper part of Fig. 1. In this design the springs are three in number and are placed in holes drilled in G. The proper pressure is applied by screws H.

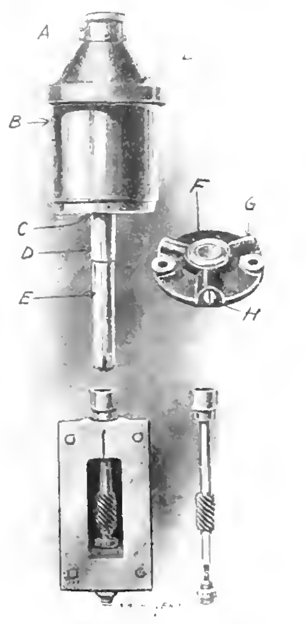


Fig. 1. Cream Separator Bowl and Stem or Spindle.

The balancing is done as follows. After mounting the bowl in a suitable frame, it is brought up to full speed, preferably by a rope drive, thereby avoiding the vibrations that result from the use of leather belting or gears. A soft blue pencil is held in a horizontal position and the bowl is marked at point B, Fig. 1. The spindle is marked at D, both over and under the spring bearing; it is also marked again at E.

The blue lines will show on the bowl on the lighter side and on the spindle at points D and E on the heavy side. The lines on the spindle at D and E should be directly in line with each other. When otherwise, it is a sure indication that the machinist did a poor job on this part. Imperfect spindles must be corrected before proceeding further.

Fig. 2 represents the top view of the spindle and bowl shell. We will now suppose that a line extends from 1 to 13 on the bowl shell at point B, and from 3 to 7 on the spindle at the points D and E. Draw a vertical line on the bowl shell directly above the center of the lines on the spindle. This is done merely to make it easier for the balancer to locate the proper place for the weight. After locating the point at about 16, melt in the bowl head on the same side, at about the point L, an amount of solder that is thought sufficient to bring the bowl shell up. This amount is arrived at by the cut-and-try method, and can only be guessed at by the balancer who judges the amount required by the noise of the bowl when running and the length of the line obtained. The size of the balancing weights required may range from a pinhead to that of a marble.

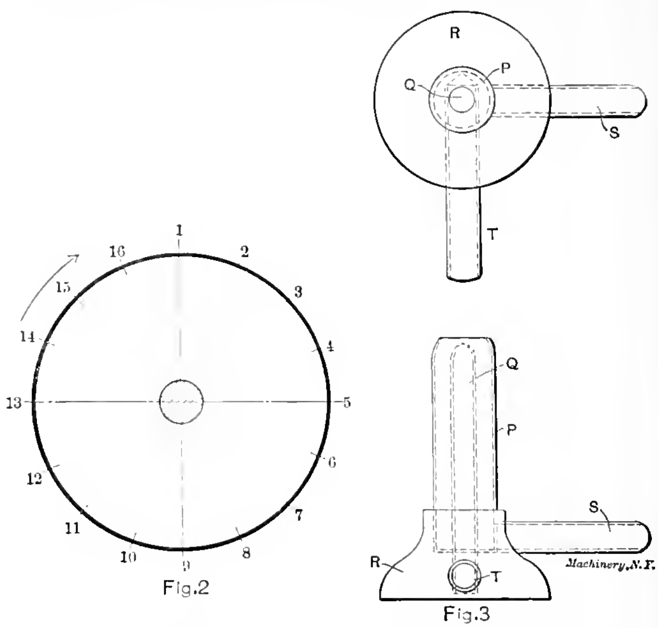
On the spindle we locate a point opposite, about 1 or 2 inches in advance or to the left of the line marked on the bowl above the center of the line on the spindle, which in this case would come at about 16. The bowl revolves, of course, in the direction of the arrow. The necessary amount of solder for this case is melted inside the bowl where it makes a joint with the bottom. All this work should be done neatly so that it is not readily noticeable by the purchaser, and also to facilitate cleaning.

Another case of a defective balance met with is as follows: Sometimes the blue-pencil lines on the bowl are directly above the lines on the spindle. In this case we put the weight in the top only and above the center of the lines. If the spindle should run very "rough" we work as described in the first case. A bowl very nearly balanced will finish up nicely and easily when showing such marks.

Still another case may be the condition in which we find the spindle when the top is not out very much, or the right end of the lines on the spindle falls under the left end of the bowl lines. All that is required in a case of this kind, usually, is to throw the weight in the bottom of the bowl slightly to the right, being governed by the amount the bowl is out of balance.

The reason that a bowl shows marks on the light side is that the axis of gyration lies between the axis of the bowl and the heavy side. This, then, makes the light side eccentric and causes it to describe a circle of a longer radius than the heavy side, hence it touches the pencil point first. The bowl being above the spindle is in a measure free to move as the forces direct, but being confined in the bearings the condition is exactly opposite. To insure perfect alignment between the bowl and spindle, revolve the bowl slightly and mark a line on same at point B. If this line does not extend entirely around the bowl, or should the bowl, as is many times the case, be more or less oval in shape, and the broken lines are not directly opposite, place a calking chisel in the fillet between the bowl and spindle and directly under the center of the lines on the bowl. Give the chisel a blow with the hammer according to the degree that the bowl is out. The chisel should be ground the same as the radius of the fillet, so as not to mar the spindle more than necessary. Repeat the operation, if required, until the alignment is perfect, as this condition is very important. Unless the alignment is perfect the bowl will shake badly when running up to speed.

A Bunsen burner for melting in the solder can be made as follows: Referring to Fig. 3, R represents a base, about 2 inches diameter. The air inlet T is about 3/8 inch diameter, and the gas inlet S is of the same diameter. The tubes Q, about 1/4 inch diameter, and P, about 5/8 inch inside diameter, are connected as follows: Q is connected with T, and P with S. Tube P is drawn in slightly at the top so as to throw the gas toward the center. Tube Q is drawn in at the top until the outlet is about the size of a common pin. The top of this tube must not extend above the top of P.



Figs. 2 and 3. Plan View of Bowl, and Bunsen Burner.

A soldering fluid which is stainless and which enables the bowl balancer to make the soldered weights flow nicely should be used. In case it is desired to place the weights in the bowl without soldering, melt about 4 ounces of resin and pour in about three teaspoonfuls of red oil. After cooling, this composition will never harden. It is superior to putty.

The above-mentioned cases are not all of the conditions that a separator bowl balancer has to meet, but they are sufficient for a beginner to contend with, and it is practically certain that if he learns to handle these cases well, he can become a first-class balancer.

* The following articles on balancing have previously appeared in MACHINERY: Wool Cleaning Machinery, August, 1899; Notes on Balancing High Speed Machinery, December, 1904, Engineering Edition. See also the De Laval Steam Turbine and its Manufacture, November, 1904.

LAYING OUT A PROPELLER.*

J. S. WATTS.†

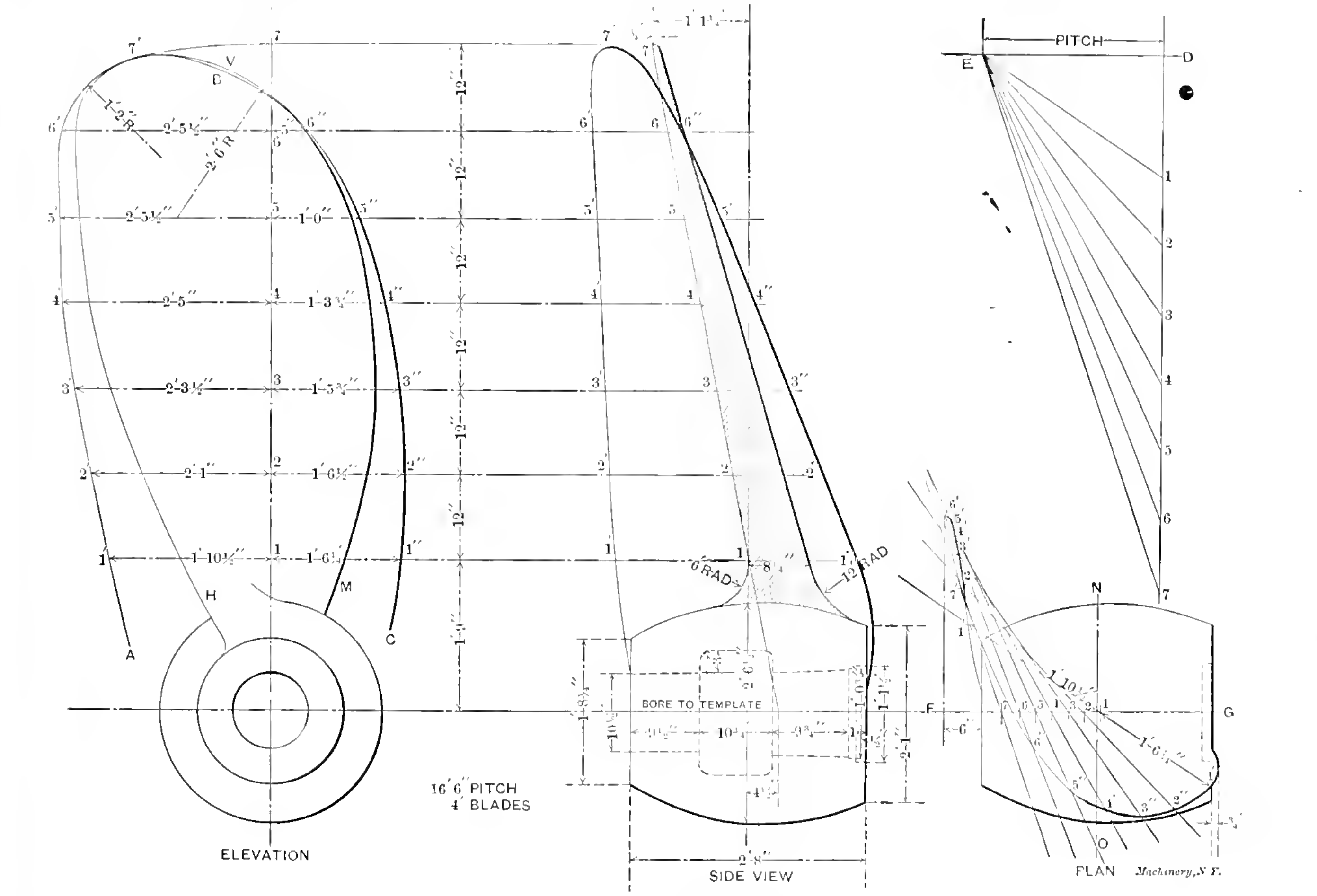
The making of a working drawing of a propeller is a problem that seems to be neglected by all technical works which the writer has had access to, and there are very few draftsmen who can successfully cope with it. The following method, while only one of the many ways in which it can be solved, may therefore be useful and interesting to many.

Formulas for finding the diameter, pitch, and surfaces required for any given horse-power and model of ship can be found in most books on marine engineering, and we will assume these dimensions of the propeller to have been fixed. The propeller shown in the cut is 15 feet 6 inches diameter, 16 feet 6 inches pitch, and 86 square feet developed surface of blades. The pitch is, of course, the amount the blade would advance in one revolution if it were made continuous around the shaft, similar to the thread of a screw. The surface is the total surface of the four blades flattened out or developed as shown in the elevation by the line *A B C*.

We will start by drawing in the boss in the elevation. The proportions can be found in any marine engineering book. Then draw an arc of a circle equal to the diameter of the propeller. Now we can sketch in by free hand the blade laid out flat on the sheet, or, in other words, a development of the blade to about what we think will give us the right area, that is, in a four-bladed propeller one-fourth of the total surface required. Then, by trial with a planimeter, and adding to or cutting off as required, we finally arrive at the correct area and shape of blade, keeping in mind that this is not a true view of the blade as seen in elevation, but is a development of the blade. The shape of the blade is largely a matter of experience and varies for different models of boats. Every designer, in fact, has his own peculiar shape, and the variety of the forms of blades on equally efficient propellers would seem to show that, within certain limits, it is not a matter of vital importance, so long as the pitch, diameter and area are correct.

We will assume that the development of the blade, as shown by the line *A B C* in the elevation, fills all the requirements, and we are to proceed to lay out the true elevation, side view, and plan view of the blade. First, on the development of the blade fill in dimensions at every 12 inches by scaling the drawing. Then draw out the blade in section, showing the droop which it is desired to have. This dimension is, like the shape of blade, a matter of controversy, varying from about 1½ inch per foot of diameter aft to about the same amount forward. The plan view of the blade can now be drawn; lay off the boss, and mark, on the center line of the boss, the positions of the center line of the blade at each 12-inch line as at 7, 6, 5, etc., taking the distance from center line of boss from the side view.

Now we must find the angles at which the blade must stand to the vertical center line to give the required pitch. To arrive at this we lay off a vertical line *D*-7 equal in length to the circumference of the circle on which point 7 is located



Layout of a Large Propeller.

in the elevation, and a horizontal line equal to the pitch, making this figure to any convenient scale as shown. From point *D* measure off points 1, 2, 3, etc., equal to the circumferences of the circles which these numbers represent on the elevation, that is, in this case, the circumference of a 42-inch diameter circle to be the distance from *D* to 1, of a 66-inch circle to point 2, and so on. Now join these points to the other end of the line representing the pitch, and we have the angles of the blade at each of the seven points. This will be evident, if one remembers that the figure just made is a development of the thread of which the blade is a part, or, in other words, that while the propeller makes one revolution, that is, travels through one circumference (which at point 1 equals the distance from *D* to 1; at point 2, equals distance from *D* to 2, etc.), the points 1, 2, 3, etc., on the blade advance an amount equal to the pitch. This figure is generally drawn on the plan view to save trouble in transposing the angles from one view to another, but it shows the idea clearer to have the views separated in this way.

Now draw a line parallel to *E*-7 through point 7 in plan

* The following articles dealing with the design and making of propellers have previously appeared in MACHINERY: A Screw Propeller Planing Machine, October, 1903; Bauer Propeller Blade Shaping Machine, November, 1903.

† Superintendent of I. Matheson & Co., Ltd., New Glasgow, Nova Scotia.

view, one parallel to E-6 through point 6, and so on for all the points. On these lines mark off the distances shown in the elevation for the respective points, as on line 1 lay off 1 to 1′ equals 1 foot 10½ inches, and 1 to 1″ equals 1 foot 6¼ inches; then draw a curve through all these points, which curve is a plan view of the edge of the blade. We can now find the projection of the blade in elevation by measuring the perpendicular of each point 1′, 2′, 3′, etc., and 1″, 2″, 3″, etc., from the center line $F G$, and transferring them to the elevation. Then, by drawing a curve through these points, we get the blade as shown by line $H L M$. And, similarly, by taking the horizontal distances of each point above or below the center line $N O$, and laying them off on their respective lines on the side view, we can draw in the projection of the blade by drawing curves through the points obtained. This view should have the propeller aperture of the ship drawn round it to scale in order to be certain of the clearances, which ought not to be less than 3 inches at any point.

* * *

A writer describes in a recent issue of the *American Blacksmith* how he fits brass gear teeth in a broken gear. A dovetail is first cut out at the base of the broken tooth to a depth of about ⅛ to ¼ inch, depending on the size of the tooth and the thickness of the rim. Then two or more holes are drilled in the bottom of the cut, and threaded. Short studs are screwed in and cut off slightly shorter than the height of the tooth. Then a form is made of thin iron plates of the height and width of the tooth and shaped to the proper curves. This form is set with care and two plates are clamped on the ends, and the whole is luted with clay on the sides and ends so as to hold the plates firmly in place to prevent the escape of the molten metal used to make the tooth. The form is filled with melted brass poured from a plumbago crucible. After cooling, the form plates are removed and the tooth dressed down with a file. It is claimed that this method of repairing is successful in mill work and other machinery employing cast teeth.

THE UNIVERSAL MILLING MACHINE PATENT.

The Brown & Sharpe Mfg. Co., Providence, R. I., has sent us photographs of patent No. 46,521, this being the patent granted to Joseph R. Brown, February 21, 1865, for the universal milling machine. The accompanying half-tone reproduction of three pages of the patent is of considerable interest in view of the fact that the universal milling machine has come to be one of the most useful of machine shop tools. The patent is on parchment, and the pages are about 14 x 18 inches.

When the universal milling machine was exhibited by J. R. Brown & Sharpe in 1867 at the Paris Exposition it attracted much attention from foreign engineers and manufacturers, this being the first public exhibition of the machine, which was destined to make the name of its manufacturers known all over the world, and which undoubtedly has had a great influence on the development of the mechanical arts. A comparison between it and the latest type with constant speed drive gives a good idea of the growth of the milling machine in size and power during the past forty years.

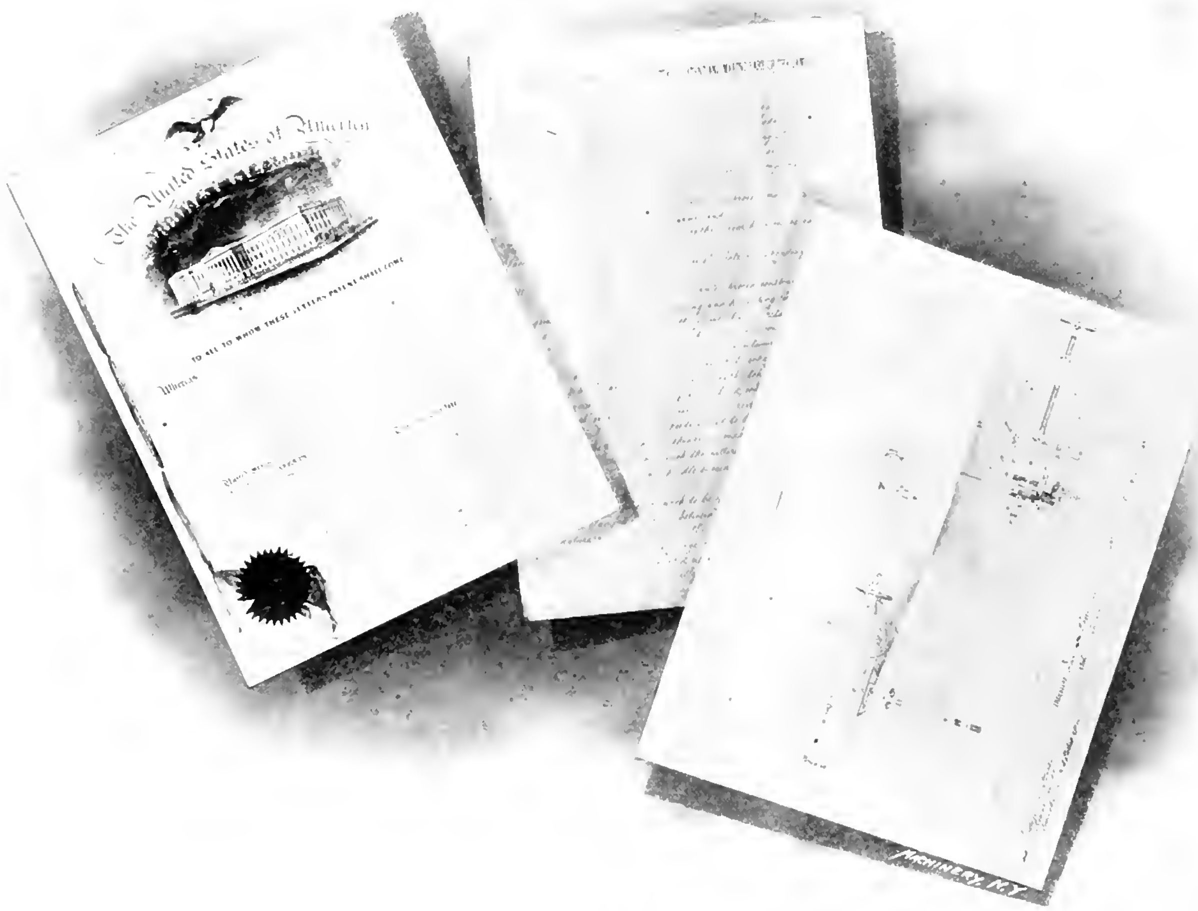


Fig. 1. Three Pages of the Universal Milling Machine Patent granted to Joseph R. Brown.

In this connection we also show in Fig. 3 a view of the old shop in which the original milling machine was designed and built. As most of our readers no doubt know, the business is one of the oldest in New England, having been founded in 1833 by David Brown, and his son Joseph R. Brown. In 1853 Lucian Sharpe became the partner of Joseph R. Brown, David Brown having retired in 1841. The firm was then known as J. R. Brown & Sharpe. The early growth of the business was very slow. In 1853, twenty years after inception, the total floor space was only 1,800 square feet, and in 1857 the total force comprised only 20 men, but in 1872 more than 300 men were employed. In this year the Brown & Sharpe Mfg. Co., which had been incorporated under this name in 1868, removed from the old shop to the present site near the center of the city. The present floor area of the five manufacturing buildings is 436,200 square feet and of the foundry, 160,740 square feet.

TOOTHED GEAR MEMORIES.

INTERNAL.

In ancient days in England, when water wheels were common, there was a large amount of heavy mill gearing work to be carried out. There are no great water powers in Great Britain, but quite numerous mill sites with a fair volume of water and a low fall. In order to get a fair amount of power, the water wheels were made very wide and of the low breast variety. To prevent racking stresses there were large spur

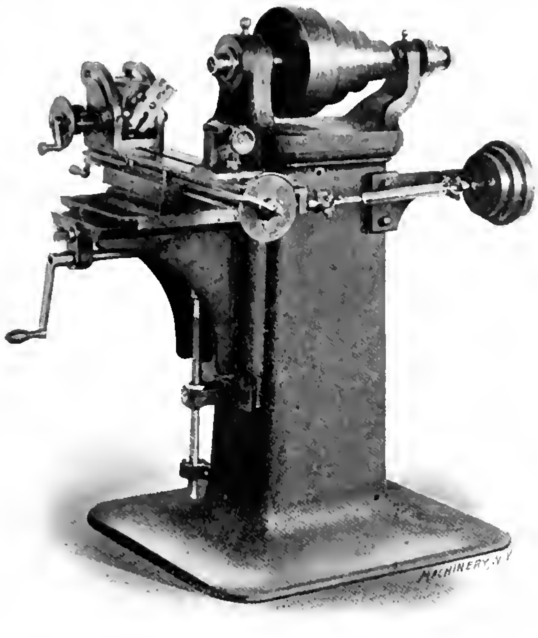


Fig. 2. The First Universal Milling Machine, built in 1862.

toothed gears at the ends of the wheel, and these drove two pinions on one second motion shaft. The large spur wheels were built up of segments bedded on the timber framing of the water wheel. The timber bedding brackets were turned off to a true radius by fixing up a tool rest and letting the wheel run, and turning down the bracket to the true radius to fit the segments. It was customary to lay out the segments on the ground, which had been packed level, and to set them to the radius by means of a trammel, or long board pivoted

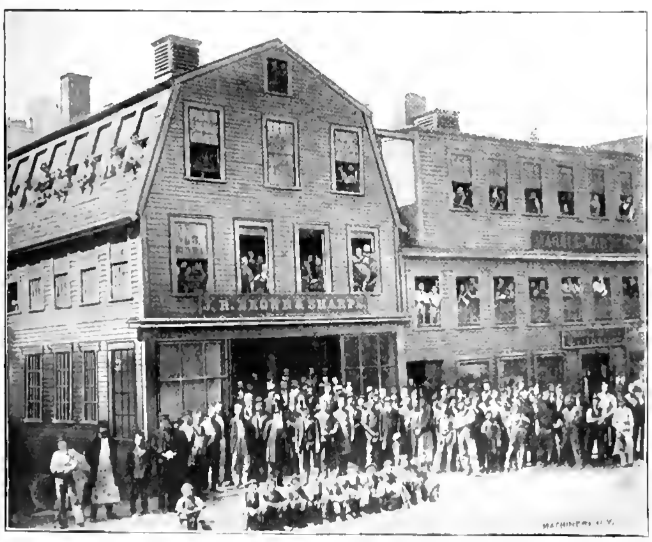


Fig. 3. The "Old Shop" in which the business of the Brown & Sharpe Co. was conducted until 1872.

upon a center post and carrying a scriber. The segments were moved in and out until, when properly butted at the ends, the scriber just touched each segment end when the trammel was revolved round the circle. Then this scriber was measured to the center of rotation and gave the radius on the brackets.

Sometimes, in spite of care, too much was turned off the brackets, and the segments would not bed when butted end for end. This was a very trivial matter. What was one tooth in 375? So one tooth would be cut off one segment and the bedding-down carried out with the smaller wheel of 374 teeth. On one occasion when this had been done the men forgot to do the same by the opposite end wheel, and so there was one wheel of, say, 375 teeth at one end of the water wheel, and there was a 374 tooth wheel at the other end, and both drove equal pinions on the second motion shaft. Such a combination forms a most powerful differential gear, capable of working up an enormous stress. The water wheel was started under these curious conditions, which, it is needless to say, made themselves known by the amount of wreckage produced as regards wheel teeth, all of which were stripped. There was a great wreck.

Another curious oversight occurred in connection with an engine. It was usual, when the engine had not a spur fly-wheel, that is to say, one with teeth directly on the rim face, for a toothed wheel to be built in segments upon projecting brackets cast on the arms of the fly-wheel. The spur wheel was thus slightly less in size than the fly-rim. With the above method of construction the second motion pinion was close alongside the fly-wheel and it overhung its bearing, for there could be no support on the fly-wheel side of the pinion. But on one occasion when a new engine was being put into a mill the fact was overlooked that the engine was at the middle of the building, and that the second motion shaft ran each way from the engine. This was discovered only when it came to putting things together, when of course the fact that the second motion shaft passed through the arm space of the fly-wheel produced some disconcerting moments. The net result was that new fly-wheel arms and a new rim of smaller diameter and heavy section had to be made, in order that the rim might not extend to the second motion shaft. Such were some of the incidents that added color to life in the old shops.

Another very funny incident occurred at Bellhouses' foundry in Manchester, where a large wheel rim was wanted, cast in one piece, and there was not room enough to do this anywhere between the wall and the post of the old-time center post jib crane. Some genius, however, offered a solution of the problem which was at once accepted heedlessly and with acclamation. Let us cast it round here, said he, indicating the ample space of which the crane post formed the center. And cast it round the crane post they forthwith proceeded to do. The error was found out when the time came to move the casting. Only then was it found how much a fourth dimension in space is really required. I am told that if there was a fourth dimension of space one could turn an India rubber ball inside out without having any hole in it through which to do the turning. Presumably, in a fourth dimensional heaven even a cast rim could be gotten off a crane post, fast at both ends to floor and ceiling. But being only—for a time—in a three dimensional "other place," they had to break the rim to set it free.

To-day, when a man has an engine to put up, he waits until the overhead traveler is ready and proceeds to lift all the heavy pieces into place by its aid, just as easily as if they only weighed a few ounces. In the old days, engines were erected with no aid but the hand crab and block tackle. With these, the heavy cylinders, the boss of the fly-wheel, and the great beam, all had to be gotten into place, and it was often necessary to carry such pieces through long distances, and even over other buildings to get them to their final resting place. This work required a considerable degree of judgment and careful handling, for the hand crab was a paltry affair, and I have since marveled at the way we had to risk life and limb in order to get along at all. Once when lifting a four-ton spur pinion with a ¾-inch chain, the chain snapped, and the wheel fell about eight inches with the leading erector standing on its face; it was being lifted in vertical or running position. This man (who never hurt himself or anyone else, but was most risky in his hazards) used the same chain again, lifted the wheel about eight feet, and through a window right above the four men who were working the crab. As they were nervous, he stood with them at the crab handles so that if the wheel fell it would have fallen on him worst of all. He traversed that wheel from "hang" to "hang" across

the engine room and to its place; he threaded the second motion shaft through the eye of the wheel; and had got everything lowered within an inch of its bearing, when the chain again snapped and the wheel fell, but only an inch or less, for the shaft was nearly down on its lower brasses. The salient facts are that the same chain broke at each end of the journey. It might just as well have broken when the great spur pinion hung three feet above the five men when working at the crab handles. They do say that Satan cares for his own; he certainly does seem to have done so effectually that time, and many others, for the man died properly in the end, and not by accident.

Cheap makers of wheels would only make one pattern for a pair of bevel wheels. A pair of true bevels of equal size maintained an equal speed of both shafts, but good makers laid greater value on a hunting tooth, and a pair of equal bevels were always made 1 tooth different. One wheel would have 45 teeth; the other 44 or 46 teeth. Many have heard the story of the hysterical locomotive—a tale founded on this practice, which records how one Sammy built a locomotive valve gear which involved the use of a pair of bevel wheels, and how the engine sawed itself back and forth on the shed tracks like a steering gear engine—always overtaking the phase of its valve gear and finally getting it so far over that the engine ran back, and got as far into the opposite phase—and so on, all because the bevel gears had the hunting tooth.

The old water wheels had their large spur driving wheels built up of many segments, and some of the patterns were very rough and warped with usage, so that the cast teeth were often more or less twisted and out of pitch. They would work noisily at first, but it was usual when the noise was too pronounced to correct it by grinding the teeth—a very simple operation performed with very simple apparatus—water and sifted sand. The wheels being set to work were supplied with sand and water until they ran reasonably quietly. They could not help grinding truly to pitch for there was always some hunting of the teeth even if the wheel and pinion were not prime to one tooth. The heavy bearing teeth got the most grinding and soon the pitch became even.

It was many years ago that we made the first departure from the traditional length of tooth of $\frac{3}{4}$ pitch, which had once been regarded as short. We made a pair of wheels for a corn mill in the County of Durham, and gave them a length of two-thirds the pitch, and they looked well. It was about that time that the Hawkins translation of Camus on Wheel Teeth fell into my possession; the genial Hawkins fell terribly foul of the men who had stood by chord pitch measurement. He advocated short teeth of only half pitch length, and though this is too long, it was a length I used myself for several years; not that I would not have used much shorter teeth, but that one had to make certain concessions to public taste, and a very short tooth frightened men accustomed to the older lengths. My own advocacy of short teeth dated from the above book, and the idea spread until at last one found teeth with a length on the true teeth faces of only about one-eighth the pitch; but some men also conceded to public opinion in a way they ought not to have done, for they made the teeth with true short faces, and then joined them into apparently long teeth by means of semi-circular arcs below the flanks, and similar arcs above, so that the teeth looked just like a series of corrugations of circular arcs. The arcs were absolutely meaningless, and were hideous and clumsy additions merely to conceal the actual fact of very short teeth. They were, in fact, a sort of mechanical lie or fake construction, offensive to good taste and to mechanical rectitude. If public opinion had to be bowed to at all, why go beyond a certain shortness of tooth? A tooth of one-third pitch should be all tooth if it can be pressed on the purchaser, but to give him a tooth of $\frac{1}{8}$ pitch, and build it up to approximately $\frac{5}{8}$ pitch by meaningless additions and subtractions of metal of no use, is bad taste and bad concessions into the bargain.

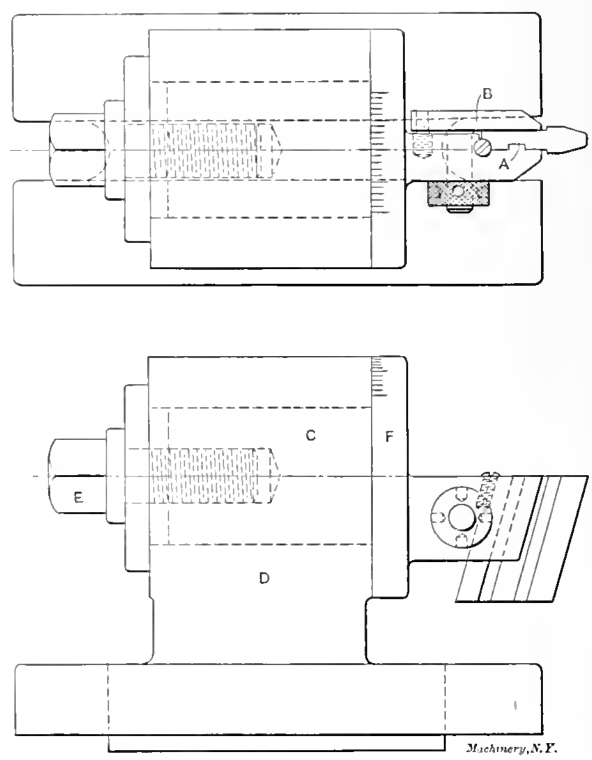
It is known that teeth drive easier when in contact past the line of centers than when approaching. In a full wheel pattern, either of two wheels may be the driver, and it is therefore not practicable to make one wheel with all the teeth projecting above the pitch line, while the teeth of the driven wheel are nearly all below pitch line; for the contact, when the latter became the driver, would be all before the line of centers. Where, however, wheels are molded from a simple gap pattern of two teeth, every pair of wheels may well be thus made, the driver having only points, and the driven wheel flanks only, so that little or no contact takes place before the teeth have passed the line of centers. Such teeth will run quietly.

At one time a very quiet running tooth was made under the patent of one Gee. He argued that wheels run one way only, so he only made one side of a tooth to the proper tooth form. The backs he sloped off so as to get a tooth very strong at the root, and a very little increase in depth of mesh reduced the play or back lash to nothing. By this means he could practically reduce back-lash to a minimum, and his teeth certainly ran very quietly.

* * *

THE INFLUENCE OF THE THREAD MILLER ON TAP MAKING.

With the advent of the thread milling machine the extreme accuracy of thread forms hitherto scrupulously adhered to was sacrificed for the greater commercial advantages in rapid thread cutting. The thread milling cutter, while, as a rule, itself ground to the correct form of the thread, is, when in use, swiveled around a horizontal axis at right angles to the axis through the center of the hole of the cutter in order to



Swiveling Tool Post for Thread Cutting.

conform to the angle of helix of the thread to be cut. By swiveling the cutter in this way the exact form of thread is not duplicated in the screw to be cut, inasmuch as the correct angle of the thread will not be measured in a horizontal plane through the axis of the screw as it ought to be, but in a plane at right angles to the direction of the helix of the thread. It is obvious that the inaccuracy is increased in proportion to the angle of helix; for fine pitches the inaccuracy is so small as to be insignificant for practical consideration, but as the pitches grow coarser, the same diameter being retained, the differences between the correct thread form and the one produced become enough pronounced to demand attention.

It is particularly when cutting Acme threads that this difference is great enough to cause difficulties, because of the fact that the pitches on Acme screws are usually twice as coarse as those on U. S. or V-standard screws. The head of the thread milling machine carrying the cutter has to be tilted over so much in cutting the screw that the dimensions of the thread produced differ by measurable amounts from the standard thread, and if a screw with such a thread is placed in a nut cut with a tap having a correct thread, a very poor fit

will result. The variations are, of course, even greater in the case of multiple threaded screws, and the use of the thread milling machine for cutting such screws may be prohibitive in extreme cases, unless the taps for the nuts are produced in a manner similar to the one used for the screws.

One way would be to mill the taps on screw milling machines. This is also done to a certain extent by manufacturers of these taps. But if it is desired to cut the taps in a lathe, and there are not enough taps to be made to warrant the making of thread tools to suit all the different angles of helix which may occur, a correct thread tool or single point cutter may be used and placed in a tool post or holder capable of swiveling adjustment, so that the tool can be tilted over to the same angle as the milling cutter would be set to in cutting the screw. Such a tool-holder is shown in the accompanying cut. An incidental advantage and saving of expense is gained by the use of such a holder, because of the tool or single point cutter, being set over to conform to the angle of the thread, does not need to be provided with side clearance, but can be made as if intended for cutting a circular groove or a thread of very fine pitch.

The tool-holder shown is provided with a tongue *A* and a clamp *B* to hold single point cutters of the kind manufactured by the Pratt & Whitney Co. The stem *C* of the holder is fitted to a cast iron bracket *D*, which is clamped to the cross slide of the lathe. The screw *E* clamps the holder in position. The shoulder *F* of the holder is graduated in degrees in order to indicate the angle to which the tool is tilted. The holder, as shown, is of the very simplest construction in order to merely convey the idea of the tool. With a little more elaboration in the design a still more efficient tool may result, but for temporary use the one shown will prove efficient.

* * *

A RECORD WITH AN AUTOMOBILE.

A remarkable record was made June 28 and 29 by Mr. S. F. Edge on the Brooklands racing track at Weybridge, near London, England. In twenty-four hours he traveled 1,581 miles with a Napier six-cylinder car. This is at the average rate of nearly 66 miles per hour, and is said to be the greatest distance ever traveled by man in the same length of time. It is noteworthy that notwithstanding the locomotive has done so much to promote the world's progress in increasing the speed and ease of transportation, a car built to run on the ground instead of on steel rails has made a far higher record than any locomotive has ever accomplished. Of course the comparison is not really so very bad for the locomotive, for the automobile record was made on a racing track and under conditions that permitted instant repairs to be made from time to time as they were required. No doubt under similar conditions a locomotive could be made to run as far or further in twenty-four hours. A very important difference is that the locomotive is a practical machine for conveying freight and passengers and earning its way, whereas the motor car is as yet largely the plaything of a sporting class.

* * *

In the August issue of MACHINERY we published a letter from one of our readers concerning industrial life insurance. In this letter the enormous waste in connection with the industrial life insurance companies was pointed out. A remedy of the evil of the present condition in this respect has been proposed and acted upon in Massachusetts, and in that state the conduct of industrial insurance is about to be undertaken by savings banks. Investigations having shown that of the total amount of assessments paid by those insured in regular industrial companies nearly 40 per cent is used for conducting the business, it is gratifying to find that in the Massachusetts savings banks the expenses of management are only 1.47 per cent of the amount of deposits. As industrial insurance is a necessity to the majority of industrial workers, this departure is a very important one. Hereafter it will be possible for the residents of Massachusetts to obtain industrial insurance at actual cost, and, for the same amount expended, about double the previous amount of insurance can be carried, the payments being made easy by applying the installment plan in the same way as do the industrial life insurance companies.

FORGING A LATHE BORING TOOL.

J. F. SALLOWS.*

J. F. Sallows.†

Cold shuts, the starting point of the water cracks so often found in lathe tools, may be caused by heating the steel too quickly or too slowly. In heating too quickly, the center of the bar does not reach the same degree of heat as the outside of the bar, and consequently the outside part of the bar draws out under the hammer more freely than the center, thus causing a parting of the metal. This is the starting point for a water crack when hardening the tool. Heating a tool too slowly, and exposing it to the air either at the top or bottom, decarbonizes the steel, and a poor lathe tool may be the result.

When heating tool steel a heavy fire should be used, a good solid foundation of coke being laid in the bottom of the fire, and the steel should be well covered with coke. The smith must watch the steel carefully and not allow it to remain in the fire and "soak," as is sometimes the case, especially if he has struck a position that is restful, or has started an earnest conversation with his working mate.

When forging a boring tool, a bevel set should be used of the form shown in Fig. 1, having a round corner at *A*. After

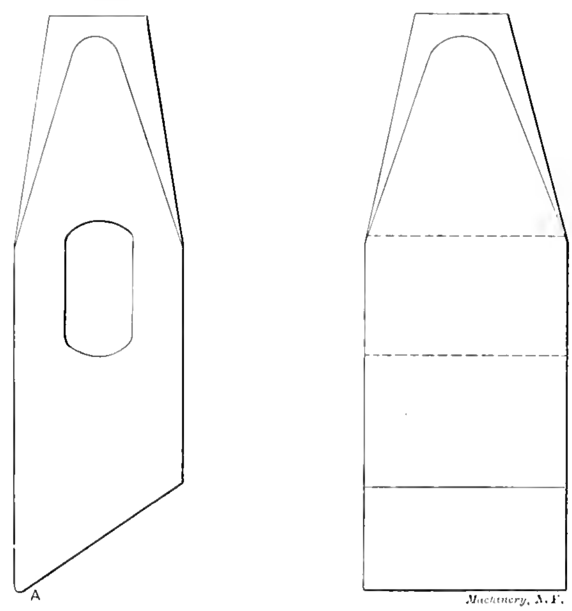


Fig. 1. Bevel Set.

heating the steel, drive the set down making a "V," as shown at *A*, Fig. 2. The rounded corner forms the fillet at the bottom. Some smiths use a large top fuller for making the "V," but the result is a clumsy round corner as shown by the dotted line *B*. If after drawing out the stem of the tool we turn over the lip on the end on an anvil having sharp corners, we shall get another sharp angle that may be the starting point for a water crack. See *A*, Fig. 3. The same also applies to angle *B*, lower view Fig. 3. The anvil used by the tool-dresser

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should have round corners for about four inches from the square end on both sides. Then, when forging a tool that should have fillets in place of the sharp corners, as shown at *A* and *B*, Fig. 4, the means are at hand for forming them. Never use a chisel on a lathe tool if it can be avoided.

When about to lengthen out the stem on a boring tool, it is a common practice to heat the tool to a lemon heat, and with a chisel chop out a piece at *A*, Fig. 5, thus leaving the tool

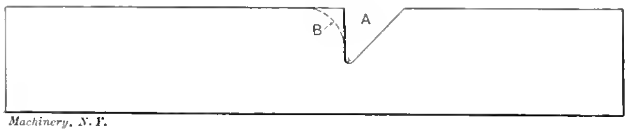


Fig. 2. Characteristic V made by Set.

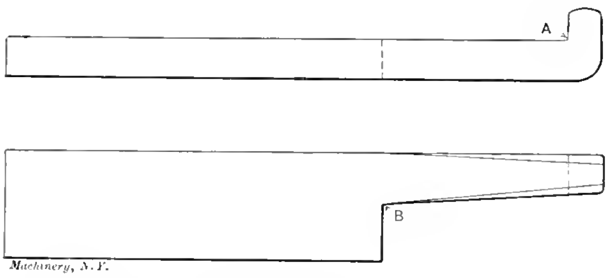


Fig. 3. Tool Blank with Objectionable Sharp Anglee.

marred by chisel marks that cannot be removed by hammering. Now, when the tool is used up to that part, it cracks every time it is put in the water. The proper way to lengthen a boring tool is as shown in Fig. 6. Drive the bevel set down as at *A*, then cut off the corner *B*, and draw out the stem to the proper length and size. If a boring tool has a fairly good lip and has to be lengthened in the stem, give the stem a half twist after lengthening, and the job is completed.

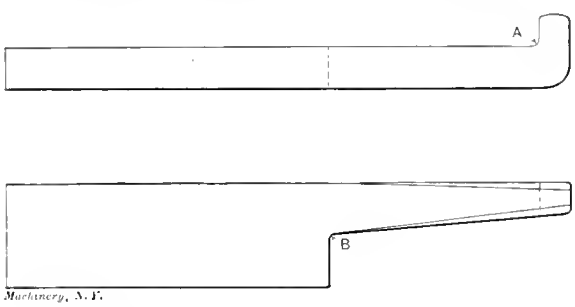


Fig. 4 Tool Blank with Form of Fillets to be Provided.

A common mistake a great many smiths make when tempering or hardening a boring tool is to heat the tool a little too hot, and dip the end into fresh water to a point just above the lip, and hold it still until it is cold. This is bad practice. In the first place the tool-dresser should use salt water for hardening all kinds of tools, for the tools will harden at a much lower heat, and this will do away with cracking. In the

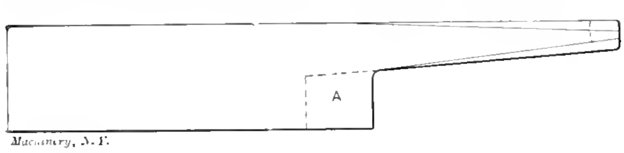


Fig 5. Bad Practice in Lengthening a Boring Tool Stem.

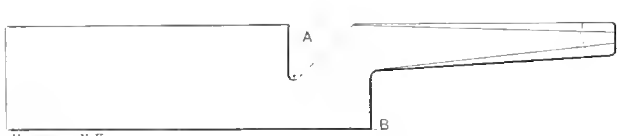


Fig. 6. Recommended Practice for Lengthening a Boring Tool Stem.

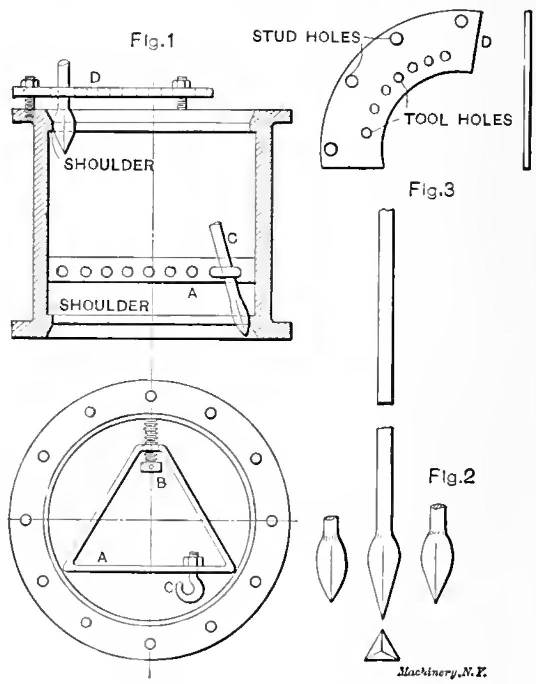
second place the tool should be moved around in the water constantly until ready to be removed.

An inside threading tool should be forged in the same way as the boring tool, except that, when trimming off the cutting part, it is shaped differently, being brought to a sharp point with clearance below. It should be tempered the same, however, as the boring tool, but will not stand to be quite so hard.

ITEMS OF MECHANICAL INTEREST.

SCRAPING OUT THE CYLINDER OF A MARINE ENGINE.

A few months ago a contributor to the *Mechanical World* described how he accomplished the job of scraping out the cylinder of a marine engine. After opening up the cylinder, it was found that the counterbore at each end had not been carried in far enough, and that a sharp shoulder had been formed by the piston at the end of the stroke. This shoulder had to be removed. It was almost impossible to chip it out or to use a file to any advantage. Finally the device shown in the cut was rigged up. The tools used, Fig. 2, were made from $\frac{7}{8}$-inch octagonal steel, 4 to 5 feet long, with one end drawn out to a triangular point. In the plan view, Fig. 1, is shown the tool stay *A* for working at the bottom of the cylinder. A piece of bar iron was bent into a triangular shape and welded, the corners being slightly rounded, and one side being longer than the others. At the corner opposite the long side a hole was tapped for a pointed screw *B*. This, when screwed out, together with the two opposite corners



Tools used for Scraping Out a Cylinder.

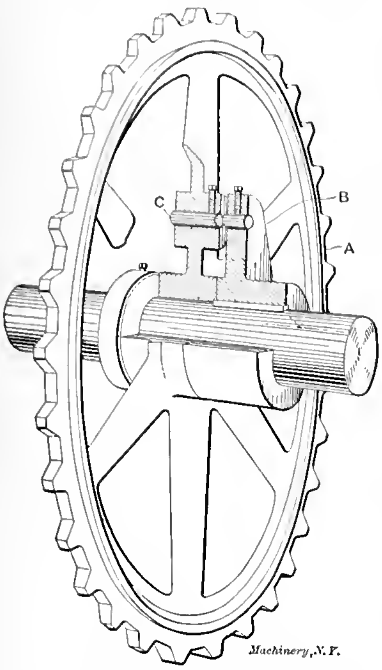
of the triangle, pressed against the wall of the cylinder, and formed a rigid frame. Holes were drilled around the triangle to take a hook *C* against which the tool pressed when cutting. Fig. 3 shows the tool stay *D* used when scraping the top of the cylinder. A piece of plate was cut to about one-quarter circle, and holes were drilled to the same circle and pitch as the studs in the cylinder; inside these another row of holes was provided, large enough to allow the cutting tool to pass through. After a little practice, says the contributor, it is surprising what an amount of metal can be removed, as the long lever gives a considerable amount of power.

THE BREAKABLE PART AS A PREVENTION FOR OVERLOAD.

In a contemporary we find reference made to a design of hub for a chain wheel used in connection with some kind of hoisting apparatus. The design is shown in the accompanying cut. In order to prevent the overload and consequent breaking of other parts of the machinery, a safety device is applied in the form of a pin connecting the driving hub *B* with the hub of the gear *A* itself. As seen from the cut, the gear, instead of being keyed to the shaft, is loosely mounted, and the hub *B* is keyed to the shaft instead. This hub is connected to the chain wheel by pin *C*, which is necked, the extent of the reduction of the neck of the pin determining the amount of power which may be safely transmitted. If the apparatus is subjected to an unusual strain, the pin will break, leaving the wheel free, and thus preventing the breakage of parts which would cause serious accident.

This scheme of applying a breakable part in machinery

to prevent overload and the breakage of more important portions has been resorted to in several classes of work. It is, however, one that can hardly be recommended as an extremely happy one. In the case of a pin for transmitting the power, the temptation of the operator will always be, in case the pin should break, to replace it with one of stronger material so as to prevent the annoyance due to frequent replacement. In the case in hand there is, of course, an obvious temptation, if the pin should break, to replace it immediately with another pin without taking time to neck it down, in which case the new pin may have a power of resistance about double that of the one broken, and the original object of this safety device would be lost. The ideal safety device is one which does not break in the case of overload, but which is simply thrown out of action when the load becomes too heavy, and which can be moved back in position again by simply turning it like a lever. In such a case there is no temptation for the operator to prevent the proper action of the safety device, and there is less risk that the device will be inoperative at the very time when its action is most required. In electrical work this principle has been realized and acted upon, and the old-fashioned fuses which were inserted in circuits in order to prevent overload are being replaced by circuit-breakers. The fuses, in fact, correspond directly to the breakable pin, and circuit-breakers have their direct counterpart in some kind of a lever arrangement in mechanical design which would automatically be thrown out of engagement in case of too heavy load.



Example of a Design having a Breakable Pin as Safety Device.

REPAIRS TO A DYNAMO ENGINE ON A REVENUE CUTTER.

A writer in the May issue of *International Marine Engineering* describes a rather discouraging repair job which was successfully undertaken by the engineers of the United States revenue cutter *McCulloch* in Alaska. The dynamo engine of that craft was wrecked by the breaking of a crank-pin bolt. The damage consisted of a broken piston and ring, bent, and upset piston rod, bent connecting-rod, and smaller injuries.

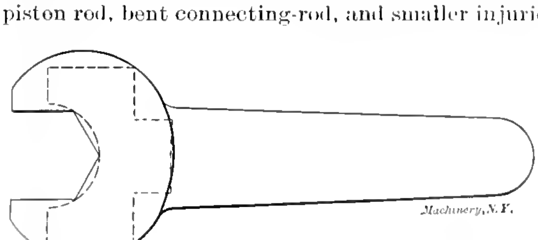


Fig. 1. Wrench from which the Stub End of the Connecting-rod was Made.

For repairs, the material available was sufficient for all purposes except to make a new piston, and the ship had a lathe and drill press. For a piston, a piece of cast iron was secured from the scrap heap at a mine, and drilled out and turned into shape. A spare piston rod on board was found to answer, after a bushing and a new gland had been made for the stuffing box.

When the repairs were practically finished, the connecting-rod disappeared, having supposedly been thrown overboard by a drunken fireman. There was nothing on board from which a connecting-rod could be forged, and a search at the next two points touched at failed to produce suitable material. It was therefore decided to build a skeleton rod of material that was available. The stub end was made from a disused open ended wrench of sufficient dimensions to be cut into shape. The handle of the wrench was cut off, and the jaws were sawed, filed, and machined to the proper size, as shown in the sketch, and holes drilled for the crank-pin bolts.

For side pieces a grate bearer-bar, 7-16 by $2\frac{1}{2}$ inches, was used. These pieces were shaped and temporarily bolted to the stub end with five $\frac{1}{2}$-inch bolts. A block of hard wood, the length of the cross-head pin, was placed between the upper ends to hold the side pieces rigid while the holes for the pin were being drilled. When a new cross-head pin had been turned, the bolts in the stub end were removed, and the pin

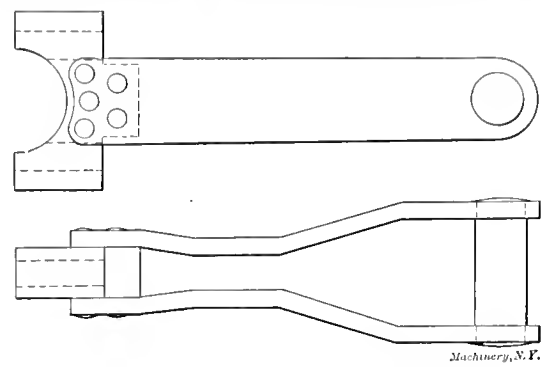


Fig. 2. Two Views of the Completed Connecting-rod.

was shrunk in and peened. The lower ends of the side pieces were then secured to the stub with five $\frac{1}{2}$-inch rivets of soft steel turned to a driving fit, annealed, and riveted cold.

The shape given to the side pieces as shown in the cut was necessary to clear the counterweights on the crank. The completed connecting-rod was found to be sufficiently rigid without the use of distant pieces, and proved to be satisfactory in every way.

THE RESISTANCE OF SOFT MATERIALS.

The note in the May issue of MACHINERY with the above title served as a text for a discourse by the editor of *Wood Craft*, in which he brings together a number of other illustrations along the same lines as those we gave.

He speaks, for instance, of cases in which hardened tool steel bearings have been replaced by soft cast iron shells with great success, especially where the journals had been hardened and ground. This combination of hardened journal and hardened bearing is a rather risky one, as every machine operator who has ever met with it knows. The difference between bronze and babbitt also presents some puzzling peculiarities. Many a hard metal bearing has been replaced by an emergency job of babbitting that, at the time, had nothing but its immediate applicability to warrant its use, but which was found, in service, to make good in every sense of the word. The use of *lignum vitæ* and other wood bearings under water lubrication, and not infrequently in places where they get very little care, is also well known and need not be enlarged upon, beyond referring to the really remarkable showing the bearings often made under these conditions. There is also the common practice of using wooden teeth in water-wheel gearing, where the shock and strain usually form a severe combination.

But a more curious case of metal being quickly worn away by a very much softer substance, plus an abrasive, was quoted from *Stone*. This journal says that yarn with powdered stone can cut a steel bar. The facts to bear out this claim are thus presented. Major McClaughry, warden of the Federal prison at Fort Leavenworth, found a prisoner working away at one of the bars to an outside window. A grating of the same description was placed in his cell, and a guard stationed over him to watch the cutting process. With the limestone dust and silicate from the stone pile, the yarn from his sock and a little water, he cut through the Bessemer steel bar in eighteen working hours. With some fine emery, a chalk line and two wooden handholds to save his fingers, he made a clean cut of the other Bessemer bar in five hours. *Stone* does not say what thickness the bars were nor are we told what reward was earned by the prisoner's persistence.

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REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

SEPTEMBER, 1907.

PAID CIRCULATION FOR AUGUST, 1907, 23,474 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

PHOTOGRAPHS FOR ILLUSTRATION.

One of the editor's difficulties is getting good photographs for half-tone illustrations. Many subjects are offered, but the majority of photographs submitted lack sharpness and the clear cut quality necessary for "snappy" engravings. More negatives are spoiled by under-exposure than by over-exposure, and the former fault is very marked in most machinery and shop interior photographs.

Machinery and machine shop interiors generally lack sharp contrasts, and all dark surfaces need plenty of time to impress themselves on the plate. There is little danger of over-exposure in the ordinary run of shop interiors. Our experience with an f-8 rectilinear lens in a 5 x 7 camera indicates that with a 16-stop, exposures of from 40 to 50 seconds generally result in fair negatives. This, of course, is only a rough and approximate rule, but we find that it applies very well in most cases.

Another fault of present-day photographs is the very general use of gas-light papers instead of sun-printing papers. The latter are far superior to the former for illustrative purposes, but on account of convenience the tendency is to use gas-light papers almost exclusively. The best photographs that we get come from abroad. Few of our professional photographers are able to produce as good prints as those that are made every day in Great Britain and other European countries.

The gist of the above is that contributors who would please the editor, and who would see the best half-tone illustrations in their favorite trade journal should insist on first-class negatives and "silver" prints for all contributions and descriptions that they may submit.

* * *

THE DROP FACE FLANGED LOOSE PULLEY.

The drop face flanged loose pulley is a feature of shop installation more frequently used in wood-working establishments than in machine shops. A number of machine tool building concerns, especially those who build grinding machinery, have, however, recently made some use of the flanged loose pulley. The theory of its construction is that as the belt is relieved of part of the tension when thrown onto the loose pulley, the latter is not so likely to heat up and cause trouble as it would if it were of the same diameter as the tight pulley.

There is a difference of opinion as to the merits of the drop flanged loose pulley. One concern has hundreds of them running in its own plant, and has adopted them as a standard of all the equipment it furnishes requiring tight and loose pulleys. Another concern speaks favorably of the advantages of the device for driving grinding machinery, although it suggests that relaxing the stress on the belt when running on loose pulleys causes the former to deteriorate and lessens its life.

Another concern, however, points out that the decreased tension of the belt is comparatively slight with long center distances. Suppose that the center distance is 12 feet and that the loose pulley is 3/8 inch less in diameter than the tight pulley; then the shortening of the center distance does reduce the tension of the belt, but ordinarily not so much but that the loose pulley is still under considerable pressure, sufficient to make it run at full speed. In fact, the drop face pulley almost invariably runs faster than normal speed, inasmuch as its diameter is reduced. From this it appears that the reduction of diameter to reduce the belt tension tends to increase, if anything, the danger of heating on account of the more rapid rate of rotation.

One well-known grinding specialist does not hesitate to characterize the drop face pulley as an example of mechanical quackery, and further adds that there is much of this sort of thing in wood-working machinery design. If a loose pulley heats, it is pretty good evidence of insufficient lubrication or length of bearing, or both. Altogether it would appear that the solution of the loose pulley problem in rapid running machinery is simply long bearings and provision for constant lubrication. When these are provided, it will be unnecessary to resort to dropping the face or any other expedient of like nature.

* * *

DYNAMIC BALANCING.

The article on another page of this issue on balancing cream separator bowls is, we believe, a contribution to general knowledge of a somewhat obscure subject. It is a brief description of the method followed in a large factory in adjusting the rotating part of a dairy machine, which runs at a normal speed of about 8,000 revolutions (say 10,000 feet at periphery) per minute. At so high a speed it is positively necessary that the rotating part be put in a state of dynamic balance. This may be a quite different condition from a standing balance, as every well-versed mechanic knows. An armature, for instance, may be in perfect standing balance, and still vibrate badly when run at speed. The reason is simply that somewhere within its length there is an excess weight on one side that is not balanced directly opposite or in the same plane at right angles to the shaft. The fact that there is an exact equivalent to the excess at some other point in the armature length on the opposite side of the shaft, does not answer. The effect of centrifugal force at high speeds is enormous in proportion to weight, and small fractions of an ounce, unsymmetrically located, may quite easily be sufficient to perceptibly spring a comparatively large shaft, this force being 1,500 to 4,000, or more, times the weight in cream separator apparatus. The discovery of the exact seat of trouble is not always a simple matter, and to remedy it is, indeed, often extremely difficult.

The fact that some cream separator makers claim to make bowls that do not require balancing by the *addition* of fused metal to the unbalanced portions does not vitiate the principles enunciated. The fact is that, no matter how accurately the machine work is done, the minute variations in homogeneity of all metals whether rolled, forged or cast, make it entirely necessary to balance by test. Whether it is done by addition or subtraction of material is merely a matter of practice to be determined by individual preference.

The article referred to is a shop man's description written for other shop men, and is a good example of the practical matter that MACHINERY aims to publish. It may easily be worth the price of several years' subscription to those who have to do with the balancing, and no mechanic knows how soon he may be called on to handle work of just this character.

THE STEEL TRUST AND THE TARIFF.

It has been said with a great deal of truth that the tariff is the mother of monopolies, although, of course, there are monopolies which are not fostered by the tariff. At the same time there are industries which remain competitive whether there be a tariff or not. These industries are those which depend mainly upon individual enterprise, skill, and hard labor for their existence. Such industries, however, which depend merely upon their access to natural resources, such as coal, ores or lumber, for instance, are likely to become monopolies when they have been able to corner the supply of a special necessity. In such cases the tariff is plainly the nurse of special privileges, and serves no other conceivable purpose than that of enriching the privileged few at the expense of the many. Consider for a moment the case of the steel industry of the country. There is no exaggeration in saying that it is virtually controlled by one single corporation, a gigantic monopoly, which can command its own prices from those who use the product, whether the users be the machine builder, the structural contractor, the railroad engineer, or in the last hand, the general public. This company produces from one-half to two-thirds of all the iron and steel used in this country. Of all Bessemer steel ingots and castings, for instance, the production of the United States Steel Corporation amounted to 67.4 per cent in 1905; of wire rods, 69.9 per cent; of rails, 53.6 per cent; of structural shapes, 54.6 per cent; and of wire nails, 66.1 per cent. This operation also controls the greater portion of the ore lands in this country, in fact, according to the best authorities, from 75 to 80 per cent of all the ore land of the Lake Superior region, which at present constitutes practically the only cheap supply of workable good iron ore in this country. The monopolized value of the control of these ore lands it would be futile to try to estimate. In view of all this, it seems as if we ought to be ready to recognize, as a nation, that the time has come when even the most avowed believer in protection cannot help but see the fallacy of our present course.

When protecting our output of steel and iron by a tariff, we protect no infant industry. Moreover, the steel mills of the country cannot at the present time supply the demand for their product. The country has reached the point of development where the domestic supply is insufficient. We have been forced to import steel and iron, tariff or no tariff. What a farce then to burden our legitimate industries with this import tax in the name of protection to domestic enterprise, when this latter cannot possibly supply the raw material necessary. The only purpose the tariff serves under such conditions is to permit the interests which practically control our enormous natural resources of iron ore to exact from the users of steel an unreasonable tribute. When it is possible for British makers of steel to ship it all the way to San Francisco, paying an ocean freight rate of $5.90 a ton, pay the tariff, and still sell in competition with our own steel monopoly, then it appears to be plainly in evidence that we are paying slightly more for our domestic steel than it is actually worth, and that a tariff which produces such abnormal conditions is worse than useless.

* * *

INVISIBLE ECONOMIES.

S. H. BUNNELL.*

The effect of distributing the shop expense among the various paying jobs is to obscure its details, particularly to obscure the proportion of wasted expenses, lost time and the like, which may be caused in particular by the doing of certain classes of work, but which are, by the general system of distribution, hidden from view and spread over all, with the result of increasing the computed cost of everything, and diminishing the profits on all. It is an important part of the manager's duty to investigate invisible losses of all kinds, and to conduct matters so as to reduce these as far as possible.

Among such losses are those due to faulty arrangement of plant, so that unnecessary steps must be taken by workmen. There is little difficulty in transporting material by tracks or cranes over almost any desired distance, and in shop work this expense is not a large item, though in the manufacture of steel and similar work, where the masses transported are enormous, it becomes of much greater importance to reduce unnecessary transportation by arranging the plant so that material may progress readily from one operation to the next. The steps taken by workmen, however, cannot be disregarded, and every unnecessary walk is so much unnecessary expense to the shop. Toilet rooms are often arranged at great distances; tool-rooms and storerooms are so located, in the endeavor to concentrate supplies and reduce the expense of caring for them, that many workmen have to walk long distances several times a day. It is easy to compute the loss in dollars and cents due to the time taken by an average man to walk one hundred yards and return. It will generally be found from such calculation that the expense of dividing tool-rooms is more than covered by the resulting saving, although this will never appear in dollars and cents on the books except as a reduction of general expense. In many cases the transportation of tools can better be taken care of by the use of cheap messenger boys, thus saving the time of the expensive men. Unnecessary writing on workmen's time cards, or requisitions for material, and on other reports which must be kept by workmen, more or less careless with such matters, but possibly earning good wages, may involve a large unnecessary expense. A computation of the number of seconds taken by a workman to find his bit of pencil and write a dozen words on a piece of paper or card held on his knee, or against a post, or some rough surface, may show that the employment of a special clerk to make out these cards would result in a large saving. Further, the cards written by the clerk could be more quickly handled, and necessary records made from them with small chance of error, while the time lost by the cost clerk's force in looking up errors and obscurities on time cards written by workmen will generally amount to much more than the cost of making out the cards in the first place.

The physical comfort of the workmen, due to spending their time in a well-lighted and comfortable shop with clean floors, and neatness visible everywhere, is a valuable adjunct in saving lost time. Mental satisfaction is also important. A raise of pay when requested may be expensive for the shop in one way, but the refusal of the raise is certain to be more expensive, as the workman will not equal his former efforts after a disappointment of this kind. Almost everything, however trivial, has its bearings on the expense of getting out the shop product, and too much care cannot be given to reasoning out the probable effect of each move, even though time cannot be afforded to go deeply into all such small matters. The outsider coming into a shop is often able to see chances for saving in what may be called "invisible expenses," which have entirely escaped the men employed there. It is a common occurrence that a city will refuse taxation sufficient to pave an important street and provide a good bridge, while a large number of its inhabitants are at the same time losing many times the amount that would be required for such taxes in hauling small loads, and in unnecessary wear and tear on their vehicles over this same street. The good roads agitation has brought this point clearly before the public, and the agriculturalist has been held up to ridicule for his refusal to assist the cause of road improvement, while he himself was losing every year fifty times the amount he would be called upon by the broadest scheme of road improvement to contribute to the general good. The man in the machine shop office should not have his point of view limited to the direct expense accounts, but the indirect expense should receive more, if anything, of the manager's time and skill, and the obscure and invisible losses should be sought out with the utmost persistence.

* Address: Watertown, N. Y.

* * *

We hear a great deal spoken of this or that new bridge as being the longest in the world. As a matter of fact, states *Railway and Locomotive Engineering*, the longest bridge is located in Sangong, China, and is called the Lion bridge. It extends five and a quarter miles over an arm of the Yellow Sea, and is supported by 300 huge stone arches. The roadway is seven feet above the water, and is enclosed in an iron network.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

According to a news item in the *Pittsburg Despatch* of July 1, the United States Steel Corporation intends to gradually replace the steam power for the blowing engines with gas engines, using blast-furnace gas.

The steel ship may properly celebrate its 50-year anniversary this year. It is stated that the first steel ship ever built was the paddle steamer *Ma Robert*, constructed in 1857 for the Livingstone expedition. The fifty-year anniversary is indeed worthily celebrated by the completion, in the same year, of three such giants as the *Lusitania*, the *Adriatic*, and the *Kronprinzessin Cecilie*.

According to *Page's Weekly*, the municipal council of Paris has adopted a resolution in favor of a project of making Paris accessible to large sea-going vessels by the construction of a large canal from Paris to the sea. The council has two schemes under consideration. The first would utilize the Seine, while the second consists in the creation of a maritime canal from Paris to Dieppe.

Some weeks ago the results of the experimental trials of the *Lusitania* were made public, and they are regarded by her builders as being extremely satisfactory. The vessel obtained a speed of 25 knots, and her engines performed splendidly. Taking into consideration the fact that the *Lusitania* was not running under full pressure at the time of the trials, the results are considered remarkably good.

The production of gold in 1906 was nearly double that of ten years ago, and materially larger than that of the preceding year. The world's production of gold is still on the increase, and it has been estimated that in 1907 the total output will be nearly ten per cent larger than that of 1906. Transvaal is producing the largest amount of any country, the United States coming in the second, and Australia in the third place.

It is reported by *Engineering* that the Russian government has decided to proceed with the construction of a double track on the Trans-Siberian railroad. This step has been taken because high military officers have arrived at the conclusion that if the Trans-Siberian railroad had been double-tracked during the war with Japan, the result of the conflict would have been different, as Russian troops could have been despatched to Manchuria much more rapidly.

In reporting to the American Foundrymen's Association upon tests made with cast iron containing nickel, James B. Webb states that the results of the tests do not indicate a marked improvement in the physical strength of the castings, and bear out the supposition that nickel in cast iron is either not distributed uniformly enough to do much good, or else will find its best use in special classes of the metal freer from the high percentages of impurities incident to the ordinary castings. These tests were undertaken on behalf of the association, and authorized at the convention last year.

In *Annalen der Physik* of July 5, an account is given by Mr. M. Gildemeister of some experiments which he has carried out in order to find how long a time it takes for the magnetism in an electro-magnet to disappear after breaking the circuit. He states that 1-300,000 second after breaking the circuit, the magnetism has gone down to one-half, and after 1-150,000 second to one-tenth its original value. After 1-50,000 second only the residual magnetism is left in the magnet. The core of the electro-magnet which was used for these experiments consisted of a great number of very fine low carbon iron wires.

An interesting comparison between the cost of operating automobile fire engines and horse-drawn engines has been made in Hanover, Germany. This city was the first one in that country to procure a complete automobile fire engine service. It appears that while the first cost of the engine and horses for the horse-drawn service is $11,050 as compared with $13,090 for the automobile, the cost of maintenance is so much less for the latter fire engine that already at the end of the first year the automobile service is the cheaper one, and at the end of five years there will be a total saving of nearly $15,000. If these figures be correctly arrived at, it would seem that the automobile would, before long, entirely occupy this field.

A new tube railway has been opened in London, having a total length of eight miles. This underground railway is remarkable in several respects. It rises 272 feet in its course, and at one point it is 250 feet below the surface, one station beiug 192 feet under the surface. This is the sixth underground electric railway in operation in London, and five more are projected or under construction. The subways in London differ from those of New York City in that all run at a considerable depth, from 50 to 100 feet below the surface being a common location. In so doing, the subways do not interfere with surface conditions, or conditions near the surface, such as gas and water piping systems, etc.

The British Thomson-Houston Company has supplied the *Times Engineering Supplement* (London), with the results of tests made upon one of four Curtis turbines installed at the Fisk Street station of the Commonwealth Electric Company of Chicago. This turbine, which is rated at 9,000 kilowatts, was tested at loads varying from 5,374 kilowatts to 13,900 kilowatts, or from 60 per cent load to 55 per cent overload. The steam pressure ranged from 176 pounds to 198 pounds per square inch, and the vacuum was fairly constant about 29.50. The steam was superheated 116 to 148 degrees, and the consumption in pounds of steam per kilowatt-hour ranged from 12.9 to 13.6. The constancy of the consumption over so wide a range of load is remarkable.

While speed indicators on railway trains do not seem to have met with great favor on American or British railroads, they are very commonly used in continental Europe. According to *Railroad Men*, in France every passenger engiue is equipped with this instrument. On nearly all the lines on the Continent their use is customary, and in some countries even main-line freight engines are so equipped, and the indicators are considered quite as important as steam gages and automatic brakes. It would seem that their use would tend to minimize accidents caused by fast running. The indicator not only shows constantly the speed at which the train is running, but records it in a locked box to which the engineer has no access. The trip record is taken to the office when the engine completes the run. There are said to be 20,000 indicators in use in Europe.

Since the use of concrete had been introduced in this country, the uses to which it has been put have been many and varied. One of the most remarkable departures in the direction of the use of reinforced concrete is that of making concrete telephone and telegraph poles from this material. Nearly a year ago experiments were begun at Richmond, Ind., with reinforced concrete poles. These poles were 30 feet in height, octagonal in shape, and tapered towara the top, provided with gains to be used in climbing and for the insertion of cross arms. A number of these poles were erected on one of the main lines of the company's road, and a short line was constructed wholly with concrete poles. After a year of service it has been found that these poles give as much satisfaction as do wooden poles, and that they have the additional quality of being almost indestructible.

Some interesting statistics are given in the *Archiv für Eisenbahnwesen* respecting railway mileage in various countries. It is estimated that the total length of lines constructed and open all over the world, down to the end of 1905, amounted to 562,436 miles. The annual rate of mileage increase varies from about 3.4 per cent to 2.3 per cent; the total increase in the number of miles open for traffic in the five years ended with 1905 was 10.9 per cent. America, North and South, naturally heads the list of the different continents with a gross total of 285,781 miles. Europe is but a poor second, with a total of 193,133 miles; Asia follows next, with 50,562 miles; then comes Australia, with 17,431 miles, and Africa brings up the rear, with 16,528 miles. It is stated that the cost of land and construction of the European railways is about double that of the lines in any other quarter of the globe. The assumed total expenditure for European railways amounts to about $23,000,000,000, and the cost of the railways in all other parts of the world nearly $22,500,000,000. The cost per mile of European railways averages about $120,000, and of the roads in the United States $54,000.

The use of electrical power in modern steel mills is now extended to cover practically all the machinery of the plant, the systems of telpherage, conveyors and practically all the appliances for handling the hot metal, being now universally driven from individual motors. At the Gary plant of the Indiana Steel Co., the rail mill will probably require the greatest amount of power. This mill is situated about a half mile from the power house in which the sixteen huge units will be housed, and will consume approximately 10,000 kilowatts to operate the induction motors which drive the main rolls. These motors range in capacity from 2,000 to 6,000 horse-power, and three of them have overload capacity of 9,000 horse-power for an hour. The breaking-down stands in the rail mill for reducing ingots to fair-sized blooms, will be driven by two 2,250-horse-power motors. The blooms will then go to the blooming mill, which is operated by one of the 6,000-horse-power motors, and from this they will pass to the mills driven by two 4,500-horse-power motors, receiving their finishing passes in the mill driven by a third 2,500-horse-power motor. All the tilting and feed tables for the various passes, all hot saws, hot and cold pull-ups, the transfer tables, straightening machines and cold saws, and all auxiliary machinery of the mill will be driven by electric motors.

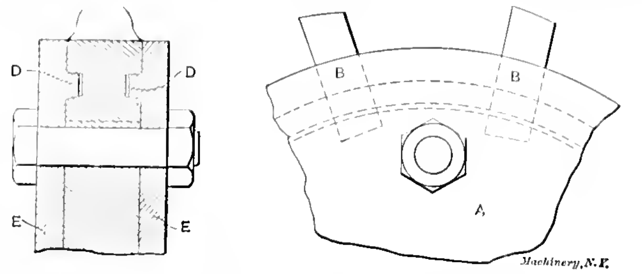
THE VALUE OF OLD VALVES FOR SCRAP METAL.

According to the *Brass World* there is no old metal, with the exception of copper wire, that commands so high a price from the brass founder as "old valves." A foundryman is always willing to buy them, as they are the best material he can obtain. There is no class of brass castings made with more care than valves. Not only must the metal be of a good bronze color, but it must cast well, so as to stand the pressure test. It must also contain sufficient tin to harden it and prevent its bending while being worked, or when screwed to the pipe. It is a pretty good metal that will stand these requirements, and a valve that has passed inspection must surely be of good quality. There may be said to be practically two standard valve mixtures on the market to-day. One of them is very extensively used and all ordinary grades of valves are made from it. The mixture is as follows: Copper 86 per cent, tin 5 per cent, zinc 5 per cent, lead 4 per cent. For the best grade of valve the following mixture is usually employed: Copper 86 per cent, tin 7 per cent, zinc 4 per cent, lead 3 per cent. Scrap cocks should always be carefully sorted from the valves, as the quality of metal used in them is inferior. In sorting over the material, also, the founder should take care that no iron wheels are included. The wheel is the only part of a brass valve that is made of iron, so that the rest may be thrown in indiscriminately. In general, however, if a first-class quality of metal is wanted, the best material will be found in valve bodies. There need be no hesitation in melting them up as they are, without the addition of any other ingredient.

IMPROVED INSERTED BLADE MILLING CUTTER.

The Mechanical Engineer.

The accompanying cut shows an improved method of securing the teeth of inserted blade milling cutters to the body. This arrangement is the joint patent of H. S. Moorwood of Onslow House, Brocco Bank, Sheffield, and J. M. Moorwood of Millhouses Lane, Millhouses, Sheffield, England. The body *A* of the cutter is provided with slots *B* to receive the cutter-blades as usual, but the lower ends of the cutter blades, as well as the portions of the body between the blades, are grooved to receive the annular projection *D* of two disks *E* which are screwed tightly to the body, thus holding the blades



Improved, Inserted Blade Milling Cutter Design.

in place. The groove in the blades as well as the annular projection on the side plates are slightly tapered on the inside so that the inserted blades are drawn inward and held firmly against the bottom of the slots for the blades in the body, when the bolts are tightened. While, without modification, this method may have its difficulties, and may be rather expensive, the idea involved is commendable, and may serve to suggest something of better practical application.

SECURING UNIFORMITY IN PHOSPHOR-BRONZE SPRINGS.

The Brass World, April, 1907.

Among the copper alloys, there is none which is surrounded with so much uncertainty as phosphor-bronze. This is particularly true of springs made of this material. If a spring of a material other than steel is desired, phosphor bronze is usually specified. If the mixture is rightly made, such a spring cannot be surpassed by anything except steel. The action of the phosphorus in phosphor-bronze is to reduce the oxides of copper and tin that are formed in melting. Any amount over and above this quantity acts deleteriously and injures the metal. Experience has taught that if the phosphorus in rolled metal exceeds 0.05 per cent, the bronze is injured.

The greatest variation in rolled or drawn phosphor-bronze, however, is caused by the tin content. A bronze which contains only 3 per cent of tin is inferior to one which contains 8 per cent, though both may be phosphor-bronze. On account of the difficulty in the rolling or drawing of phosphor-bronze containing a high tin content, manufacturers will substitute a lower percentage if it is possible to do it. The presence of zinc is also an unsatisfactory condition. A good spring should contain only copper, tin, and a very small quantity of phosphorus.

Those who have had trouble with phosphor-bronze springs should ascertain whether their troubles are not caused by the absence of the necessary amount of tin, or the presence of zinc. When rightly made, phosphor-bronze is an excellent spring metal, but if not, it is inferior to yellow brass. The "temper" is produced by cold-rolling, of course, but unless plenty of tin is used in the mixture, the requisite "temper" cannot be produced, no matter how much the metal is rolled.

GENERAL CONCLUSIONS FROM THE A. C. A. SEALED BONNET AUTOMOBILE CONTEST.

Albert L. Clough, in the *Horseless Age*, June 26, 1907.

On June 19 the Automobile Club of America arranged what has been termed a sealed bonnet contest; that is, all the machines taking part in the contest were completely equipped before the start, and then seals were affixed to all operating parts. The contest consisted of a run over a more than 600 mile long route, accomplished without adjustment or repairs of any kind, and lasted for four days. The outcome of the

contest shows that 41, out of 47 cars entering it, accomplished the feat of being driven the distance mentioned over good roads without suffering any derangement in their machinery. This is a remarkable showing, and a demonstration of the present reliability of modern motor cars. It is a result which is believed to have been unattainable one year ago, and which two years ago would seem to have been absolutely impossible. The mileage equals that which the average private car covers in an entire month, and is, in fact, in excess of the mileage which a locomotive or trolley car covers without being laid off for attention and repairs. But, of course, the result of the contest must not be understood to mean that 87 per cent of all modern motor cars are capable of covering 600 miles without adjustment or repairs, for the cars concerned in this test were of higher grade than the average, comparatively few of the lower priced cars having entered the contest. Nor can it be said to be a marked distinction for the 41 cars, out of the 47, that they accomplished the feat, or that they were of superior make to the remaining ones, for the element of chance in a contest like this is greater than in a contest of any other kind.

The conclusions reached are more as to the general reliability of motor cars as at present manufactured than in regard to the distinct superiority of the cars that accomplished the feat. One car, for instance, built by a company of established reputation, and known as being reliable, suffered the breakage of an inlet valve spring. It is hardly likely that the inlet valves of this engine were inferior to those of many of the other cars, or that in this engine there would be, in say 10,000 miles of running, any more broken valve springs than in the other cars in the same period of service. It would therefore be unjust, indeed, if any one draws the hasty conclusion that because a particular car has been unsuccessful in this contest, it is necessarily inferior to any of the successful ones. A good showing for the automobile was that in only two instances were cars crippled by the breakage of any essential part, and in one of these cases the breakage happened after due warning. The final conclusion of the sealed bonnet contest, for this reason, is simply that it furnishes the strongest vindication that we have ever had of the adaptability of motor cars in general, but that it throws no certain light upon the reliability of different makes. If another contest of this sort is ever run, it is obvious that much harder roads will have to be selected, and the contest must be prolonged greatly in regard to mileage.

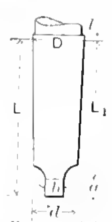
STANDARD GERMAN TAPER SHANKS.

Zeitschrift für Werkzeugmaschinen und Werkzeuge,
July 15, 1907.

Since a long time back the Association of German Machine Tool Manufacturers has been endeavoring to establish a standard system of taper shanks, based on the metric system, to replace the Morse system, which on account of its irregularities and its basis of English measurements is not considered desirable in Germany. With the exception of a few machine tool builders who fear the effects of such a move, particularly on their export trade, the proposition has met with favor not only on the part of machine tool manufacturers, but on the part of their consumers as well, and many governmental officers and state railway shops have pronounced themselves in accord with the movement for a metric standard taper shank, based on a constant taper for all sizes. The difficulties that necessarily must follow the introduction of a new standard are duly appreciated, but the final gain is expected to be great enough to outweigh the unfavorable influences. The introduction would be gradual, and thus cause as little disturbance as possible.

The taper of the proposed standard is *one in twenty* or 0.6 inch per foot, which, in fact, is the same taper as proposed by Mr. Oscar J. Beale in the Jarno taper system, and also the same as in one of the Morse standard tapers, the No. 1. In the accompanying tables are given the dimensions for the proposed standard system of taper shanks, both with and without tang, and the dimensions for the hole in the socket. All dimensions are in millimeters. The first four sizes, Nos. 1 to 4, correspond closely to Nos. 1 to 4 Morse standard taper. From and including No. 5, the system is based on the formulas given, but the *first four sizes do not conform to these formulas.* No dimensions have been given in this standard system for unessential details, such as the radius of the cutter for milling the tang, etc., as this was not considered necessary.

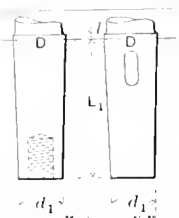
TAPER SHANKS, WITH TANG.



Machinery, N.Y.

		1	2	3	4	5	6	7	8	9	10	11
Largest diameter....	D	12	18	24	32	40	50	60	70	80	90	100
Length of taper in socket............	$L = 2\ D + 60$	60	80	100	120	140	160	180	200	220	240	260
Projection outside of socket...........	$l = 0.1\ D$	4	4	4	4	4	5	6	7	8	9	10
Smallest diameter...	$d = 0.9\ D - 3$	9	14	19	26	33	42	51	60	69	78	87
Length of tang......	$a = 0.2\ D + 8$	8	10	12	14	16	18	20	22	24	28	28
Thickness of tang ...	$b = 0.3\ D + 2$	5	6.5	8	11	14	17	20	23	26	29	32

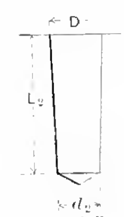
TAPER SHANKS, WITH THREADED HOLE OR KEYWAY.



Machinery, N.Y.

Largest diameter....	D	....	....	24	32	40	50	60	70	80	90	100
Length of taper in socket.............	$L_1 = 1.8\ D + 52$	...	.....	88	106	124	142	160	178	196	214	232
Projection outside of socket.............	$l = 0.1\ D$	....	....	4	4	4	5	6	7	8	9	10
Smallest diameter...	$d_1 = 0.91\ D - 2.6$	....	....	19.6	26.7	33.8	42.9	52	61.1	70.2	79.3	88.4

DIMENSIONS FOR SOCKETS AND TAPER REAMERS.



Machinery, N.Y.

Largest diameter....	D	12	18	24	32	40	50	60	70	80	90	100
Length of taper in socket............	$L_2 = 1\ 85\ D + 52$	52	71	88	108	126	144 5	163	181.5	200	218.5	237
Projection of reamer, minimum	l	4	4	4	4	4	5	6	7	8	9	10
Smallest diameter...	d_2	9.3	14.45	19.6	26.6	33.7	42.775	51.85	60.925	70	79.075	88.15

THE WORKING OF LARGE GAS ENGINES.

Times Engineering Supplement.

At a meeting of the British Society of Engineers, Mr. George Moore read a paper dealing with the working of large gas engines. It was pointed out that while the use of large gas engines had increased remarkably during the past few years, very little information had been given as to the characteristics and behavior of these engines while in operation. Continental engines are divided by the author into three different types: the double-acting 4-cycle type, the Oehelhaüser and Körting types. The Körting and Oehelhaüser engines possess the advantage over the Otto cycle type that there is no need of water cooled exhaust valves. The thermal and mechanical efficiencies of the Körting type, however, are comparatively low. Trouble has arisen in this engine, as well, in regard to the piston, owing to its great size and weight, and certain designers make a piston in three pieces to overcome certain difficulties in this respect. The complicated form of the cylinder head of the Körting engine renders it liable to crack, and experience has shown that the greatest wear takes place in the middle of the cylinder near the exhaust ports. Gas engine designers are still in doubt about whether it is expedient to chamber the tail rods, and practical experience seems to bear out that the tail rod itself is not of any great advantage on engines of less than 500 horse-power. In the actual running of large gas engines it has been found that one of the most persistent troubles is the liability of pre-ignition, and with large engines having cylinders of about 24 inches in diameter, pre-ignition is never entirely absent when using producer gas. The author's experience is that Mond gas is satisfactory for larger engines if reasonable care is taken. Gases containing a high percentage of hydrogen are not very suitable, because the hydrogen ignites at a comparatively low temperature, and a high percentage of this gas is liable to cause pre-ignition. The question of the value of positive scavenging has not, as yet, been settled in regard to the four-cycle type of gas engines. In regard to various methods of governing, it is pointed out that the by-pass governor valve, commonly used on the Körting engine, does not work satisfactorily with producer gas.

POWER REQUIRED FOR MILLING MACHINES.

S. Streiff, in *Werkstatts-Technik*, January, 1907.

The following experiments for finding the power required for driving milling cutters have been carried out on a special milling machine. The results are given in the accompanying table. Only the results of such experiments where the power required was determined definitely are taken into consideration. A number of experiments, where either the time

TABLE OF MILLING MACHINE EXPERIMENTS, SHOWING RELATION BETWEEN FEED, DEPTH OF CUT, AND POWER REQUIRED

Number of Experiment.	Number of Revolutions of Cutter per Minute.	Feed: Per Minute, inches.	Feed: Per Revolution, inches.	Cutting Speed of Cutter per Minute, feet.	Depth of Cut, inches.	Width of Cut, inches.	Power Required, H. P.	Metal Removed per Hour, pounds.	Power Required per Pound hour, H. P.
1	24	2.46	0.10	37	0.26	23.6	25	245	0.102
2	24	3.50	0.15	37	0.26	10.2	17	150	0.113
3	24	4.35	0.18	37	0.14	9.8	17	97	0.175
4	24	3.50	0 15	37	0.49	9.8	27	490	0.055
5	19	4.33	0 23	29.5	0.28	9 3	17	331	0.051
6	23	4.17	0.18	36	0 28	20 5	27	386	0.070
7	23	4.17	0.18	36	0.28	9.8	20	183	0.109
8	40	1.89	0 05	64	0 24	10.2	17	74	0.230
9	40	3.94	0 10	64	0.37	13.8	21	331	0.063
10	40	5.79	0 14	64	0.16	16.5	17	123	0.138

of cutting was insufficient to get a good average, or where some other disturbing factor entered in the experiment, have been left out of consideration. The milling cutters used were made from high speed steel. It will be seen from the table that a proportionally higher amount of power is required for light milling than for heavy, a result that is rather natural, as the running of the machine itself, irrespective of the work being performed, would require practically the same amount of power in either case. It will also be seen from the table that the depth of the cut does not increase the power required in the same proportion as does the width of the cut, and that work with a heavy feed and a deep but comparatively narrow cut requires far less power for the amount of metal removed than does a slow feed, and a cut of moderate depth, but wide. In general it seems as if a slow feed is particularly uneconomical in the use of the milling machine. The figures in the table have been transformed into the English system of measurements, to facilitate comparisons.

PRECISION GRINDING.

Paper by H. Darbyshire, read before the Engineering Conference of the British Institution of Civil Engineers.

Speaking comparatively, the gratifying advantages that may be obtained from the use of high speed steel are limited to a certain point, that point being where a fractional quantity of material must be left, and extreme care exercised in arriving at the precise dimensions. For this final finishing I claim that the grinding machine is the most rapid and economical tool to use, for the following reasons: It removes this fractional amount of material in the shortest comparative time; it arrives at the desired dimensions by a series of rapid and minute chips which cover the whole surface repeatedly, and whose depth is under perfect control; any variation in its shower of sparks is instant and visible evidence of its change of form, either through distortion or accident; and, finally, it allows of the actual surface finisning being the last operation, thereby removing all those errors and distortions which are a result of keywaying or other operations. To those who are not conversant with the more modern development of the grinding machine, the first of these reasons may appear an exaggeration; but an inquiry into what is being done in the matter at the present time will only serve to substantiate the statement. For the correcting of hardened work it has long been considered a necessary part of the engineer's equipment, but its use for general finishing purposes has been, and is still, considered by many to be indulging in a luxury.

As instances of the amount of stock which may be removed by a modern grinding machine, I may quote the following examples of work done: Several cast-steel bars, 10 feet in length and 1 15/16 inch in diameter, were reduced 0.080 inch in an average time of 75 minutes, the greatest variation in diameter being 0.0004 inch. A chilled-iron roll, 4 feet long and 17 inches in diameter, was reduced 5/16 inch in diameter in 7 hours. A cast iron roll, 4 feet by 6 1/16 inches, was reduced 1/16 inch in diameter in 25 minutes, the greatest variation being 0.0005 inch. These examples will convey some idea of the amount of material which may be removed in a given time by a grinding wheel; and in the first two examples it was found more economical to grind outright from the rough black bar and casting than to turn and grind. I find the leaving of a grinding allowance of 0.015 inch to 0.030 inch on the diameter to be the most economical for general work. These broad limits allow the lathe hand to use coarse feeds and work rapidly. In order to keep within these limits, rough tolerance gages are desirable, for if the maximum amount given be exceeded, waste of both grinder's time and abrasive material must ensue. The fact that a ground surface is superior to that produced by a file or water-cut is indisputable, and the rapid manner in which a fixed dimension may be obtained is a further recommendation; that the result is effected by a series of minute chips with a visible index of their depth is another point in its favor. In order to start a finishing cut in the lathe and control its size, the length of its traverse requires a sense of touch which may have taken years to attain; to obtain a similar result, but a better surface in the grinding machine, is an easier matter, because another sense is enlisted, and the work is simplified. Given a few days' practice with a grinding-machine, an operator can judge to 0.001 inch the depth of the cut he is taking, by the shower of sparks displayed. In actual practice, where accurate results are necessary, the following points must receive attention. The first in importance is that there must be an abundant supply of water delivered at the grinding

point. Secondly, hard bonded wheels should be avoided, as they do not cut freely, and may well be compared to a dull milling cutter; they are mostly chosen through mistaken ideas of economy.

Where a high degree of surface finish is required for appearance only, the grinding machine is superior to hand labor, for various reasons; it is more rapidly done, and leaves a surface more uniform and pleasing to the eye. This latter recommendation may seem a trivial one if we fail to remember that this method of finishing secures the most accurate results; it yields cylindrical work which is both truly round and concentric with the center points on which it is held, and this is always an advantage. Again, in the finishing of plane surfaces the easiest method of holding the work to the machine table is that which will give the most precise results; thus a slide or similar body would be outwardly finished by clamping its scraped and finished ways to packings ground in position. This insures absolute truth of outer alignment, which would be of great value to the operator of the future built-up machine, and its beauty of finish would probably be a means of insuring his care that its accurate condition be maintained. The great advance that has been made in grinding practice recently has been mostly in work of cylindrical form, and for this purpose its claims to attention are undeniable. Personally, I see no reason why the same advantages cannot be obtained in the grinding of plane surfaces with a suitably designed machine.

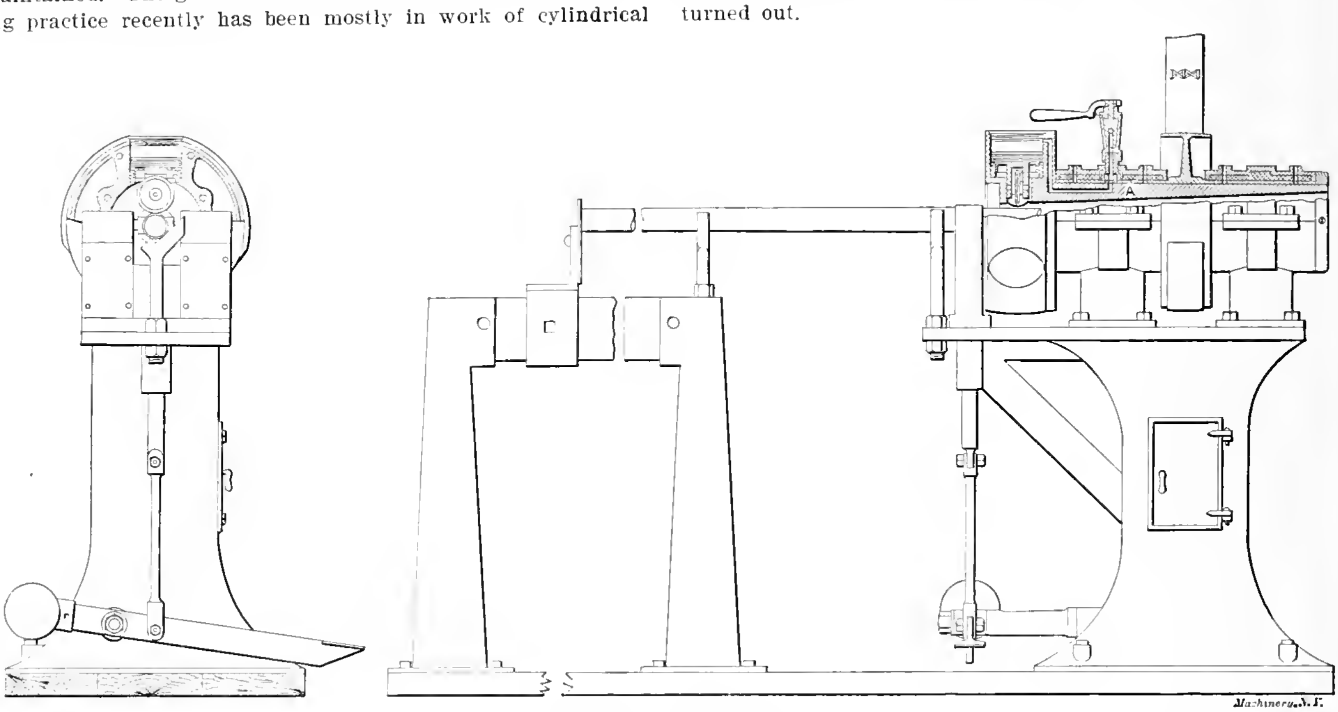
PNEUMATIC TUBE AND PIPE CUTTER.

Railroad Gazette, August 2, 1907.

A pneumatic tube and pipe cutter of interesting design is used in the shops of the Seaboard Air Line at Portsmouth, Va. This machine can be easily operated by one man, and can cut three two-inch locomotive tubes per minute with an air pressure of 50 pounds per square inch. If the air pressure is increased, the machine will perform its work even more rapidly.

The machine consists of a sleeve *A* turning in long bearings and driven by a pulley keyed near its center. At the end of the sleeve is an enlargement containing three cylinders to which pistons are fitted. These cylinders stand on radial lines and the pistons have roller cutters attached. There are ports through the sleeve, as shown, that lead to the outer end of the cylinders, through which air is admitted by means of a three-way cock. Stops for the tube and Y-supports are provided beyond the end of the machine. After the machine is started the tube is placed in position to be cut, resting on the supports and shoved back against the stop. It is clamped by pressure on the pedal shown, and the handle of the three-way cock is turned to admit air to the outer ends of the cylinders. This forces the pistons in and the cutters against the tube. As the circular head revolves the cutters roll around the tube and are forced in, and cut off the piece in a few revolutions.

The piece cut off passes out at the back end through the hollow tapered spindle. When the tube is cut, the air valve is moved to exhaust, and the cutters open by centrifugal force to receive another tube. As the tube is clamped by the pedal it can be fixed and released instantly without loss of time, and as the tube does not revolve, the machine is practically noiseless. In addition to these advantages the boiler maker does not have to mark each tube where it is to be cut, as the length is fixed by the adjustment of the stop. The cutters are of steel, ⅛ inch thick and 3 inches in diameter. One set of cutters in the Seaboard Air Line shops has been in service for four months and has made 24,000 cuts, without grinding, on 2-inch tubes, approximately ⅛ inch thick. Previous to building this machine, the number of engines that could be turned out of the shop was dependent on the tube work; but since its installation the amount of tube work to be done is not considered in deciding upon the number of engines to be turned out.



Pneumatic Tube and Pipe Cutter.

PREPARATION OF ENGINEERING ARTICLES AND TECHNICAL PAPERS.

Proceedings, American Society of Mechanical Engineers, October, 1906.

In preparing an article for publication, or for presentation before a professional society, there are some general principles, the observance of which will add greatly to the value of the work. These principles do not relate to the subject matter directly, but rather to the manner of presentation. In the first place, as a paper generally does relate to some especial department of work with which the author has had experience, he is very apt to assume many things as matters of common knowledge, when in fact they are not nearly so familiar to most of the readers as they are to himself. It is not usually a mistake to be too clear, or too definite, particularly in the preliminary statements. If, therefore, the author avoids undue assumptions as to the familiarity of his readers with the subject in hand he will add greatly to the value of his statements. The rules to follow for the presentation of the subject itself may then be given as follows:

State first, in a brief and clear manner, just what the article is about, what the author is endeavoring to show, or what he expects to prove. This introductory statement should be *very brief*, and having been made, it should be kept in mind throughout. A paper should be about but one thing at a time, and that one thing plainly stated at the start.

Then should follow the general treatment; description of work, of experiments, of opinion, etc., this portion constituting the matter usually forming the body of technical articles or papers.

After this should come what may be called "proof," that is, a statement showing how the general matter immediately preceding has demonstrated what the author set out to show.

Finally there should come a very condensed summing up, in such a form that a brief glance would enable a casual reader to grasp the substance of the article, and decide without reading the whole, whether or not he wants to examine it in detail.

The introductory statement, and the final conclusions, should in every case, enable the reader to get at the kernel of the whole matter, of which the bulk of the article should be the detailed and expanded treatment.

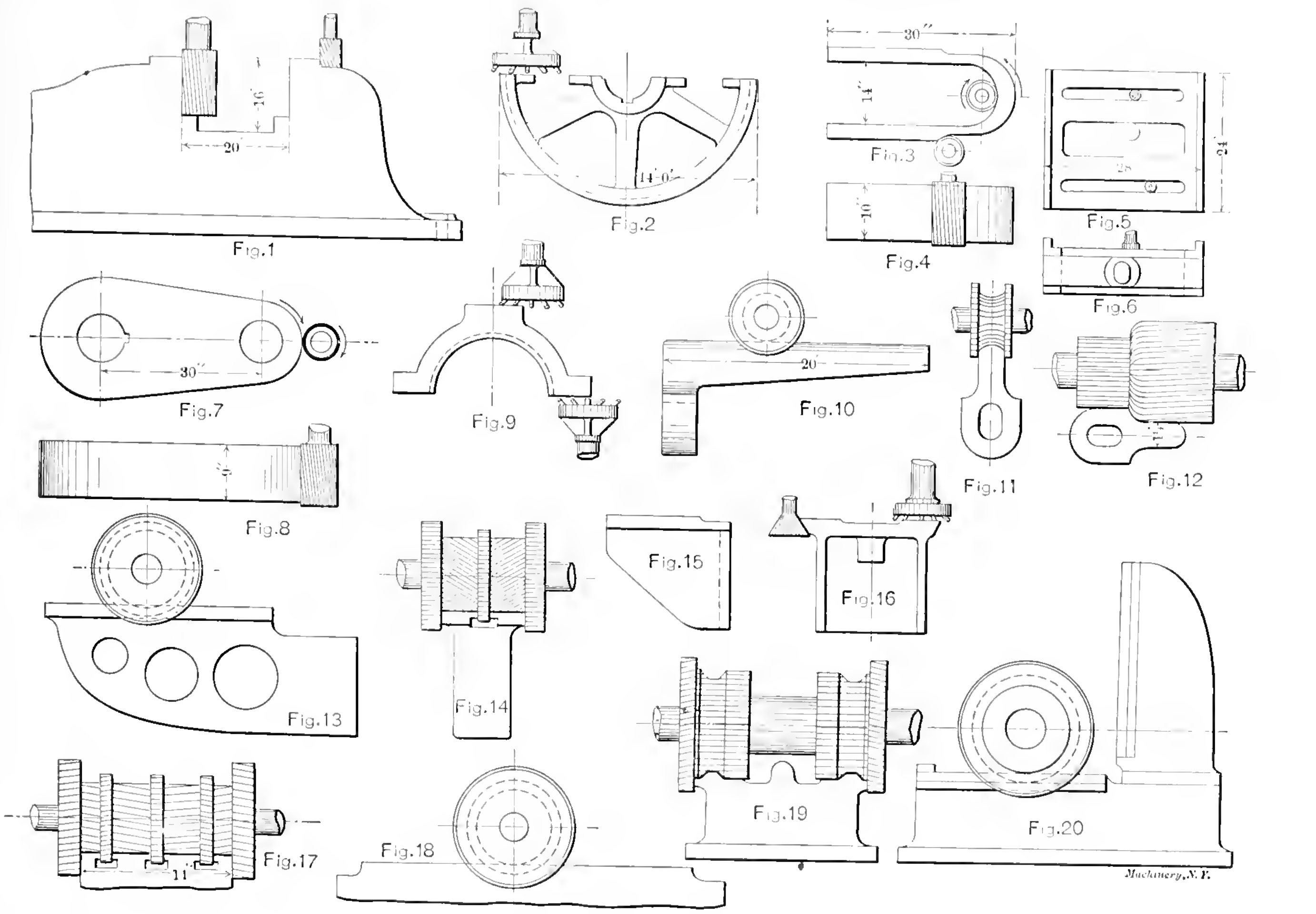
The following rules should be adhered to in regard to the mere mechanical preparation of copy for publication. Write plainly, on one side of the paper. Number the sheets consecutively in the upper right-hand corner, and have them of a uniform size. Put full name and address on all manuscripts. All sketches, drawings and tables should be made on separate sheets of paper. In selecting photographs or making photographic prints for illustrations, it should be remembered that the glossy solio prints are better suited for reproduction than velox, or other matted surface paper; besides, they bring out all the detail in the negative to the best advantage. Photographs should not be printed too deep, and the reproductions are better made from prints of a slightly reddish tone than from those over-toned to a bluish tint.

All copy intended for illustrations should be clearly marked with the title, subject and author's name, a reference to the manuscript to which it relates, and all other data of interest. This had better be written on the back in pencil; ink is apt to show through, especially when written on the back of light portions of a photograph. If the illustrations be many, a list of them, giving their titles in brief, should properly accompany the manuscript.

THE RELATIVE VALUE OF MILLING AND PLANING.

Walter Duckitt, in *The Engineering Review*, July, 1907.

The relative merits of milling and planing processes is a subject which has received the attention of some of our most capable engineers and machine tool builders during the past few years. Speaking broadly on the question, it must be admitted that the field of operation of the planer is comparatively small compared with that of the miller, the latter machine having developed, during recent years, to such an extent as to bring it into the front rank of machine tools, and to render it an indispensable acquisition to the shops. It has by no means, however, displaced its older rival, the planing machine, which has to be considered in its redesigned and appropriately named "high speed" type. One of the chief and most advantageous features of the planing machine is the comparative cheapness of its cutting tools and general equipment, as compared with those required for its more modern competitor, the miller. The former, when belted up, can generally be set to work at once, as any tool smith can easily forge the general run of cutting tools that are required, whereas, in the case of the miller, a large equipment of cutters and fixtures is required, sometimes amounting in value to a thousand dollars or more.



Examples of Milling Operations.

The milling machine, therefore, in some respects, is at a disadvantage as compared with the planer, namely, that whereas the former requires a good tool-room to keep its equipment in thorough order, a tool smith and a simple grinder suffice for the latter. Even with this to be said in favor of the planer, however, it must not be taken that it scores as heavily as at first appears in the matter of cost of equipment, as most of the leading brands of high speed cutting steel now on the market are very expensive, and in a full set of tools for a planer, therefore, there is a large amount of capital sunk in the weight of steel alone, to say nothing of the labor.

Milling machines which enter the field of competition with the planer may be classified under vertical and horizontal types. Of the horizontal spindle type there is the small hand

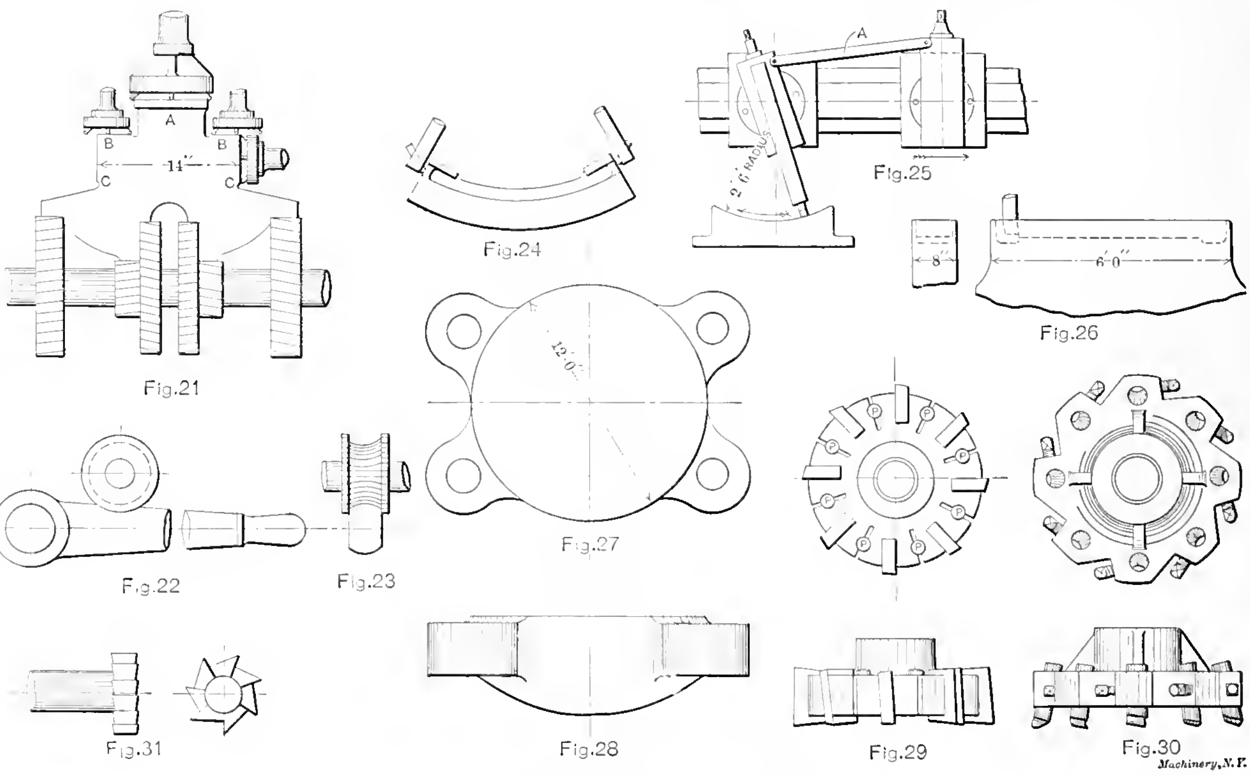
feed class, which can scarcely be said to come into actual competition with the planer, except for milling keyways into shafts, spindles, etc., which, if of any length, was formerly done entirely on planers. For keyway cutting, the milling machine may fairly claim to have scored heavily, and of late years has taken this class of work entirely off the planers, as with the latter machine a highly skilled man is required to cut the keyway to its proper dimensions, whereas with a miller, all that is required is a simple keyway cutter of the required width, and the only dimension the operator has to watch is the depth. A comparatively unskilled, and, therefore, much lower rated man can accomplish this.

Coming to the Lincoln type of miller, this machine is chiefly used for manufacturing operations of the medium and light trades, such as automobiles, small arms, sewing machines and bicycles; indeed, it is in a great measure due to this type of machine that these trades have developed to their present magnitude, enabling the various small operations to be performed by cheap labor by the aid of jigs and fixtures, coupled, of course, with good supervision. A very large variety of operations can be performed on the Lincoln miller for a mere fraction of the cost that would be involved were a planer used.

correct radius as shown. These levers are milled on both edges in exactly fifteen minutes each, at a cutting speed of 46 feet per minute, and a table feed of 3 inches per minute. Of course there is not much to remove, but it would take a planer at least one and one-half hours to perform the same piece of work to a very indifferent finish.

Figs. 17 and 18 show a gang of cutters operating on a plain milling machine table. The two outside cutters finish the table to width, the four small cutters operate on the top of the table, while the three narrow cutters finish the T-slots to width, leaving them to be finished with the T-slot cutter, Fig. 31, on a vertical machine. The gang cutters when not used for the job, are stored away complete with their arbor, because, if used singly on general work, they would lose their size, owing to the necessity for constant grinding and resharpening. This is a very important item with expensive gang cutters, which should be borne in mind. It formerly took twelve and one-half hours to plane up this table; it is now milled in four hours at a cutting speed of 35 feet per minute and a table feed of $1\frac{1}{4}$ inch for the roughing and $1\frac{3}{4}$ inch for the finishing cut.

Figs. 13 and 14 show a planer housing arranged to be gang milled on the face on a heavy horizontal slab miller of



Examples of Milling and Planing Operations.

We then come to the upright plain miller with overhanging arm for support to the cutter arbor and adjustable knee or table support. These machines are adaptable to a wide range of work to which the planer formerly claimed a monopoly, effecting, in the majority of cases where they are employed, a very considerable economy.

Examples of Saving Afforded by Milling.

A very good example and typical piece of work suitable for either the Lincoln or upright plain types is the forged steel cotter shown in Figs. 10, 11 and 12. Machined all over for the connecting-rod ends of a large stationary Corliss engine, this is a difficult piece of work to perform on the planer, due to so many curved surfaces and radius corners for forming the head. It formerly took nine hours to plane, and then only resulted in a very imperfect job, necessitating several hours filing and fitting to finish it. A boy now completes it in a miller in $4\frac{1}{4}$ hours, representing a clear saving in labor cost of over 250 per cent. Another example of milling suitable for the Lincoln and upright plain type of machine is the brake lever for an automobile shown in Figs. 22 and 23. This is a mild steel stamping, with round edges, 2 feet 6 inches long, formed with a simple form cutter of the

the Ingersoll and Newton types, at a table feed of $2\frac{1}{2}$ inches per minute. This is done with about 60 per cent economy, as compared with the planer. Figs. 19 and 20 show a very excellent piece of work done on a heavy slab miller. The work is a bed for a gear hobbing machine, only four cutters being required for the operation, including the finishing of the sliding ways for the table on each side. These ways are completed with the two form cutters shown, spaced the exact distance apart, which is a very vital point, and saves a lot of bedding when fitting the table. The latter is also gang milled, with suitable cutters, to fit on the ways. The housing shown in Fig. 20, and also the head for carrying the cutter spindle, are milled in a similar manner. Fig. 1 shows the crank-shaft end of a large stationary engine bed, the adjustable bearing gap being milled out to size by a large and extremely powerful machine of the milling and boring type. The cutter is fed to the work, the latter remaining stationary; the bed end is milled complete for the bearing and cap in ten and one-half hours, a performance that would be very difficult to duplicate on a planing machine, however powerful.

Fig. 2 shows part of a large rope driving fly-wheel, cast in halves, being milled across the joint in the same machine with an inserted tooth cutter. In this case also a great

saving is effected as compared with the planer. The latter machine has to travel across the entire face, and thus fully 75 per cent of the stroke is wasted, as reversals and very short strokes on heavy planers are not to be recommended; whereas with the miller, only the surfaces actually operated on are traversed. The keyways are also cut at the same time with an end milling cutter the same diameter as the width of key, and thus much time is saved in that direction also. Fig. 9 shows an eccentric strap being milled in the same manner, at a great saving compared with planing.

The vertical spindle miller has been developed to include a large field of operations from keyway cutting up to work of very large dimensions. Figs. 3 and 4 show a large forged steel strap for a connecting-rod, milled all over on a vertical spindle machine. The top and bottom are milled first with inserted tooth cutters, the strap being then finished inside and out, in the manner shown, at a cutting speed of 45 feet per minute and a feed of 2 inches per minute. The time taken is now twenty-one hours, whereas formerly, to plane and slot these straps took twenty-nine hours. Figs. 5 and 6 show a large double-ported slide valve, the ports of which are milled to size in a vertical spindle machine, after the valve has been planed all over, on a high speed planer, cutting at 35 feet per minute. This is an instance where both the planer and the miller can be used to advantage on the same piece of work for different operations, as it has been found that, excepting the port holes, these pieces can be planed cheaper than milled.

Figs. 7 and 8 show two large steam engine cranks of forged steel, planed top and bottom, and then finished all round on a large vertical spindle machine with a circular milling attachment. This machine has two spindles, the crank shaft and pin holes being bored both at the same time after the milling is completed, thus saving the time of extra handling, no small item where heavy weights are involved. Figs. 15 and 16 show a knee or table support for a milling machine, being milled on a vertical spindle machine, the angular cutter operating on the sides as shown. In Fig. 21 one of the most remarkable examples of milling is shown. It consists of an aluminum crank case for a 30 H.P. motor car engine, 2 feet 6 inches long. The top face marked *A* is first milled, the faces *B* being operated on at the same setting. The surface *A*, is then bolted against an angle plate, and the cam shaft cover faces *C* are completed. The cutting speed is 580 feet per minute, and the feed 10½ inches per minute. The case is then taken to the slab miller, and the bottom milled out complete with gang cutters as shown. These engine cases, which formerly took twelve hours to plane, are now milled in 5 hours. The milling machine is far better adapted for working aluminium than the planer, because of its having a much wider range of speeds and feeds.

The universal milling machine can fairly claim to be the king of millers, if, indeed, not of all machine tools, but being chiefly designed for tool-room work, it can scarcely be said to enter the field of competition with the planer. American tool makers, especially, have paid particular attention to this type of machine, and it is chiefly due to their efforts that it has reached its present high state of perfection.

Examples of Work More Advantageously Planed than Milled.

The design of the planer has, however, been much modified during the past few years, chiefly due to the advent of high speed steel. Whereas a few years ago it was considered good standard practice to work at a cutting speed of 20 feet per minute, and return at 40 feet, it is now no uncommon thing to see planers cutting at 40 feet, and in some cases 50 feet per minute, and returning at 200 feet per minute. Machines of this type can, on certain work, hold their own against the milling machine, and on this account will continue to keep up their established position in the shops. More particularly does this apply to the heavier branches; for instance, an example is shown in Fig. 24, which represents a segment of a large rope-driving fly-wheel rim being operated on at both ends at the same time by two saddles on the cross-slide. Eight of these segments—sufficient to build a wheel—are placed in a row on the machine table, being thus planed all at one setting, thereby ensuring extreme accuracy, cutting at 25 feet per minute and returning at 50 feet, using high speed tools. This is a very heavy piece of work which no milling machine could perform in the time taken to plane them. Fig. 25 shows a very interesting piece of work in the shape of a former plate, 10 feet 6 inches long, for a vertical plate bending machine, being planed out to a radius of 2 feet 6 inches in the manner shown. The left-hand tool box is set centrally above the work and the swivel head-bolts slacked; the saddle is then locked in position, and the rectangular bar, *A*, is connected to both the tool boxes. The right-hand tool box then commences to travel in the direction shown by the arrow, and by so doing drags the cutting-tool through the required arc. This is a job which no milling machine could accomplish satisfactorily with such primitive equipment.

Fig. 26 shows the slides of a horizontal engine which are planed to advantage, as milling cutters cannot be got in at the end, owing to insufficient clearance. Figs. 27 and 28 show a large hydraulic press top cover weighing 50 tons, which is planed on a large machine operating four cutting tools at the same time, two in each tool box on the saddle. There has not yet been found a quicker method. The concluding sketches, Figs. 29 and 30, show two types of inserted milling cutters for use on heavy milling machines. Fig. 29 is a type largely used on vertical spindle machines; the cutters are given 5 deg. forward rake, and are held in position by the taper pegs, *P*, driven into holes, which are gashed through with a slitting saw as shown, to give the necessary spring under the wedging action. This cutter gives good results, if ground accurately, on certain classes of work, but is more expensive to make than that shown in Fig. 30, which has simply round cutters secured by screws. The holes for carrying the cutters are not bored with any forward rake, that being ground on the cutter itself. This type of cutter is largely used on heavy rough work and also in smaller sizes on aluminum, where it scores heavily over the flat-tooth variety. The latter is not designed to allow of sufficient clearance on the bottom which is absolutely necessary on aluminum, otherwise the chips get under the cutters and produce a very rough finish on the work.

Weighing the profit-earning qualities of the planing and milling machines, it is generally conceded that the miller predominates, but at the same time, the planer still leads, on certain classes of work, such as long straight surfaces, plate edge planing, and lathe-bed planing, more particularly on the larger sizes, also planing the slides of their own beds, as well as tables, etc. It may safely be concluded that although the milling machine is pre-eminent, the planer will always find favor on certain classes of work.

* * *

MEASURING SCREW THREAD DIAMETERS.

WALTER CANTELO.*

It is always advisable when measuring screw thread diameters to measure them in the angle, in addition to testing their diameter on top of the threads and at the bottom of the thread groove, but unless calipers made expressly for the work are at hand, the measurement in the thread angle is apt to be omitted. The tables in the supplement were worked out by the writer in 1902 for convenient application in the inspection of screw threads in connection with ordnance inspection for the United States army. The method is known as the three-wire system of screw measurement, because three wires, of the diameter called for in tables, and applied as shown in the diagrams in the supplement, are used in connection with an ordinary flat point micrometer. The dimensions for the standard threads of the systems shown are given in the tables mentioned. For threads of special size or pitch, the values for the various thread parts are easily computed from the formulas given for the kind of thread under consideration It is especially necessary that the wires used be as nearly round in section as possible, and of uniform diameter.

Two methods of measuring are shown for the 60-degree V, U. S. standard and Whitworth threads, and for each method a formula and table of values are given. The three-wire method

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is preferred by the writer, because the error in the thread groove—if any be present—is taken into consideration twice, while by the single-wire method errors are liable to be introduced by the surface on top of the threads not being exactly concentric with the thread groove. It is evident that for each of the threads the wire to be used in any thread groove is limited in regard to diameters as follows:

The 60 Degree V Thread.

Maximum diameter of wire $= \dfrac{p}{0.866} = 1.155\,p$, if p equals the pitch of the thread.

Minimum diameter of wire $= 0.577\,p$.

The U. S. Standard Thread.

Maximum width of thread groove $= \frac{7}{8}\,p$.

Maximum diameter of wire $= \frac{7}{8} \times \dfrac{p}{0.866} = 1.010\,p$.

Minimum diameter of wire $= \frac{7}{8} \times 0.577\,p = 0.505\,p$.

The 55 Degree Whitworth Thread.

Let $p_1 =$ distance across thread groove at point where radii are tangent to angle.

Radius on thread $= 0.1373\,p$, and arc forming top of threads contains 125 degrees.

Then $p_1 = p - 2 \sin 62° 30' \times 0.1373\,p = p - 2 \times 0.887 \times 0.1373\,p = p - 0.243\,p = 0.75\,p$, approx.

Maximum diameter of wire $= 0.75 \times \dfrac{p}{0.887} = 0.84\,p$.

Minimum diameter of wire $= 5/6 \times 0.6068\,p = 0.505\,p$.

The dimension D_1 (see diagram in supplement) has to be considered for both the single-wire and three-wire methods and has values as follows:

For the 60 deg. thread: The depth equals $0.866\,p$ and as the apex of the thread angle and root of thread groove are at the same point, it follows that $D_1 = D - 0.886\,p \times 2 = D - 1.732\,p$ or $= D - \dfrac{1.732}{n}$.

For the U. S. Standard thread: The depth equals 6/8 of the 60 deg. V thread, being flattened on top and filled in at the root an amount equaling one-eighth of the V thread depth and the distance from the top of thread to apex of thread angle at root, therefore, equals $\frac{7}{8}$ of the V thread depth, or $\frac{7}{8} \times 0.866\,p$ and $D_1 = D - \frac{7}{8} \times 0.866\,p \times 2 = D - 1.5155\,p$ or $= D - \dfrac{1.5155}{n}$

For the Whitworth 55 deg. thread: The depth equals 4/6 of the 55 deg. V thread depth, being filled in at the root and cut away on top an amount equaling 1/6 of the V thread depth. The depth of the 55 deg. V thread would be $0.96045\,p$ and the distance from top of Whitworth thread to apex of thread angle at root equals $5/6 \times 0.96045\,p$ or $0.8004\,p$ and $D_1 = D - 2 \times 0.8004\,p, = D - 1.6008\,p$, or $= D - \dfrac{1.6008}{n}$.

From the foregoing it will be seen how the formulas $x = D_2 + 2b + a$ for the three-wire system, and $x_1 = \dfrac{D}{2} + \dfrac{D_2}{2} + b + 2a$ for the single-wire system are produced, and also, it will be readily seen how easily the formulas $x = D - \dfrac{1.732}{n} + 3\,a$ for the 60 deg. V thread and $x = D - \dfrac{1.5155}{n} + 3\,a$ for the U. S. Standard thread, as given in the article by E. A. Johnson in the January, 1907, issue of MACHINERY, may be arrived at.

The Acme 29 Degree Screw Thread.

For this thread I prefer to use a separate wire for each pitch, of such diameter that when laid in the thread groove of the tap or thread plug gage, it will be flush with the tops of the threads when they are of correct dimensions, and when laid in the thread groove of the screw it will extend 0.010 inch beyond the tops of the threads.

The Brown & Sharpe 29 Degree Worm Thread.

For this thread also I prefer to use a separate wire for each pitch that will be flush with the tops of the threads when laid in the finished thread groove.

NICKEL STEEL.*

E. F. LAKE.†

Nickel steel is used to a large extent in the construction of high-grade machinery, and can be purchased in the open market, to-day, in almost any percentages of nickel from nothing up to 35 per cent, and with the carbon component varying between 0.10 and 1.00 per cent. Thus it covers a wide field of usefulness in which greater strength, wearing qualities and other properties are demanded, than can be obtained in the ordinary carbon steels.

Nickel Prevents "Sudden Rupture."

Nickel was added to carbon steel as the result of investigations which were started for the purpose of overcoming the "sudden rupture" that is inherent in all carbon steel product. This property or tendency of carbon steel to rupture is the subject of numerous investigations by the railroads of the country at the present time, owing to the many accidents that have occurred in the past few years being blamed to broken rails. Nickel added to steel largely overcomes this tendency, and we see it used successfully for parts of machinery that have to withstand high shock and torsional tests, such as the crank-shafts and connecting-rods of explosive

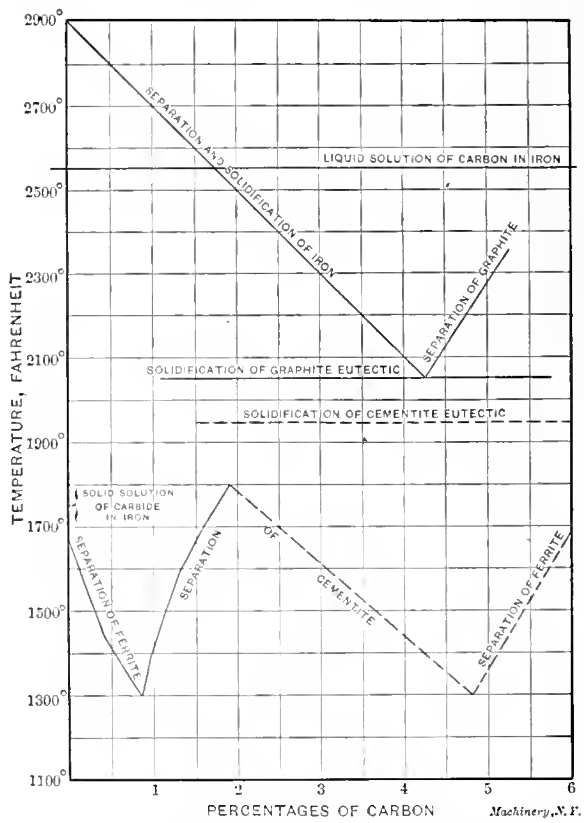

Diagram of Characteristics of Nickel Steel.

engines, propeller shafts for marine and automobile use, and other parts of a similar nature which have to withstand similar strains and stresses.

Effect of Nickel Not Uniform.

Nickel gives to steel one peculiar property, in that it can be added in percentages up to 8, and the tensile strength and elastic limit will be raised by so doing, but in percentages from 8 to 15 these become nil, as a zone of brittleness is produced and no tests can be applied, but at 16 per cent the strength and elastic limit are returned, and from there on these gradually decrease, while the extensibility increases.

Beneficial Effects of Nickel in Heat Treatment.

The qualities of carbon steel are susceptible of change by heat treatment the same as alloy steels, but the higher the carbon content is, the more liable it is to burn and thereby reduce its strength, and it is extremely difficult to case-harden steels which contain more carbon than does mild steel with-

* For additional information regarding the manufacture and characteristics of this and kindred steels, see the article in the July, 1907, issue of MACHINERY: Nickel-Chrome Steel, and previous articles referred to in the same issue.

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out destroying their good qualities and strengths. By the addition of nickel the tendency to burn is largely overcome, and the extent to which it can be swayed by heat treatment is remarkable. This is best illustrated by Table I in which the steel was given different degrees of hardness. Its composition was as follows:

Nickel, 3 per cent; carbon, 0.30 per cent; manganese, 0.40 per cent; phosphorus, 0.05 per cent; sulphur, 0.04 per cent.

TABLE I. STRENGTH OF NICKEL STEEL AT DIFFERENT DEGREES OF HARDNESS.

Hardness.	Tensile Strength, pounds per sq. in.	Elastic Limit, pounds per sq. in.	Elongation in 2 inches, per cent.	Reduction of Area, per cent.
Annealed..........	88,000	60,000	28	58
Medium Hard.....	130,000	130,000	20	6
Hard...............	220,000	190,000	12	37
Very Hard.........	225,000	225,500	8	19

A good quality, open-hearth, 0.30 per cent carbon steel, as received from the mill in the untreated state, shows the same strength as the untreated nickel steel in Table I, but it cannot be raised to much more than one-half of the strength of the nickel steel in its hardest state, and even then it is much more liable to fracture under shock tests.

What the Microscope Reveals in Testing Steels.

Steel subjected to different heat treatments shows different properties when examined under a microscope, and microscopy is becoming one of the methods of examining and testing different steels. If we take a piece of steel containing less than 0.85 per cent of carbon, polish it, attack it with a few drops of picric acid and examine it under a microscope, the results will be widely different according to its composition and the treatment it has undergone. In a piece of steel that has been cooled slowly, small dark masses will appear which are more numerous the closer the carbon is to 0.85 per cent, and for this percentage the small dark masses occupy the entire surface with alternate layers which are iron—called ferrite—the dark masses being called cementite, they being an iron carbide. When nickel is added to carbon steel, this latter element has the appearance of mother-of-pearl, and is called pearlite.

Nickel steel containing less than 0.85 per cent carbon is, therefore, composed of ferrite and pearlite, and the proportion of the former grows smaller as the carbon content is reduced. If the steel contains more than 0.85 per cent carbon it will show, and is composed of pearlite and cementite, and the cementite increases as the carbon content is raised. These pearlitic steels may also contain chromium and manganese.

Next heat this steel to 1,400 degrees F., or a dull red, and quench in water, then polish, attack with picric acid, examine under the microscope as before, and it will show extremely fine lines intersecting each other in the direction of the sides of an equilateral triangle. This constituent is called martensite, and is found in all carbon steels quenched in an active bath after heating to the above degrees.

If the temperature is increased to 2,200 degrees F., or a bright orange, and the steel quenched in a very cold bath, as, for instance, one that is made 32 degrees F., by a salt-and-ice solution, there appears, in addition to martensite, another component called austenite, and this is easily scratched with a needle.

Then if the steel is quenched, during its transformation or above this point, in an oil bath, or one of little activity, a component is obtained that appears jet black, and is very easily colored with picric acid. This is known as troostite.

Therefore by annealing or heating and quenching this steel we can change its components from troostite to austenite, martensite, or pearlite, or *vice versa*, and its condition is readily determined by the aid of a powerful microscope.

If we take a large piece of steel in which a microscopical examination always indicates martensite to be present in the surface layer, different constituents will be shown at a certain distance beneath the surface and often very close to it. These constituents are only slightly colored by picric acid and are known as troostite and sorbite. In this case the transformation is not as complete as in the small piece, and there has been a sort of partial return to the normal state.

Other Effects of Heat Treatment.

Other molecular changes take place in heat treating steels and some of these are governed by the carbon contents. These changes are shown by the accompanying diagram.

If certain steels are given the heat treatments as described above, the average blacksmith would try them with a file, and if the file bites as well as it did before heat treating he would throw the steel out as not hardened, yet transformations have taken place which would show by tests that the tensile strength and elastic limit have been raised while the elongation and reduction of area were reduced. In the case of the nickel steel of which Table I shows the test, these transformations have been given a range for strength—*i. e.*, from 88,000 pounds to 225,000 pounds per square inch—that would have been considered impossible a few years ago.

Thus annealing, hardening and tempering steel are resorted to for raising the tensile strength, elastic limit, and its ability to withstand shock and torsional tests, as well as to put a fine cutting edge on tool steels. For another example of this, a nickel steel containing silicon was heat treated as shown in Table II, and with the resultant strengths as shown.

Need for Annealing.

In heating treating steels for strength, and especially nickel steel, it should always be remembered that hardening by quenching produces internal strains which can only be removed or destroyed by tempering or drawing after it is quenched. Thus nickel steel cannot be used in its hardest state, and in which it has the highest tensile strength and elastic limit, for crank-shafts, connecting-rods or other parts of machinery that have to withstand similar strains and stresses, but the piece must be tempered, thereby reducing the strengths and increasing the elongation in order to reduce the brittleness as well as the internal strains caused by hardening. These internal strains may also be caused by forging, hammering, or working, and the best results will be obtained if the steel is annealed after each important operation.

Liability of Nickel Steel to Warp, Decarbonize and Crack.

Three things work to the detriment of nickel steel and should always be taken into consideration when hardening it. First it nearly always warps in quenching; second, it may be decarbonized in heating; and third, fissures and cracks might occur in quenching.

TABLE II. EFFECT OF HEAT TREATMENT ON NICKEL STEEL OF THE FOLLOWING COMPOSITION

Nickel, 2.51 per cent; Silicon, 0.26 per cent; Carbon, 0.33 per cent; Manganese, 0.43 per cent; Phosphorus, 0.023 per cent, Sulphur, 0.032 per cent

Treatment.	Tensile Strength, pounds per sq. in.	Elastic Limit, pounds per sq. in.	Elongation in 2 inches, per cent.
Quenched at 1600 F.................	225,000	208,000	4
" " " tempered at 600 .	215,000	201,000	6
" " " " " 800	190,000	150,000	9
" " " " " 1000 .	170,000	145,000	12
" " " " " 1200 .	155,000	125,000	14
" " " " " 1400 .	135,000	98,000	17
" " " " " 1600 .	104,000	65,000	24

There are several rules which can be followed to minimize the tendency of steel to warp in quenching. If a piece is cut from stock that has been subjected to some mechanical treatment, it is very liable to be deformed on being heated, and it is undeniable that of the deformations attributed to the hardening process, a large part is due to the heating which precedes quenching, and results from the use of metal which has been mechanically worked. To overcome this, the steel should be thoroughly annealed before it is machined to size, so that the metal will be in a state of repose, and even then the tools used in machining may cause depressions in the metal that will cause warping when it is hardened.

In quenching, the piece should be immersed in the bath in the direction of its principal axis of symmetry, so that the

liquid can cover the greatest possible surface, and it should never be thrown into the bath. Thus a shaft should be immersed vertically and a gear wheel perpendicular to its plane. The piece should also be agitated in the bath so as to destroy the coating of vapor which usually forms around the piece and prevents its cooling rapidly.

To reduce the tendency to decarbonize, it is necessary to provide against oxidation, therefore the atmosphere within the furnace must be kept as far as possible reducing, and the pieces must be prevented from coming in contact with the gases.

This can be done by placing the pieces in a protecting retort, or in using a metallic heating bath, such as one of lead.

Fissures or cracks which occur in hardening are caused by the different parts of the piece cooling unevenly, thus producing internal stresses of enormous proportions which sometimes produce brittleness and consequently fissures or cracks, as nickel ferrites have a lower degree of molecular cohesion than plain ferrites. These fissures may be prevented, by reducing the rate of cooling, in three different ways. One method is to cover water with oil from one inch to one inch and a quarter in depth. The second is to cool the pieces in a bath of a comparatively limited volume, so that the cooling is followed by a slight tempering, and the third is to withdraw the piece from the bath before it is completely cooled. This last requires considerable skill to obtain uniform results.

Nickel Steel Well Adapted for Gears.

Nickel steel is one of the best steels on the market for gears, when carbonized, as different tests have shown that 2 per cent of nickel added to the ordinary carbonizing steel will double, and in some cases more than double, the tensile strength after carbonizing, and these tests would prove that nickel steel should be used for carbonizing wherever the difference in price will warrant. It is from 2 to 2½ cents per pound higher than the ordinary carbonizing steel, but the greater safety in manufacturing, and a consequent decrease in the number of spoiled pieces, will largely overcome this difference in price.

If a 2 per cent nickel steel is carbonized so the surface layer contains 1 per cent of carbon, it will show pearlitic, when examined, but if a 7 per cent nickel steel is used it will show a surface layer that is martensitic with a core pearlitic, or, in other words, the periphery has the same constitution as if it had been quenched and hardened while the core was in the annealed state.

The different materials used in carbonizing have different effects as to the penetration of the carbon and the time required for a certain penetration.

But a general rule for the rate of penetration at different degrees of temperature is as follows, the time being eight hours:

F. Degrees of Temperature	Depth of Penetration.
1,300	0.000 inch.
1,475	0.0195 "
1,565	0.039 "
1,650	0.0625 "
1,700	0.08 "
1,750	0.110 "
1,800	0.125 "
1,850	0.165 "
1,900	0.195 "

Thus it will be seen that a rise in temperature of 150 degrees doubles the rate of penetration, and in one case a rise of 90 degrees has doubled it.

With the temperature held stationary at 1,850 degrees the speed of penetration is as follows:

Time	Depth of Penetration
¼ hour	....
½ "	0.02 inch.
1 "	0.31 "
2 "	0.40 "
4 "	0.50 "
6 "	0.80 "
8 "	1.20 "

The steel used for carbonizing should not contain over 0.2 per cent of carbon, and the manganese component should be low, as this has a tendency to produce crystallization in annealing, and cause brittleness.

The cement used should be of a definite chemical composition which does not act abruptly, such as 60 per cent powdered charcoal and 40 per cent carbonate of barium, and two rules might be followed in treating; one being to carbonize at 1,600 degrees F., cool to 1,400 degrees, and quench; and the other is to carbonize at 1,850 degrees, quench first at 1,650 degrees, and the second time at 1,400 degrees.

Nickel Steel Not of as High Grade as Nickel-chrome Steel.

Nickel steel is not of as high a grade as nickel-chrome steel or the newer vanadium steel, but it stands a good second to these, is about two-thirds the price, and is so much easier machined and forged than nickel-chrome steel that it is used in preference to the higher grades.

Care Required in Forging and Working.

In forging, great care must be taken to keep this steel at a high full forging heat and never hammer or roll it below this temperature, as cracks are then liable to occur. A great deal of talk is heard among the users of nickel steel about its cracking badly and being defective, and if defects occur in the bloom, they are pretty sure to show up somewhere in the finished product, but if the steel is properly rolled and forged these defects and cracks will not appear. Where carbon steel has been used for automobile axles and given way from fatigue, crystallization or other causes, heat-treated nickel steel has been substituted, and has given perfect satisfaction.

TABLE III. INFLUENCE OF DIFFERENT PERCENTAGES OF NICKEL IN NICKEL STEEL.

Per cent of Nickel.	Tensile Strength, pounds per sq. in.	Elastic Limit, pounds per sq. in.	Elongation in 4.72 in. per cent.	Treatment.
1 to 1½	78,000	48,000	18	water tempered at 1650° F.
2½ to 3½	97,000	82,500	15	medium hard.
2½ to 3½	80,000	68,000	20	" soft.
2½ to 3½	85,000	60,000	23 to 13	" hard, structural.
2½ to 3½	71,000	50,000	28 to 16	" so t, "
4½ to 6	102,000	74,000	15	hard, for strenuous work.
4½ to 6	121,000	107,000	12	" but annealed at 1600° F.
4½ to 6	88,000	63,000	20	medium hard
16 to 18	199,000	114,000	6	annealed at 1650°.
22 to 26	110,000	45,000	40	" " "
22 to 26	114,000	50,000	35	" " "
30	80,000	28,000	44	" " "

Proportion of Carbon Important.

We frequently hear the boast of different manufacturers that they use 2 per cent nickel steel for various parts of their machines, but this means nothing, as its properties depend as much upon the carbon content as on the nickel. To illustrate, one nickel steel that is largely used, and is the best for certain purposes, contains 2 per cent of nickel and 0.12 per cent of carbon. It has a high tensile strength and very little elongation, while another nickel-steel equally good for other purposes contains 2 per cent nickel and 0.9 per cent carbon, and gives a high tensile strength with a great elongation.

Table III shows the different percentages of nickel in steel turned out by one manufacturer, and their strengths under different treatments.

These steels have percentages of carbon ranging from 0.10 to 1.00 per cent, and those with the highest percentages of nickel are used mostly for valves, owing to their heat-resisting powers combined with a great strength. Sometimes from 1 to 3 per cent of chromium is added to these valve metals to increase the elastic limit and mineral hardness.

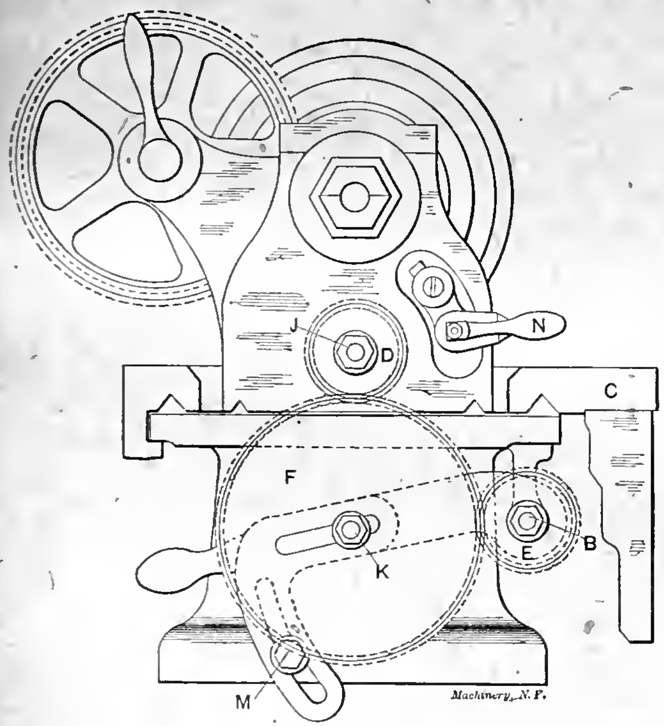
* * *

A contemporary, in describing a new form of electric meter, makes use of what it calls an "exploded view" of the apparatus. In this view the parts are shown slightly separated, thus giving a better idea of the construction of the device. Presumably, a charge of powder is supposed to have been set off beneath the apparatus, and the picture represents a snapshot taken about 0.0000001 of a second after the explosion. The expression is a graphic one, but it sounds very queer.

PUNCH PUNCH PUNCH PUNCH PUNCH PUNCH

SHOP OPERATION SHEET NO. 13.

Oscar E. Perrigo. MACHINERY, September, 1907.



To Cut a Thread having the Same Pitch as the Lead-screw of the Lathe.

1. Rotate the spindle of the lathe one revolution by hand, and observe the movement of stud J, to see whether it makes one revolution or one-half, per turn of the spindle.

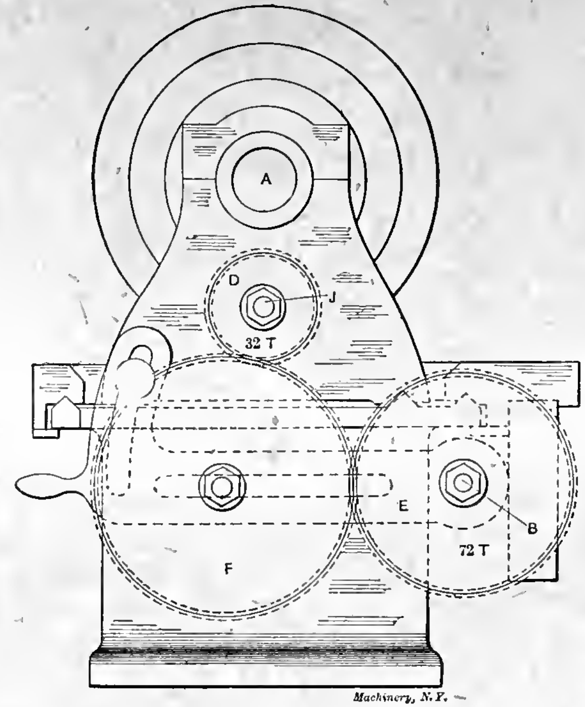
2. If stud J revolves one turn for one of the spindle, select from the set furnished with the machine two gears having equal numbers of teeth. Place one of them, D, on the stud J, and the other, E, on the lead-screw B. If the stud is geared to revolve at one-half the speed of the spindle, gear D on the stud must have twice the number of teeth possessed by gear E on the lead-screw.

3. Place on the intermediate stud, K, a gear F of any convenient number of teeth. Adjust it in position to mesh properly with gears D and E, and fasten it in position by the clamp screws or bolts at K and M.

4. With the nut on the carriage C thrown into mesh with the lead-screw, start the lathe up in the forward direction. If the carriage moves toward the headstock, the lathe will cut a right-hand thread of the same pitch as the lead-screw. If the carriage travels the other way, a left-hand thread will be cut. To change from right to left or *vice versa*, shift lever N, or make such other adjustment as is provided by the design of the lathe.

SHOP OPERATION SHEET NO. 14.

Oscar E. Perrigo. MACHINERY, September, 1907.



To Cut an 18-Pitch Thread in a Lathe having an 8-Pitch Lead-screw.

1. Observe whether the stud J revolves once for every turn of the spindle or for every two turns. If the latter, proceed as if the lead-screw were twice the pitch given, or 16.

2. Form a fraction having for the numerator the number of threads per inch of the lead-screw, and for the denominator the number of threads per inch to be cut. Reduce this to its lowest terms. Finding in Step 1 that stud J and spindle A are geared to run at the same rate, we have $8/18 = 4/9$.

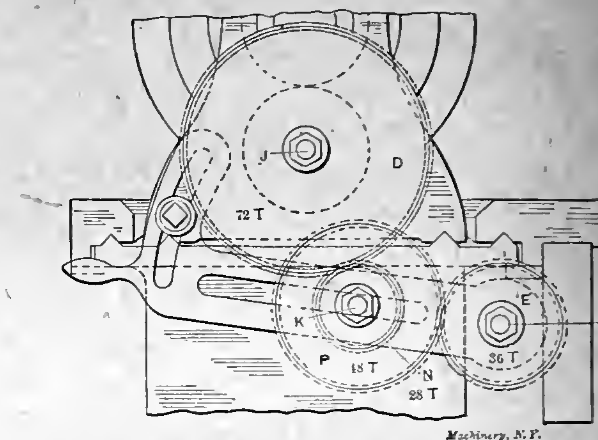
3. Find two gears from the set furnished with the lathe such that when one of them is used as the numerator of a fraction and the other as the denominator, this fraction, reduced, will equal that found in Step 2. Finding gears with 32 and 72 teeth, we have: $32/72 = 4/9$.

4. Place the first gear on stud J, as shown at D in the cut. Place the second gear on lead-screw B, as shown at E. Connect them by any suitable intermediate gear F.

5. To prove the correctness of the gears selected, multiply the number of teeth in gear D on the stud, by the number of turns per inch in the thread to be cut. Divide the product by the number of threads in the lead-screw, observing the rule given in Step 1 if the stud is geared 2 to 1 with the spindle. The result should be the number of teeth in the gear on the lead-screw, thus: $32 \times 18 \div 8 = 72$.

SHOP OPERATION SHEET NO. 15.

Oscar E. Perrigo. MACHINERY, September, 1907.



To Cut a 3½-Pitch Thread in a Lathe having a 6-Pitch Lead-screw, using Compound Gearing.

1. Observe whether the stud J revolves once for every turn of the spindle or for every two turns. If the latter, proceed as if the lead-screw were twice the pitch given, or 12.

2. Form a fraction having for the numerator the number of threads per inch of the lead-screw, and for the denominator the number of threads per inch to be cut. Reduce this to its lowest terms. Finding that the lathe in question has the stud geared 2 to 1 with the spindle, we form the fraction thus:

$$\frac{6 \times 2}{3\frac{1}{2}} = \frac{12}{3\frac{1}{2}} = \frac{24}{7}.$$

3. Next find four gears from the set furnished with the lathe, such that when the product of two of them are used for the numerator of a fraction and the product of the other two for the denominator, this fraction reduced, will equal that found in Step 2. Finding gears with 72, 48, 36 and 28 teeth, we have:

$$\frac{72 \times 48}{36 \times 28} = \frac{24}{7}.$$

4. Place either of the two gears in the numerator of the fraction in Step 3 (72, for instance) at D on stud J. Place either of the gears in the denominator (28, for instance) in mesh with it at N on stud K. Place the other gear, in the numerator, at P on stud K, meshing with the remaining gear of the denominator, 36, on the lead-screw B at E.

5. Prove the correctness of the calculation by multiplying together the numbers of teeth in the driven gears N and E, and the number of threads per inch of the lead-screw (taken at double its value in this case, as called for by Step 1). This product must equal the product of the numbers of teeth in drivers D and P, multiplied by the number of threads per inch it is desired to cut. Thus:

$$28 \times 36 \times 2 \times 6 = 12{,}096.$$
$$48 \times 72 \times 3\tfrac{1}{2} = 12{,}096.$$

HOBS FOR WORM GEARS.*

JOHN EDGAR.†

In the August, 1907, issue of MACHINERY, Mr. Flanders gives a very good treatment of both the worm and worm-gear, but he has very little to say regarding the hob. It is the desire of the writer to supplement his remarks by a few suggestions on the design and proportions of the hob.

If we were to make an extended collection of hobs from various sources, we would find a great variety in design and proportions. It is generally accepted as a fact that the hob need only be a duplicate of the worm, with the exception that it should be slightly larger in diameter in order to give a clearance at the root of the gear tooth. That such hobs are used and appear to give good results, is their only claim to existence. When we come to think that the teeth of the gear are dependent on the hob for their shape, and that the smooth-running qualities depend also on the same tool, it must be conceded that a little thought and care put into the production of the hob would not only repay for any extra trouble, but would be a source of longer life to the gear.

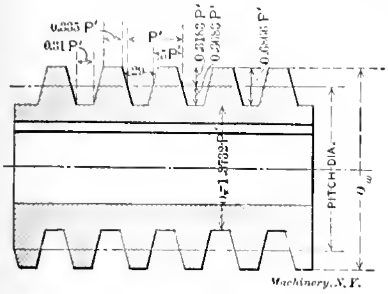


Fig. 1. Dimensions of Worm.

If a worm and gear of standard proportions are brought into mesh, we have at the bottom of both the thread of the worm and teeth of the gear a clearance equal to one-tenth of the thickness of the thread or tooth at the pitch line. The clearance at the root of the gear tooth is obtained by enlarging the hob over the diameter of the worm, by an amount equal to two clearances, while the clearance of the tooth in the thread bottom is taken care of by the proper sizing of the gear blank.

While it may be customary practice to make the hob an exact duplicate of the worm, except in the one item of outside diameter, a hob proportioned as suggested in Fig. 2 is recommended as one that will give much more satisfactory results, and be found to be well worth any additional trouble in construction required beyond that for the style ordinarily used. The peculiar feature of this hob is that it is an exact opposite of the worm with respect to the proportions of the thread shape; the depth below the pitch line in one case being equal to the height above the pitch line in the other. The object of this is to have a hob that will form the complete outline of the tooth and make it absolutely certain that the standard proportions of tooth and clearance are obtained. Thus, should the diameter of the blank be large, the hob will trim off the top of the gear teeth to the proper length, when the proper center distance is maintained.

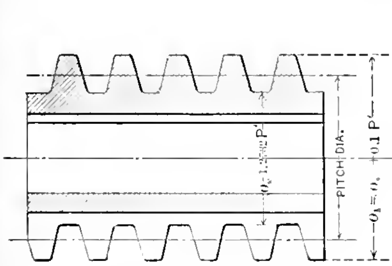


Fig. 2. Dimensions of Hob.

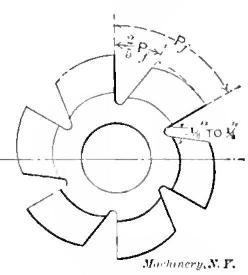


Fig. 3. Data for Fluting Hob.

There is another point that is generally overlooked, and that is the necessity for having the corners of the thread rounded over, and for providing a liberal fillet at the root of the thread. The radii of the rounded corner and the fillet may be as large as the clearance will allow, which would be one-twentieth of the circular pitch of the thread.

The effect that this fillet and rounded thread have on the shape of the tooth is something that greatly increases the quality of the gear and the strength of each individual tooth. The rounded corner on the thread points does away with any tendency to scratch the surface of the tooth in the cutting action, and leaves a much larger fillet at the root, greatly increasing the strength. The fillet at the bottom of the thread rounds off the top of the tooth in the worm-gear, removing any burrs, and leaving a nicely finished product. This fillet also removes the dangerous tendency of the hob to develop cracks in the hardening process—a common source of trouble even where care is taken. Fig. 1 shows the proportions of the worm in comparison with the hob in Fig. 2.

In forming the hob, much can be gained by making a special form tool of correct proportion that will leave no chance for error; the only dimension needing care then is the diameter. Such a tool is shown in Fig. 3. The figure is dimensioned by formulas, so that a tool for any pitch can be easily proportioned from it. This tool may be made by using a gear-caliper without resorting to the protractor, or the protractor may be used in laying out the angle. This tool may be made without side clearance, providing that the sides incline in the same direction and at the same angle that the thread takes, but under ordinary circumstances, where only one hob is to be made, little is gained by having no side clearance. Clearance may be made from 5 to 10 degrees from the angle of the thread. [Grinding a tool like this of course changes its form, so it must not be used indefinitely in making large numbers of similar hobs.—EDITOR.]

The number of flutes that should be provided in the hob is a point on which very little is said, various authorities differing widely. Where the hob is to be used in an automatic hobbing machine in which the hob and blank are positively geared together, the number of flutes may be a comparatively small number as compared with a hob that is to be used in connection with ordinary processes of hobbing worm gears. In the process in which the previously gashed worm-gear blank is swung loosely on centers and revolved by the hob as the latter rotates, the hob should have a larger number of flutes.

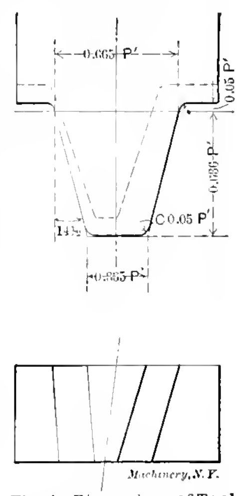


Fig. 4. Dimensions of Tool for Threading Hob.

A rule that checks up well with present practice is as follows:

To find the number of flutes in a hob, multiply the diameter of the hob by three, and divide by twice the circular pitch.

The above rule gives suitable results on hobs for general purposes. When the result gives an odd number of teeth, take the next smaller even number, to facilitate calipering.

Some authorities on worm-gearing state that the number of flutes in a hob should in no case be an exact multiple of the number of threads. Their reason for this rule is that the hob so gashed will produce a much smoother tooth and one nearer correct in shape, because no tooth in the hob passes the same tooth in the gear twice in succession, so that any little imperfections in shape of the individual hob teeth are counteracted by one another. Another authority is strong in his advice not to have the circumferential distance from flute to flute equal to or equally divisible by the circular pitch of the hob, for the same reason as stated regarding the former rule. From these statements, it is seen that to obtain a rule that would be at once simple and yet take all conditions into consideration, would be a difficult proposition. [So far as we can see, only the first of these two rules is a logical one. Owing to the fact that hobs have teeth only, instead of full surfaces matching the worm, the curved outlines of the wheel teeth are merely approximated by a series of tangents. If the number of flutes in the hob is a multiple of the number of threads, the hob teeth will "track" after each other, giving wheel teeth only roughly approximated by a comparatively small number of long tangents.—EDITOR.]

The cutter used in gashing the hob should be about 1/8 inch thick at the periphery for hobs of ordinary pitch, while for those of coarser pitch a cutter 1/4 inch thick would be much

* For further information regarding worm gearing, see MACHINERY, August, 1907: Calculating the Dimensions of Worm Gearing, and other articles referred to in that issue.

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better. The width of the gash at the periphery of the hob should be about two-fifths the pitch of the flutes. The cutter should be sunk into the blank so that it may be from 3/16 to 1/4 inch below the root of the thread. Fig. 4 shows an end view of a hob gashed according to these rules.

Where a hob is to be used to any great extent, and is subject to much wear, it would be advisable to increase the diameter above the dimensions given from 0.010 to 0.030 inch according to its diameter and pitch, to allow for decrease in diameter due to the relief, and caused by grinding back the cutting face in sharpening.

Hobs are generally fluted parallel with the axis, but it is obvious that they should be gashed on a spiral at right angles with the thread helix in order that the cutting face may be presented with theoretical correctness; but the trouble encountered in relieving the teeth on the ordinary backing off attachment is the cause of the common mode of fluting. When the pitch or lead is coarse in comparison with the pitch diameter of the hob, so that the angle is correspondingly steep, it may be best to flute on the normal helix, and if the hob cannot be machine relieved, it may be backed off by hand.

The amount of relief depends much on the use for which the hob is intended. A hand hob for hobbing a gear in position may be made with little or no relief, while hobs used on hobbing machines may have much more relief than those used on the milling machine.

In closing, I would suggest that Mr. Flanders' model drawing give the full data relating to the thread, such as the whole depth, the width of the thread at top and the space at the bottom. The pitch diameter would also be handy to have, as would also the center distance.

* * *

WITH THE REPAIR GANG.

A. P. PRESS.

Down at one end of the O. C. R.R. round-house there was a long L where they did the repair work, and where we used to hang out when there wasn't much to do. There was a boilermaker, a few machinists, and two or three blacksmiths. Jim Haven was the boss of the smiths, and did the hiring and firing for the lot. One day in came a big, stout fellow and he asked Jim if he wanted a good blacksmith.

"Can you weld two pieces of iron together?" asked Jim.

Now this was equivalent to asking a bookkeeper if he could write, and the man was mad. He didn't say much but remarked: "You just give me a chance and I'll show you whether I can or not." "All right," said Jim; "it's almost 12 o'clock and I am going to dinner, but the power runs all the noon time, and there's fire and there's plenty of stock here. See what you can do while I am gone."

"Can you weld two pieces of iron together?"

He waited until Jim got washed up and out of the shop. Then he picked out two pairs of the biggest and best tongs in all the bunch. He gripped the jaws right into each other, put a ring on each end of the tongs, put them in the fire, brought them up to a good heat, put them under the hammer and made as pretty a weld as ever you saw! Taking a stamp we use to mark O. C. R.R. on all the tools, he struck it on four sides of the job, laid it on Jim's anvil, washed up and got out.

Well—when Jim got back, the air was blue, for Jim wasn't any Sunday-school teacher and he could say things that I don't want to write, and you wouldn't print them if I did, but after he cooled off, he said: "Well, that's a good job; if he comes along again, I'll hire him."

One day old 76 ran her nose into a snow-drift up on Long Plain Hill, and buckled up her side-rods. You see the front drivers stalled in the snow, but the rear ones didn't; they sent us up there, and we towed her down to the house for repairs. We took off the rods and carried them in to Jim to straighten up.

There was a smell of burned leather.

He took a heat on them, worked out the kinks, lined them up on the centers. When they were all done he told the helper to set them away over in the corner, and then go and tell the round-house boss that they were all right. They were "black hot" and the helper took a pair of tongs and lugged them over to the corner and set them up.

Now there was a kind of "kid-glove" apprentice out in the round-house on whom we thought it was all right to put up a job any time, and Jim thought the round-house boss would send him in after the rods—and he did. The "kid-glove" fellow used to wear a pair of gloves most of the time, and I suppose that is why we were down on him. In he came, gloves and all, and asked Jim where the rods were.

"Over there in the corner," Jim replied.

He went over and grabbed a rod. There was a smell of burned leather, a string of swear words, and Eben came back to the smith's part.

"Why in the dickens didn't you tell me they were hot?" "Why any boy could tell they were hot; even my boy Tommy, coming in there with my dinner, could tell it." "It is a lie," said Eben. "It is, is it? Tommy, come over here and see if you can carry one end of that side-rod with Eben."

Now Tommy was wise, and he knew his father a good deal better than Eben did. He went over to the corner, wet his finger in his mouth and touched both ends of the rod. Then, taking hold of the cold end, he waited for Eben to take hold of the other, which he did with the tongs.

Bill put some oil on Eben's hands and cooled off the rods for him, but Eben went off with a look on his face that said: "I'll get even with Jim some time," and he did, as I will tell you later.

A DRAFTING APPRENTICESHIP COURSE.

Something more than a year ago the need for young draftsmen trained in locomotive detail work became so imperative, and the difficulty of getting them so great, that the engineering department chiefs of the Schenectady plant of the American Locomotive Company organized an apprenticeship course in mechanical drawing and locomotive design with the object of making their own men instead of depending upon the uncertain and generally unsatisfactory general supply. The move was made for no philanthropic motives whatever, but simply for the very good business reasons that have caused other large concerns to organize apprenticeship courses in shop work. This course also includes shop instruction, but it is simply given to round out the graduate draftsman's knowledge of locomotive construction and shop methods, and give his training the practical turn required of a first-class man. The result after one year's work is very satisfactory. About twenty young men are taking the course, and some are now working over the board in the general drafting department. These young men are doing good work in the main.

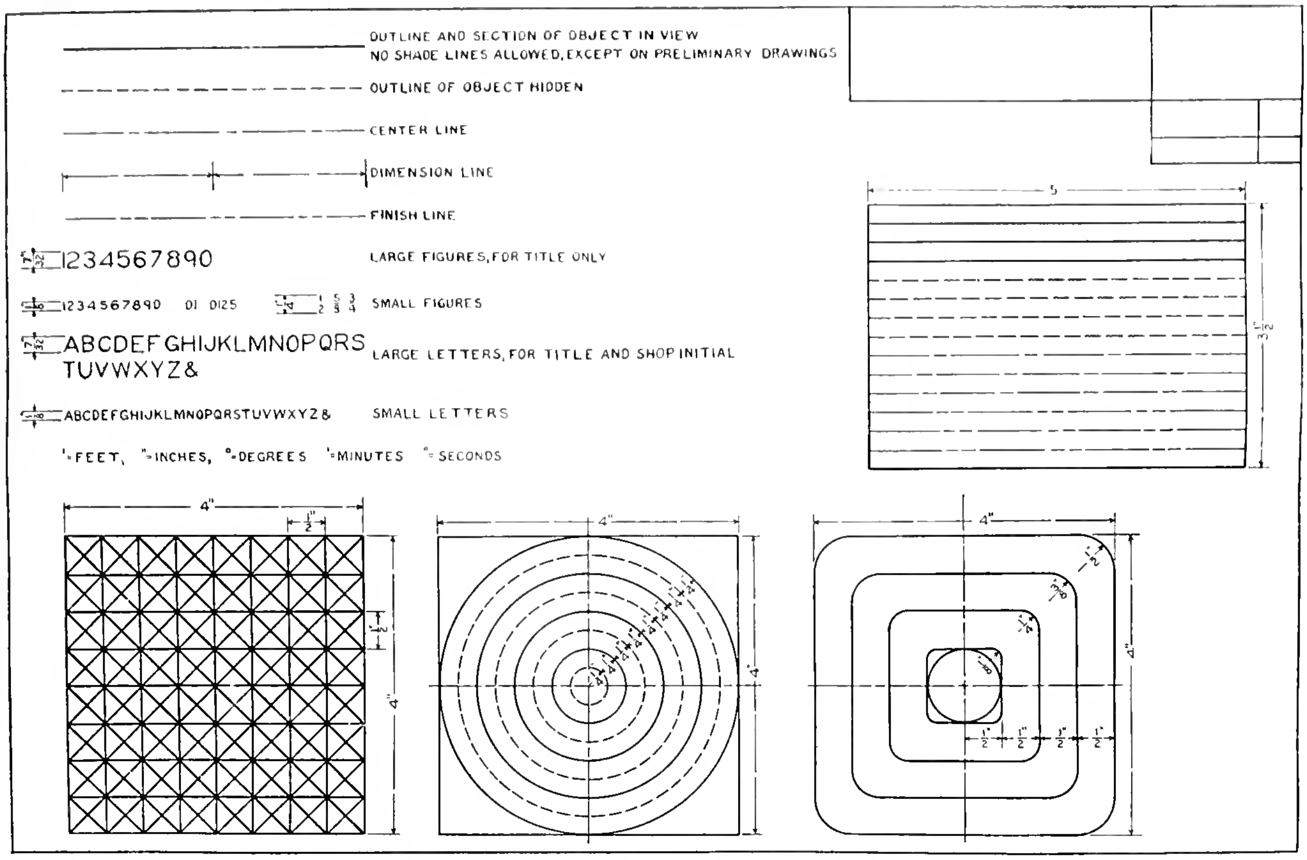


Fig. 1. First Drawing Exercise in American Locomotive Company's Drafting Apprenticeship Course.

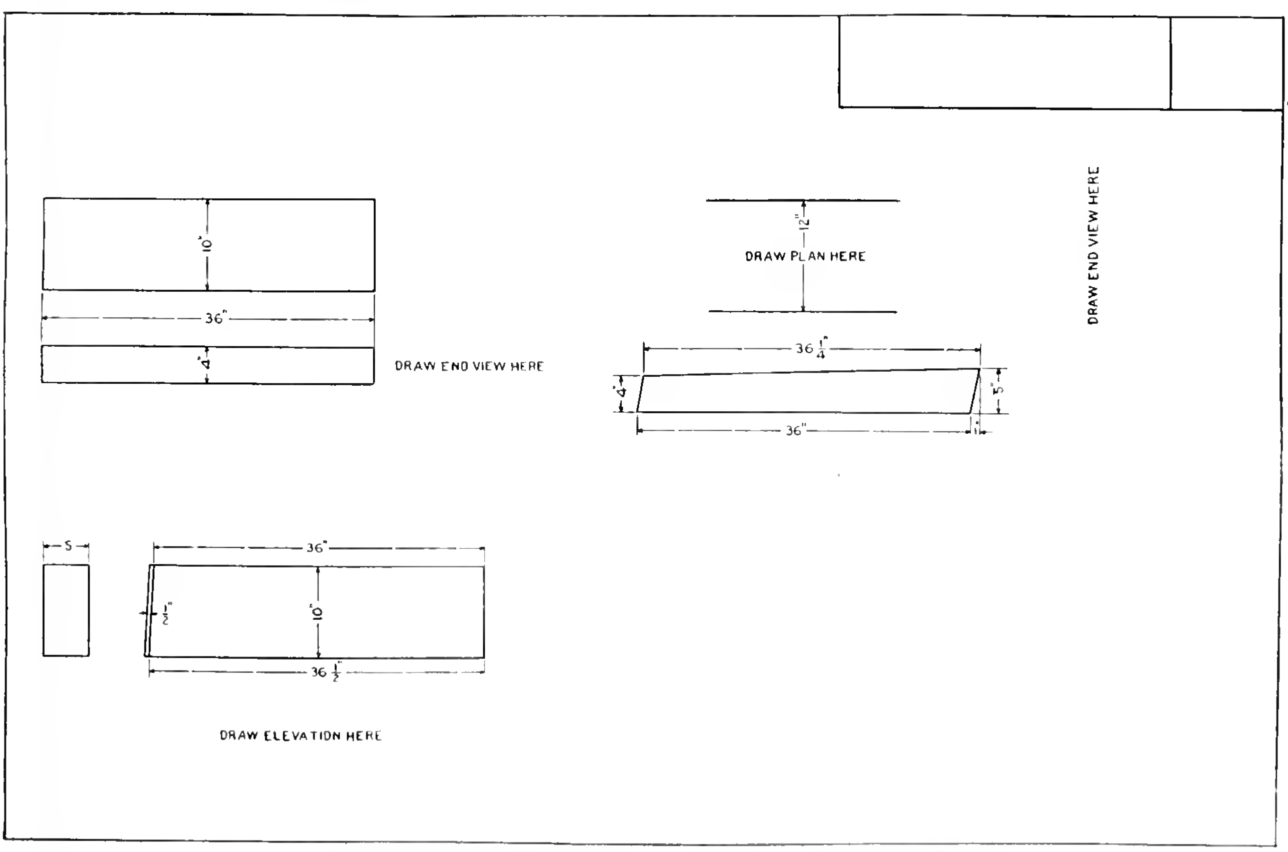


Fig. 2. Second Drawing Exercise in Course, subject being a Locomotive Fire-brick.

and are building themselves up into just the kind of men which the course was designed to provide.

The apprenticeship course in drafting is offered to a limited number of young men between the ages of sixteen and nineteen who can read, write, and answer certain simple questions in oral arithmetic. They are taken in on one month's trial, and then, if satisfactory, are admitted to the regular four years' apprenticeship course upon signing an indenture. The first, third and fourth years are to be spent in the drafting office, and the second year in the shop, receiving instruction in the use of tools and erection of locomotives. The first three to six months are spent in the blue-print room, making and fixing blue-prints, etc.

The apprentices, while at work in the drafting office, are given regular instruction, during working hours, in drafting, algebra, geometry, trigonometry, descriptive geometry, applied mechanics, strength of materials, and machine design, and they are taught the general application of these subjects to drafting room and engineering problems. The apprentices are divided into small classes for receiving instruction, in order to get the benefit of close contact with the instructor.

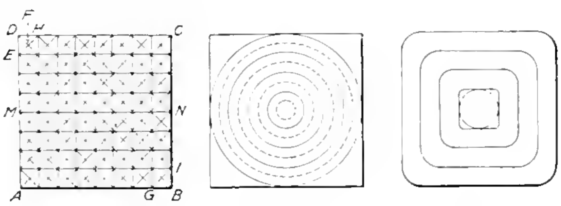


Fig. 1. Fig. 2. Fig. 3.

For dimensions of these figures see drawing exercise No. 1.

Fig. 1

1. What is the area in square inches of ABCD?
2. What is the area in square inches of the triangle ABD?
3. What is the area in square inches of the triangle DEF?
4. What is the length of the line DB?
5. What is the length of the line EG?
6. What is the length of the line EH?
7. What is the area of the rectangle EHIG?
8. What is the area of the rectangle MNBA?
9. What is the area of the triangle EHD?
10. What is the area of the figure HDEGBI?
11. What is the area of the figure DBGE?

Fig. 2

12. What is the area of the largest circle? (in square inches)
13. What is the area of the ring between the circle whose diameter is 3 inches and the circle whose diameter is 2 inches?
14. What is the area of one of the four corners spaces between the square and the inscribed circle?
15. What would be the diameter, in inches, of a circle circumscribed about the square?

Fig. 3. Examination Paper Based on First Drawing Exercise.

Each apprentice devotes four hours a week to recitation during the three years spent in the drafting office, but during the year spent in the shop the recitation hours are omitted, it being considered better policy not to interfere with regular shop routine. After the completion of the course the apprentices will be given a bonus of $150 over their regular wages, and they will be encouraged to remain in the employ of the company.

The instruction is of a strictly practical nature, the subjects being treated so as to have an immediate application to the regular work of the drafting office. There is no long preliminary course during which the students become discouraged because they do not see the use of the things taught.

The first drawing exercise is illustrated in Fig. 1. When this is satisfactorily accomplished the apprentice is given work of a simple nature to do in the apprentice drafting class. While this exercise is of a very simple nature, it contains the practical basis for future work including lettering, dimension lines, center lines, etc. Fig. 3 is a reproduction of a sheet using the same figures for an elementary examination paper on areas, etc.

The second drawing exercise illustrated in Fig. 2 has for its subject a locomotive arch firebrick which is kept in the recitation room and which forms the subject for numerous questions relative to its area, weight, density, volume, etc.

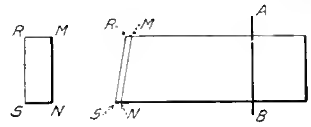
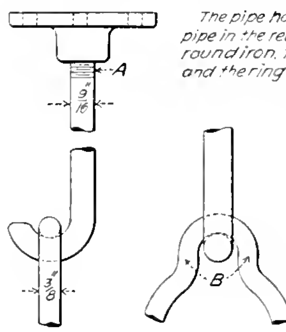


Fig. 12.

For dimensions of this brick see drawing exercise No. 2.

1. What is the area of the upper surface of the fire brick shown by fig. 12? (as shown by the plan view)
2. What is the area of the bottom surface?
3. What is the area of the cross section at A-B?
4. What is the length of the line from M to N?
5. What is the length of the line from R to S?
6. What is the length of the line from R to M?
7. What is the length of the line from S to N?
8. What is the area of the end surface of the brick which is beveled?
9. What is the area of each side of the brick? (as shown by elevation views)
10. Supposing the brick to have been originally 37½ inches by 10 inches with all corners square, how much bottom surface (expressed in square inches) was cut away by bevelling the brick?
11. How much was cut away from the upper surface?
12. How much was the area of the end which was bevelled increased by the process?
13. What are the cubical contents of the brick of fig. 12?
14. Supposing the brick to have been originally 37½ inches by 10 inches by 5 inches with all corners square (a rectangular parallelopiped), what was its original volume and how many cubic inches were cut away in bevelling it?
15. How much does the brick of fig. 12 weigh, if fire brick weighs 120 pounds per cubic foot?

Fig. 4. Examination Paper Based on Second Drawing Exercise.



The pipe hangers which support the water pipe in the recitation room are made of 9/16" round iron, threaded (see sketch and hanger) and the ring is made of 3/8 round iron.

1. If the thread is U.S. standard, what load will each hanger support before there will be a tensile stress of 6,000 lbs. per square inch at A?

2. What load could be supported by the hanger before there would be a tensile stress of 6,000 lbs. at B? (½ of the load is supported by each side of the ring).

3. Suppose the load upon the hanger to be 1,200 lbs., what would be the fibre stress due to tension at A and at B?

4. If the ultimate strength of the material is 54,000 lbs., what is the factor of safety with a load of 1,200 on one hanger?

5. If the load upon one hanger were 1,200 lbs., what would be fibre stress due to tension at A?

6. If the ultimate strength of the material is 54,000 lbs., what is the factor of safety with a load of 12,000 lbs. on a hanger?

7. With an ultimate strength of 54,000 lbs. per sq. in., and a factor of safety of 6, what load could be put upon each hanger? (Assume the weakest point to be at A)

8. (a) Suppose each foot of pipe, including fittings and the contained water, weighs 7½ lbs., how long a portion of the pipe would each hanger support before there would be a tensile stress of 6,000 lbs. per square inch at A?
(b) Approximately, what length of pipe does each hanger support at the present time?
(c) Approximately, what load is upon each hanger at the present time?
(d) Using the load as obtained under (c), what is the stress due to tension at A?
(e) With the load as found under (c) and an ultimate strength of 54,000 lbs., what is the factor of safety?

Fig. 5. Examination Paper on Strength of Materials.

The nature of these questions is shown in the reproduction of an examination paper, Fig. 4. The sheet shown in Fig. 5 illustrates practical examples in strength of materials. The few examples chosen will serve to give some idea of the nature of the instruction.

LETTERS UPON PRACTICAL SUBJECTS.

PUNCH AND DIE FOR ARMATURE DISKS.

The accompanying cut shows a compound die for armature disks for the cores for electric motors. The punch and die are shown in plan views and also in cross sections in Figs. 1 and 2. The die holder *A*, Fig. 1, is of cast iron, and is first planed on the bottom. It is then strapped to the face-plate of a lathe, and faced and bored to receive the plate *B*. This plate is also first faced on the bottom. It is then turned over and bored to the outside diameter of the disk to be punched; the depth of the bored hole is about 1/4 inch. The die sections *C* are all milled in a fixture; they are then drilled and tapped for 1/4 inch flat-headed screws. After this, the sections are hardened and tempered. The plate *B* and the sections *C* are then assembled, and after being assembled the sections are ground. The inside ring *D* is now machined. The keyway and marking notch are tapered one-half degree for clearance; the large hole for the shaft in the armature tapers also one-half degree.

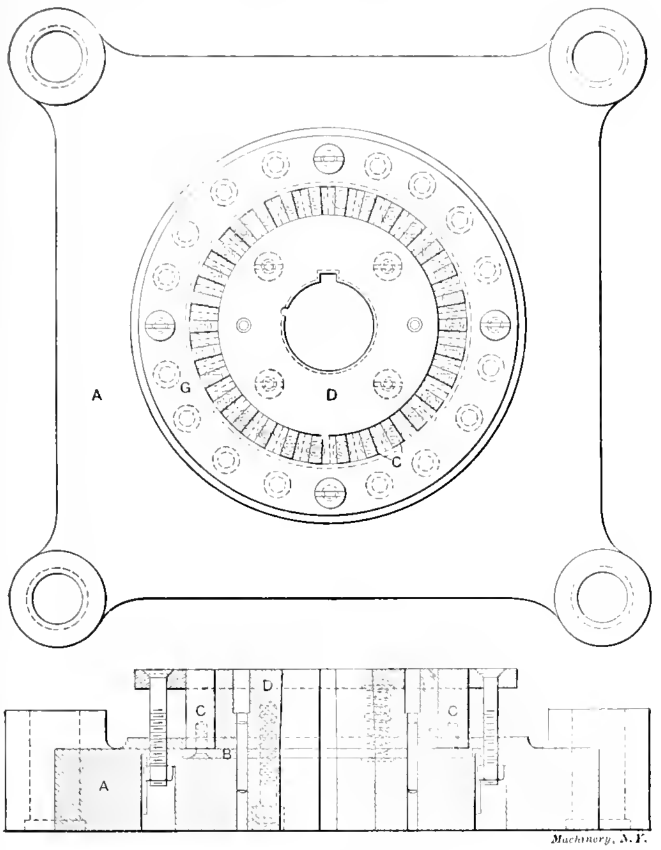


Fig. 1. Die for Making Armature Disks.

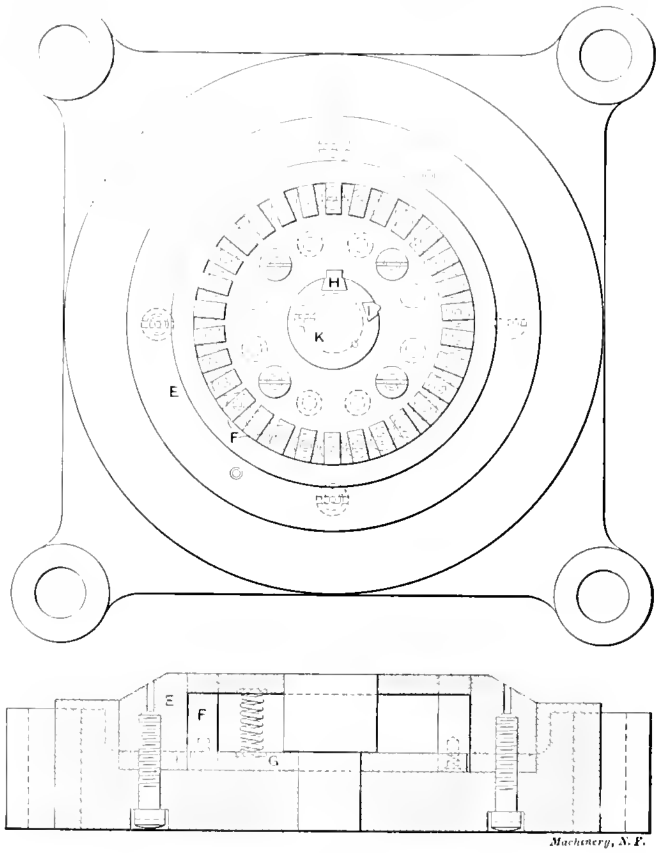


Fig. 2. Punch for Armature Disks.

The ring is drilled and tapped for four 1/2-inch screws, and drilled and reamed for two dowel pins. After this the ring is hardened, tempered and ground to a very close fit in the circle formed by the sections *C*. The center hole is also ground to the required dimension. The stripper is now made, the working of which is plainly seen from the cut, and the whole is assembled, and the die is ready.

We are now ready to proceed with the punch. In this, *E*, Fig. 2, represents a tool steel ring, which, after it is machined, drilled and tapped, is hardened and ground. Punch sections *F* are located in the plate *G* which is milled with the proper number of slots. The punch sections should be left a little softer than the die, because the punch and die will wear much longer and give much better results if this is the case. The sections *F* are held in place by a ring *J* which is shrunk on the outside at the bottom. At *H* and *I* are shown the punches for the keyway and the marking notch. These are fitted into the center punch, being dove-tailed into this. They taper from the bottom up when the punch is in working position, and are driven in so that when punch *K* is assembled they cannot work out. The holes for the sub-press pins are drilled and reamed with the punch and die together, and the holes in the die counterbored to a depth of about 3/8 inch. The pins should be a driving fit in the die and a working fit in the punch.

M. J. W.

ECONOMY WITHOUT DISCRETION.

The following incident shows the mistake of letting a non-practical man have charge of the red tape. In a certain small-sized manufacturing company, which had always paid fair dividends, the management thought that things could be run more economically, and as one of the directors knew a man who was considered an expert in weeding out all unnecessary expenses, it was decided to give him a trial. A few days after this a little sharp-nosed man came bustling around the shop asking every imaginable question in a snappy manner—he was the expert. His new methods were first noticed by Ed., who came down on the 6:55 train, and thus could not get to work before 7:05 A. M. He found he was being docked one-half hour every morning for being late. Ed. had been with the firm for over eight years, and was a good, conscientious workman, who kept first-class time, other than the five minutes late every morning, and then he always stayed until 6:15 P. M., because his train did not leave until 6:30. It made no difference, the expert said, their time was 7 A. M., and train or no train Ed. must be there or be docked half an hour. Things went fairly well until Saturday, when the expert came in about ten minutes before quitting time and caught the boys just starting to clean their machines; then there was a roar. "Ten minutes is too long to take to clean up; in the future only five minutes will be allowed," and he walked out. The following week the supply of files, hack-saw blades, waste and oil was cut to about half the usual amount, and more than that would not be given out, no matter how urgent the need; next, notices were put up saying that from the first of the month all work would be given out on time limits, and every man must keep within these limits. The result of this was that all jobs were faked up just enough to get through the shipping department without defects being noticed. The expert did not think of appointing any inspectors.

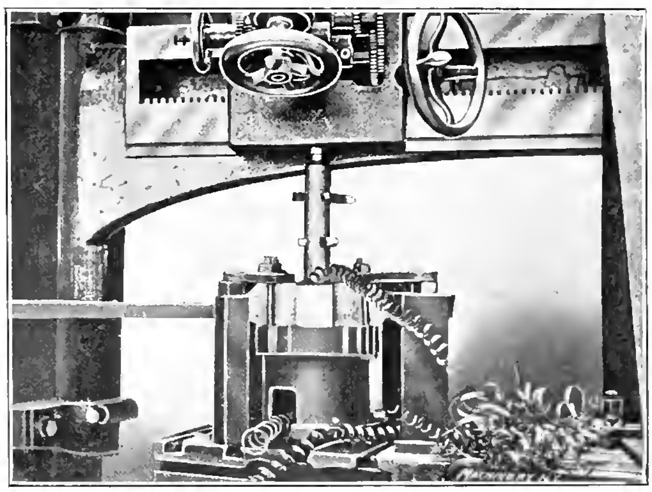
A few weeks after this a lot of tool steel came in, and then

the trouble began in the hardening department. The new steel was of the "cheap" kind, and after the die makers had spent days of work forming it into dies, it would crack or spring badly when it came to the hardening room. The final result of all this was that the working expenses were higher than ever, and the expert said that the general foreman was trying to "do him," so he had him fired for inefficient results. This caused a general strike, and the directors held a special meeting and had the whole matter investigated, and found out where the real trouble was, so they fired the expert, and reinstated the foreman, and since then there has been no more false economy in the form of cheap steel, insufficient supply of files or any other little meanness—and the firm has not lost by the change. PENNSYLVANIA.

BORING LOCOMOTIVE RODS.

The cut herewith shows an old Pond radial drill press fitted up temporarily for boring new locomotive side rods for bushings. This machine has been in constant use for twenty years, several years of this on a double shift. To the extreme right in the cut a triangular brace is shown, bolted at the base to the table of the machine, and clamped to the radial arm at the top to give greater rigidity to the machine.

A special cast iron jig was made as shown for boring the rods, having provision made for bolts to hold the rods down, and high enough to allow the three one-inch square high speed steel tools in the bar to pass through the rod without coming



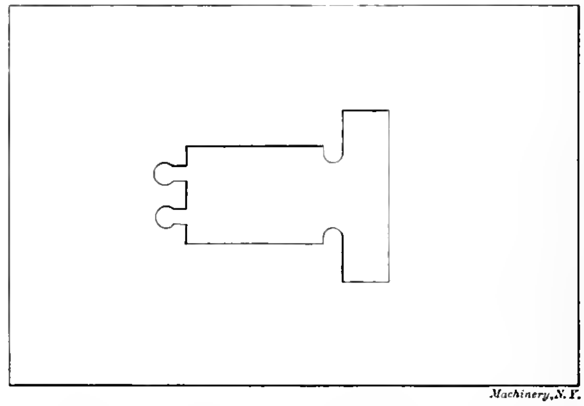
Device for Boring Locomotive Rods.

in contact with the table of the machine. The boring bar is three inches in diameter and extends through a hole in the table. The tools are sufficiently far apart so that just as the first one leaves the cut, the next one is starting a fresh cut. These tools are set out so that each one is $\frac{3}{4}$ inch further out than the preceding one, and consequently the hole will be enlarged from 3 inches to $7\frac{1}{2}$ inches by passing the bar through once. Special attention must be given to grinding the tools with enough top rake, and very little front clearance. If this is done, and the belts kept in good condition, it will be surprising what a large amount of chips can be removed in one hour. Next to having one of the modern two-spindle two-thousand dollar rod boring drills installed, I would recommend fitting up one of the old radials as shown.

Port Huron, Mich. M. H. WESTBROOK.

CONSTRUCTION OF DIES TO PREVENT BREAKAGE IN HARDENING.

Having read an article which appeared in the March, 1907, issue of MACHINERY relative to hardening dies with small projections or tongues, in which the possibility of breakage is large, I herewith give the method of practice in some shops where I have been employed. We will take, for instance, the die that was shown in the article to which I refer. This die I propose to make in the following manner. The die is first filed or machined in the regular way, with the exception that the two tongues are left out. In line with the center of the tongues and at a certain distance from the cutting edge, holes are drilled larger than the width of the tongues. These are taper reamed from the top with a standard taper reamer. A slot is then cut from the hole into the die the same size as the tongue, when the die would look as shown in cut. We now make two pieces to fit in the holes, and extend out the required distance, making sure that they will be a drive fit after hardening. It is best if the pieces are 1/32 inch longer than the thickness of the die, so that they can be ground flush after being driven into place. While this may increase the cost of producing the die, yet, if from any accident, one or



Method of Making Dies to Prevent Breakage in Hardening.

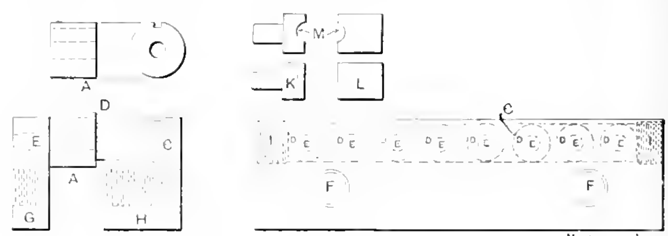
both tongues should be broken, they are easily replaced without the necessity of annealing the die. While I do not wish this article to be taken in the nature of a criticism, it is to the interest of all readers if some discussion of such subjects is entered into.

We do not use the same method of holding punches in the punch pad as the writer referred to, as the necessity of turning the punch from large stock to leave the head large enough is an expensive operation. We make the punches 0.001 inch or 0.0015 inch larger than the holes in the punch holder, and just before they are driven home, we rivet the upper ends of them, which are drawn soft enough for the purpose. If the punches are set properly, it will be impossible to pull them from the holder, for the friction on the body of the punch is greater than it would be in any metal on which the punch would stand up. K. L. ROSS.

ST. LOUIS, MO.

PUMP VISE JAWS.

The accompanying cut shows a handy device for use on a milling machine for slotting pieces such as shown at *A*, and also for slotting screw heads. The vise jaws *G* and *H* are made out of tool steel, and are left soft; they are placed in a milling machine vise, and the piece *A* to be slotted is placed between the two jaws, as shown. The chamber *C* is a cylindrical hole into which are drilled holes from the side for the cylindrical plungers *D*. The chamber *C* is filled with tallow,



Equalizing Vise Jaws.

and, as the pieces *A* are clamped in between the plungers *D* and the vise jaw *G*, the tallow provides an equalizing effect until all the parts are held equally firm. This means permits pieces of a slightly uneven length to be held securely. The plungers *D* must, of course, be a very good sliding fit in the holes running down to the chamber *C*. The pin *E* simply serves the purpose of locating the piece *A* by entering the hole in its center. The holes *F* are tapped to receive screws holding the jaws to the milling machine vise. Pieces *E* and *D* should be made of tool steel and hardened. When screw heads are slotted the parts *K* and *L* are used instead of *D* and *E*. The screws are then held in the semi-circular grooves

M, the operation of the device being the same as when slotting pieces *A*. The screws *I* in the ends of the circular chamber *C* simply serve the purpose of preventing the tallow from escaping at the ends. S. OLIVER.

Great Barrington, Mass.

TO FIND THE NUMBER OF CUTTER FOR SPIRAL GEARS.

The calculations of spiral gearing has been fairly well discussed in these columns, and many formulas and time-saving methods have been presented, but these all had reference to the determination of the dimensions of the gears themselves, while the method of determining the proper cutter to be used has not been simplified.

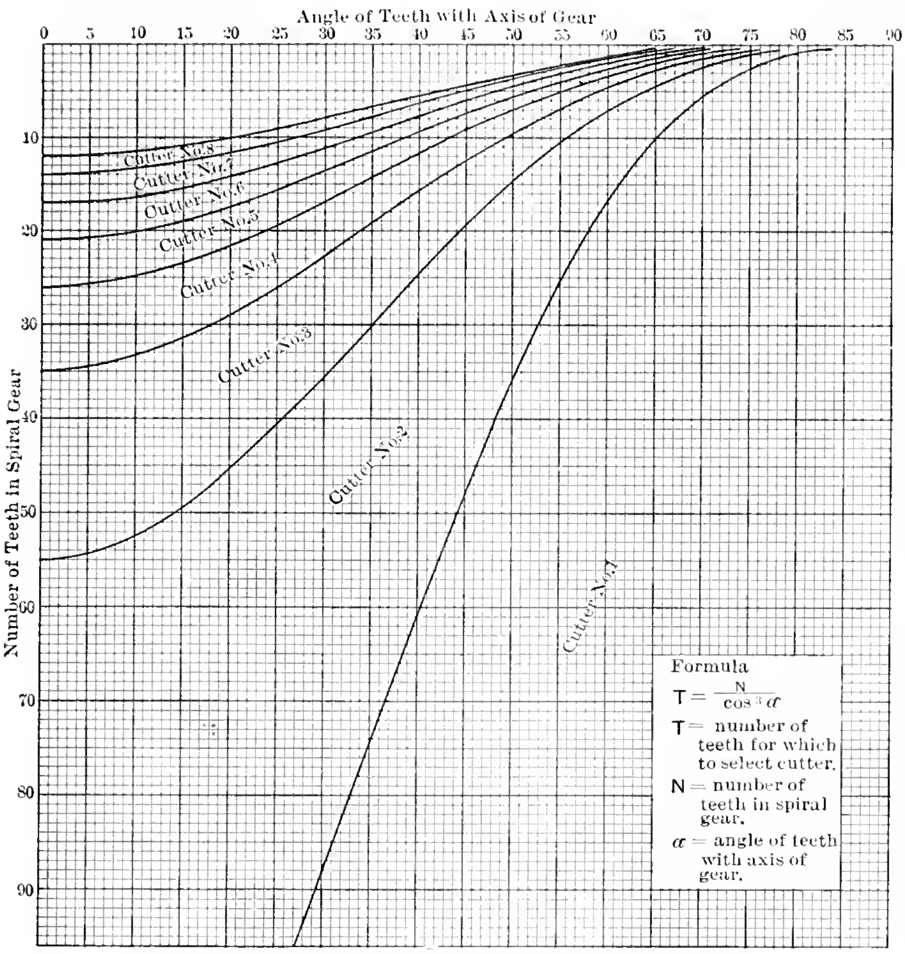


Diagram for Finding Number of Cutter to use for Cutting Spiral Gears.

The cutter used in milling spiral gears is, of course, understood to be a standard spur gear cutter, the only difference being, that the *number* of the cutter used to cut a spur gear of, say, thirty teeth, will not necessarily be the same number of cutter that is used to cut a spiral gear of thirty teeth, it of course being generally known that the angle of the teeth with the axis of a spiral gear is another factor affecting the tooth form, and, therefore, the number of the cutter. However, spiral gears are correctly cut with spur gear cutters, the problem being, to find the proper number of cutter to use.

The selection of the cutter has been determined by the formula:

$$T = \frac{N}{\cos^3 \alpha},$$

in which

N = actual number of teeth in the gear,

α = angle of teeth with the axis,

T = number of teeth for which to select the cutter.

This number, T, is sometimes called the "apparent" number of teeth in a spiral gear.

This relatively unimportant operation of calculation often involves more labor than the determination of the pitch diameter, etc., inasmuch as we have to cube a cosine. The result, moreover, is to merely give the "apparent" number of teeth in the gear, and from this result, we look up the table of cutters, to find the actual number of cutter to use.

Each cutter number covers a "group" of teeth, as for example, No. 2 cutter cuts from 55 to 134 teeth in a spur gear; therefore, by plotting a series of curves, we can represent the group covered by each cutter, by the field between two of the curves.

The accompanying diagram enables one to determine the number of cutter to mill a spiral gear, without any calculation, by simply locating the point corresponding to the actual number of teeth in the gear, and the angle of the teeth with the axis. This point then falls within the area of one number of cutter. This diagram, unlike most diagrams, gives exact, and not approximate, results, because of the fact that we are dealing with groups instead of definite quantities or amounts.

The writer has found this a great time-saver, and hopes that it may be of assistance to others.

ELMER G. EBERHARDT.

Newark, N. J.

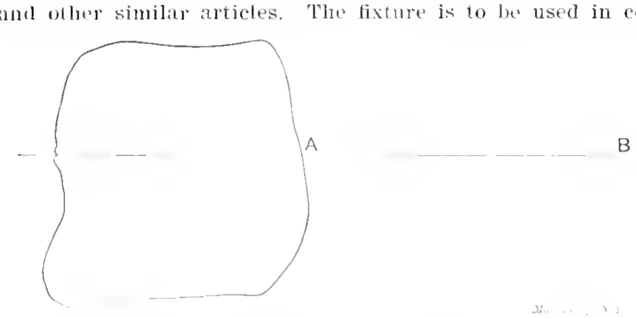
POCKET KNIFE PLANIMETER.

The following application of the knife as a planimeter is very useful and accurate to one or two per cent. I have never seen the method published, and think that it might be of interest. As shown in the cut below, a straight line is first drawn through the figure, the area of which is to be found. A common penknife or jackknife, having at least two blades, is then opened so that the large blade is entirely open, and the small one perpendicular to it. The knife is then placed on the paper with the plane of the blades perpendicular to it, the small blade at the intersection of the figure and the straight line, and the large blade on the straight line. With the left hand holding the large blade lightly against the paper, the small blade point is made to follow the outline of the figure with the right hand. When the starting point is reached, the distance of the large blade from the line multiplied by the distance between the points of the knife will be the area of the figure. H. D.

[The accuracy of the "hatchet" planimeter, of which the pocket knife used in the form described is an example, depends very largely upon the alignment of the knife edge and the tracing point. The prolongation of the axis of the blade section in contact with the paper should pass exactly through the point of the little blade used for tracing. The ordinary pocket knife seldom fulfills this condition, hence the method is more interesting than useful.—EDITOR.]

SCREW SLOTTING FIXTURE.

The cut on next page shows a fixture designed to slot screws and other similar articles. The fixture is to be used in con-

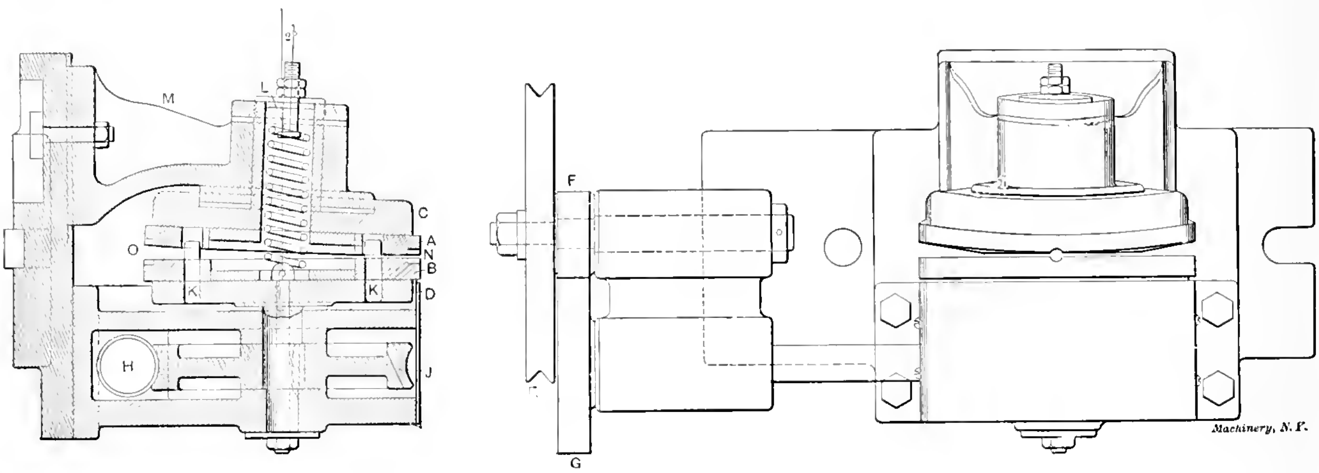


Using a Pocket Knife as a Planimeter

nection with a milling machine. At *A* and *B* are shown two rings of machine steel, case-hardened, with holes drilled on

their peripheries suitable to grasp the work to be slotted. The number of holes will vary according to the speed at which the fixture is run and the work being slotted. The rings are held and located on the holders *C* and *D* by screws and dowel pins not shown in the cut. Holder *D* is driven by means of a belt from the countershaft to grooved pulley *E* and through spur gears *F* and *G* and worm and worm-wheel *H* and *J*. Holder *D* is made in one piece with the worm-wheel shaft. Holder *C* is in turn driven by holder *D* by means of pins *K* held in holder *D*. Spring *L* takes care of any variation which may exist in the size of the pieces being slotted.

To locate and drill the holes, which retain the work, in rings *A* and *B*, they are screwed and doweled on the holders, and the fixture placed on a drill press in such a manner that an equal section of the hole will be drilled in each ring. The rings are then case-hardened. For different pieces of work it is merely necessary to make different rings to suit the conditions of the piece. The bracket *M* is adjustable forward and backward to allow different thicknesses of rings to be used. The hole in bracket *M* is bored at an angle of 2 degrees, and the plate *A* is also faced off at the same angle, so that it



Screw Slotting Fixture.

will be parallel to ring *B* at *N*. By boring the hole at an angle, it will be readily seen that at the point *O* the space between the two rings is the greatest, and at point *N* the least. In operating the fixture, it is placed on the milling machine so that the slotting saw will pass directly through the center of the piece, and directly over the center of the rings. The fixture is then started, and the operator only inserts the work in the holes. As will be seen, the piece is gripped firmly while passing under the saw, and automatically dropped when reaching the bottom.

Montreal, Canada. FRED R. CARSTENSEN.

WHAT A FOREMAN SHOULD BE.

A man may hold a position as foreman and still possess few of the qualities that go to make up an ideal one, and on the other hand a man may possess many of the qualities of the ideal foreman and still remain in the ranks all his life. Luck, push or pull may have put the first man into the place, but these alone seldom keep a man there. On the other hand, it may be the lack of push alone that has deprived the second man of his birthright. My experience has been confined mainly to machine shops, but the principal qualities that make a successful machine shop foreman are the same that are required in other branches of business. Leadership, experience, tact, self-control, foresight and system, are among the qualities that *should* be present, but often several of these are absent, and the man still counted a success from the employer's point of view. A man may be a brute to the men under him and still make money for his employers, but I am not going to discuss this.

In the first place a foreman, as the word implies, should be a leader, that is, a man who naturally leads others, and in this connection a good physique is a great aid, though not always a necessity; then comes experience, for a man can hardly be successful in solving the problems that constantly arise, and which require instant decision, without a certain amount of experience to back his judgment, and nothing so quickly shakes a man's confidence in his foreman, as the latter's lack of sound judgment. However, good judgment and common sense will make up for the lack of a vast amount of experience. Common sense prevents a man giving orders which are absurd on the face of them. An instance occurred in a shop not long ago that illustrates this. Some iron collars were to be shrunk onto pins, turned for the purpose. The foreman, a new man, ordered the pins heated and driven into the collars. As a result of this foreman's order a lot of pins were spoiled and he was made the laughing stock of the whole shop. It is needless to add that this kind of a foreman "lasts quick," as the saying is.

As for tact, it enables a man to get along where a lack of it has caused strikes and discontent. A tactful foreman does not give orders to the skilled, high-class mechanic in the same tone that he uses in ordering about a lot of meddlesome boys, or in telling the "roustabout" to do a better job of sweeping. This kind of a foreman studies his men, studies their little weaknesses and pet ideas. One man he asks about the ball score and another if he has read that piece in the last magazine about hardening steel. A certain man, or two, gets all the particular jobs, while another who likes brass work is given the preference in goods of that class whenever possible. Thus it goes all through the shop, placing work where it will be done the quickest and best, and keeping the human machinery oiled as well as the other kind. In order to get the best results from his men, a foreman must not only command their respect in regard to his judgment, but also as to his personal habits. A dirty, slovenly, drunken boss, no matter how good a mechanic, cannot hold the respect of his men, and the shop will reflect his personal habits.

Again, in order to keep the shop going so that no time is wasted, he must plan ahead. He must keep watch of his men and calculate accurately when a certain man will finish a given job and have another ready for him. He must watch his supply of material and order more, in good season, making ample allowance for delays in the order department both of his own shop and the one from which it is purchased, as well as for the time required in transit. All these things he must keep in mind, and look ahead as an engineer glances along the track to see if all is clear. Added to all this he must use system. He must have his machines grouped so that the work can travel from one to the other with the least possible difficulty in handling. He must have things so arranged that a record is kept of the original cost of a piece of work, and the amount of time that was taken to machine it, fit it, and put it in place. He must see that the machines are kept in repair, and that the workmen do not abuse them. He must have a system of inspection in order to know whether the work is properly done. He must have system in everything; if he doesn't, he is missing one of the greatest aids to success.

Briefly stated, the ideal foreman is one who gets all that is possible out of his men, keeps them contented and at the same time turns out the product of his machines at the lowest possible cost. The nearer a foreman comes to this description, the more valuable he is, and the further from it, the less he is worth. E. VIALL.

Decatur, Ill.

TOOLS FOR MOTOR CAR CYLINDER BORING.

The set of tools shown in the accompanying illustrations is used in a horizontal boring machine for motor car cylinder boring. These tools were designed by the superintendent of a large motor car factory in England. In Fig. 1 is shown a device for boring the two cylinders of an engine at one setting. A 6-pitch gear is mounted on the flange of the boring machine spindle. This gear meshes into gears on the spindles of the boring fixture. The spindles run in phosphor-bronze bushings, and the thrust is taken at the end by a ball bearing.

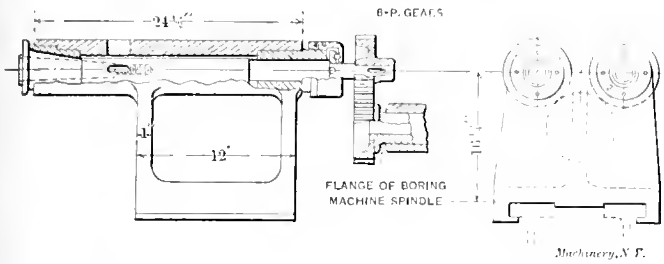


Fig. 1. Device for Boring Two Cylinders at One Setting.

The fixture has slots cut through at the front end to facilitate the removal of cutters, etc. This permits the spindle to be solid back of the hole for the taper shank of the tools used. The front end of the spindle bearing is tapered, and the back bearing is parallel. The fixture is held to the boring machine by straps. In Fig. 2 is shown the boring head. This has a tapered hole for the arbor, tapering ⅛ inch per foot. The rear end of the head is slotted for a key drive, and the front end is counterbored and a collar is placed in the recess secured to the arbor by a collar-head screw. This makes a firm and strong drive. Three Novo steel cutters are used in the head

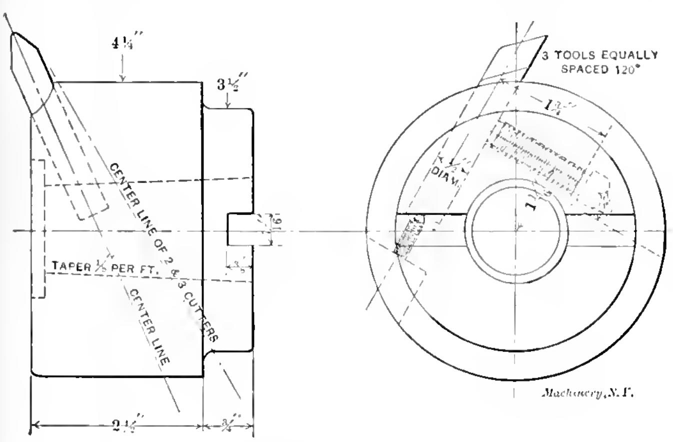


Fig. 2. Boring Head.

and are spaced 120 degrees apart, but are placed on two different centers in order not to weaken the head too much. The cutters are adjusted by small headless setscrews and are clamped in place by ⅜-inch square head screws, as shown. Two cuts are taken through the cylinders, the chips being blown out by compressed air.

In Fig. 3 is shown a facing tool holder. The facing tools are subjected to very heavy duty and must be held steadily. The hole in this holder is straight. On one end it is slightly countersunk on a 45-degree taper, and on the other side recessed to a 2-inch diameter for the spindle flange. Two keys are inserted into keyways on the spindle flange, making a positive drive. Flat tools of high speed steel are fitted into the slots in the head and are countersunk for the binding screws, so that when the screws are tightened, the cutters are brought down tightly against the back of the holders. These tools are nicked on the cutting edge in order to break up the chips. A steady rest which is used when facing the cylinders is shown in Fig. 4. The 1¾-inch diameter passes through the hole in the facing tool holder, and the ⅞-inch threaded part on the end screws into a threaded hole in the spindle. The 45-degree beveled face bears up against the 45-degree countersink, just mentioned, in the facing tool holder, and forces this

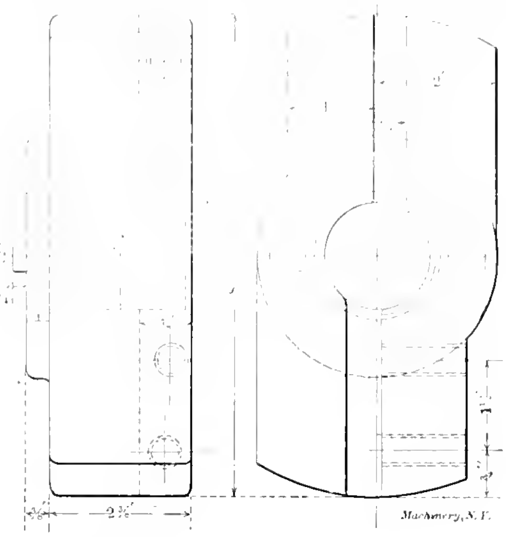


Fig. 3. Facing Tool Holder.

holder up against the flange of the spindle nose. The steady rest proper is made of cast iron and turned 0.002 inch smaller than the diameter of the cylinder. A felt washer is placed behind the cylindrical rest to permit it to give slightly.

In Fig. 5 is shown a valve boring and facing tool. The cutters for this are circular and keyed to the arbor. The pilot at the end enters into the hole already drilled for the

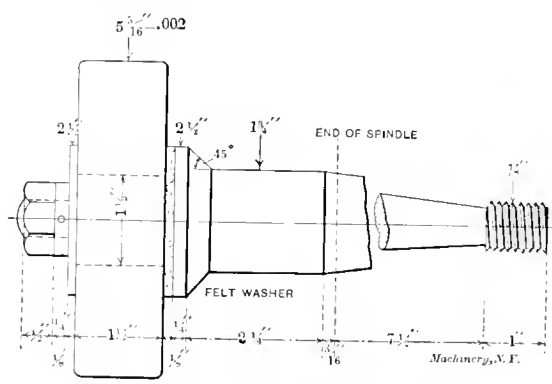


Fig. 4. Steady Rest used when Facing Cylinders.

valve spindle. In order to save space the end cutter is also made to act as a nut, and gashed for a spanner wrench. Two cutters are used for finishing the bore, one roughing and one finishing.

In Fig. 6 is shown a recessing tool which is used for recessing the groove shown at *A* in Fig. 7. A heavy center spindle which has a keyway and key in its upper portion, and then turned down to a smaller diameter, is milled at the lower end

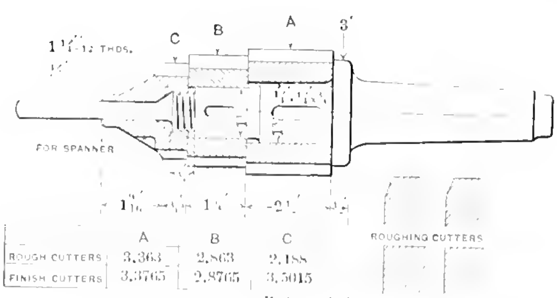


Fig. 5. Valve Boring and Facing Tool.

for a tool *D*, which is made of high speed steel and formed to the shape required. This tool is drilled for pivot *F* and slotted for pin *E*, which latter is milled flat on the sides. The stud *E* moves endwise in the slot in *D* until collar *B*, which acts as stop, comes up against bushing *C*. This bushing guides the tool and spindle in the cylinder and is beveled at the end

so as to easily enter the hole. The spring inside of the bushing allows the cutter to recede when the arbor is removed from the cylinder. BORER.

R. S.'S PERPETUAL MOTION EXPOSED.

In the July issue of MACHINERY, R. S. claims to have solved the problem of perpetual motion, but I regret to say that although it may prove financially a success—people have been known to subscribe for stock in things lots more foolish than this—his device will not be the motive power for very many factories, for the simple reason that it will not work. While it is one of the best perpetual motion devices on the market, it is easy enough to prove that there will neither be a per-

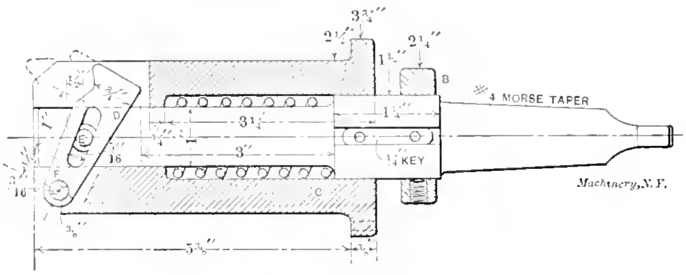


Fig. 6. Recessing Tool.

petual motion, nor even a temporary motion, except if caused by outside forces. This, of course, we all know, but an explanation why R. S.'s machine does not work may nevertheless be in place.

The explanation is simply this, that the work performed by the device when the leaden weights fall down and pull out the bags, thereby pushing the water aside, equals the work afterward done by the water on the bags. The water cannot be displaced without expenditure of energy, and the apparent gain of energy, as explained by R. S., is exactly equalized by the loss of energy due to displacing the water when the leaden weights pull out the bags. This can be exemplified by referring to the action of a cylinder in a piston under analogous circumstances. Suppose a piston and a cylinder of the same specific gravity as water were submerged in water to a depth of 10 feet. Assume the area of the piston to be 4.608 square inches. Then, a six-inch movement of the piston will displace 27.648 cubic inches of water, which weighs one pound, taking the weight of water to be 62.5 pounds per cubic foot. At a depth of 10 feet the hydraulic pressure will be 4.34 pounds per square inch. Consequently, the work done in pulling out the piston six inches and displacing one pound of water will be:

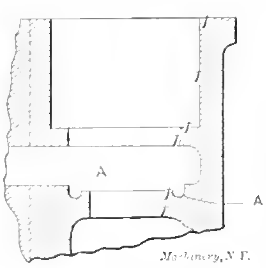


Fig. 7

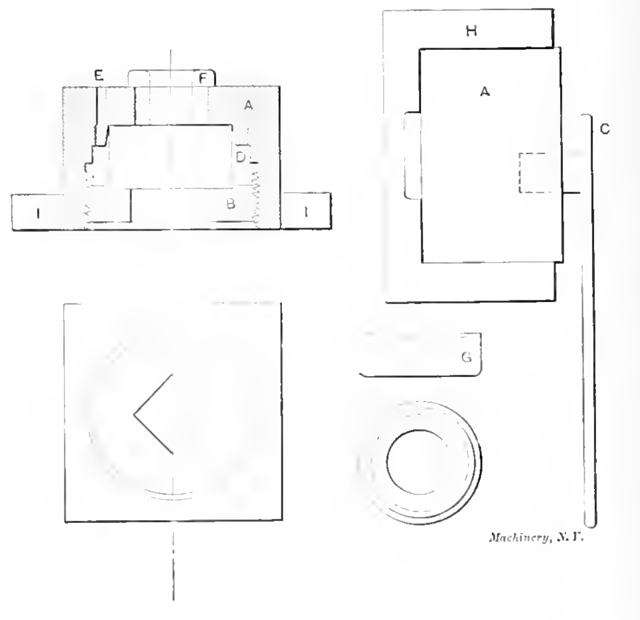
$$4.34 \times 4.608 \times 6 \div 12 = 10 \text{ foot-pounds.}$$

The piston and cylinder have, however, acquired a buoyancy of one pound, and in traversing 10 feet to the surface the work of lifting would be equal to 10 foot-pounds, or the exact equivalent of the work required to pull out the piston and create the buoyancy effect. N. MEYER.

New York.

INTERCHANGEABLE JIGS FOR DRILLING COLLARS.

The article in the June issue of machinery by Geo. T. Coles regarding the making of collars under the steam hammer, reminded me of the methods I adopted in the machine shop some time ago to reduce the cost and increase the output of a variety of sizes of collars. These collars are made of annealed tool steel in sizes varying in thickness as well as in diameter and size of hole. They are cut off on a cold saw by a boy who attends three machines. They were previously made from the bar in a monitor lathe, and the cost was far in excess of what it ought to be. Having a three-spindle gang drill in the shop, which was idle part of the time, I therefore decided to make use of it in the production of these collars. Four jigs like the one shown in the cut were made. They were made to take any diameter or thickness of collars within their range. The body of the jig is a square block of steel, with the hole to receive the collars exactly in the center. The lower end is threaded left-hand to receive piece *B*, which has a square hole in the center to receive wrench *C*. The ring *D* is bored taper, and fits the collar operated upon at the top end only, so that the collars will drop out of the jig easily. The rings are made to fit collars of different diameters, and are just an easy drive fit in *A*, the body of the jig. They are driven out with a soft punch through holes *E* in piece *A*. Drill bushings *F* are also interchangeable. Piece *G* is a distance piece used when drilling thin collars in order to avoid screwing piece *B* into the jig too far. It is apparent from the cut that these pieces are made to fit the collar at one end, and beveled at the other to center in piece *B*. The reason piece *B* is threaded left-hand is as follows: If the collar operated upon should turn in the jig, the piece *B*, taking the thrust, would also turn, and being threaded left-hand would thereby tighten the collar in the jig. Piece *H* is a channel iron the function of which is to hold the jigs while refilling. In operation, one of the jigs is placed upon the drill



Jig for Drilling Collars.

press table under each spindle between flat strips *I*, which keep the jigs from turning, at the same time leaving them free to be removed for refilling. It will be seen that by having four jigs, and a three-spindle machine, by timing them so that they will finish the holes one after the other, it will give plenty of time to refill the fourth jig, and thereby, with an extra drill or two, kept sharpened by the tool grinder, the machine may be kept in constant operation. This machine is equipped with a pump keeping a constant flow of cutting fluid on the drills. As this machine is also handled by comparatively cheap labor, a saving of almost 400 per cent was shown by actual test. C. G. H.

SOME AUTOMOBILE FACTORY WRINKLES.

A simple and effective method of finishing the big end bearings of the connecting-rods of gasoline automobile motors is in use at the factory of the Locomobile Company of America, at Bridgeport, Conn. The rods, which are of drop-forged steel, heat-treated, are bushed at the wrist-pin ends with solid bushings of hardened steel and the split big ends are lined with Parsons' white brass. Heretofore the custom at this factory has been to bore the big end bearings as accurately as possible in special boring machines and then fit each to its individual crank-pin by hand, with the aid of the scraper. The new method, which saves time in turning out the work and also makes a better job, consists in boring the bearing a few thousandths small, and then forcing through it a tapered mandrel of hardened and highly finished steel, the largest part of the mandrel being of course of the size required for the finished bearing. The mandrel is forced

through the bearing by means of a hand-press whose plunger is depressed and raised by a rack-and-pinion arrangement, worked through a ratchet by a hand lever. The mandrel is passed through twice, from opposite sides of the rod. At the completion of the operation the metal is somewhat compressed near the surface and is very highly polished, having a glaze such as it would acquire after running for some time in actual service under favorable conditions. The bearing is a very good fit on its crank-pin, and no hand fitting whatever is required, so that the polished surface is not broken. The compression of the metal, together with the glaze on its surface, apparently increases its ability to resist wear. Preliminary tests showed that bearings finished in this way would wear considerably less than carefully hand-fitted bearings run under exactly similar conditions. Of course the crank-pins must be very accurately finished, or the accuracy and high finish of the bearings will be of little benefit. Preparations are being made to finish the main bearings of the crank-shafts in the same way.

At the same factory the idea of giving new parts the same finish that is acquired by running under proper conditions is carried out in finishing the piston rings, which in a high-compression gasoline engine must be as well fitted as possible. After being finished on grinding machines, the rings are put into a holder which corresponds to the piston and holds the rings just as a piston does, and this is worked to and fro in a cast-iron tube bored and finished exactly the same as a cylinder of the motor, a small quantity of a fine abrasive substance being employed. The rings so finished bear all round when placed in their own cylinders, and also bear right across from edge to edge. The piston is tight from the first, and wears very well. Of course the tubes used in the finishing process are subjected to considerable wear and must be renewed frequently; but this is found to be a very unimportant detail as compared with the excellent results obtained by the employment of the process.

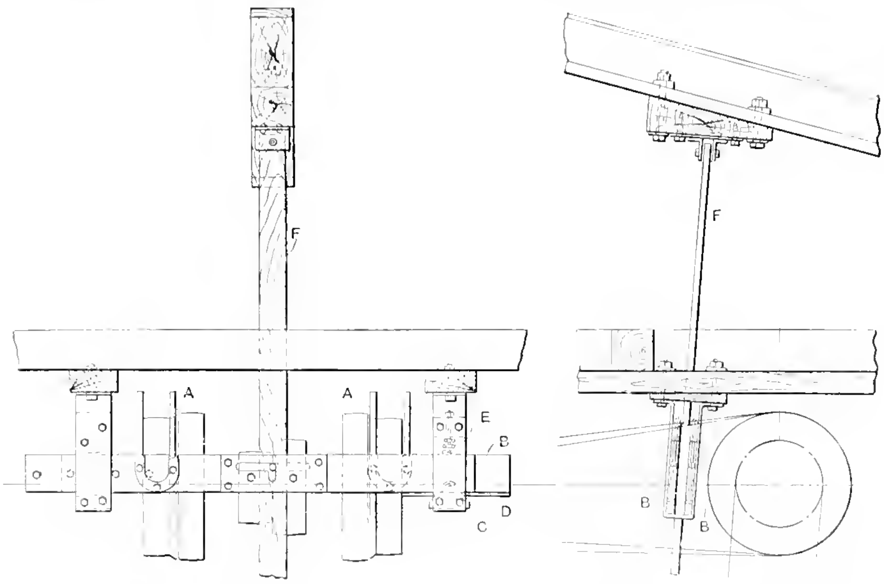
An interesting detail, which would probably not present itself to the mind of the average man, is that piston rings, after being ground on a magnetic chuck—a very widely used method in automobile shops—are more or less highly magnetized, and if allowed to go into the engine in this condition they will attract and retain any small particles of iron or steel that come near them, with unfavorable results in the matter of wear. Consequently it has been found necessary, in the factory in question, to install a demagnetizing apparatus which effectually removes this cause of trouble.

HOMER GREENE.

SHIFTING TWO BELTS WITH ONE LEVER.

The cut herewith shows a design for shifting two belts with one lever, which I think might be of interest to some of the readers of MACHINERY. The belt shifter fingers *A* are bolted to the sliding bars *B*. These bars are carried in the supports *C*. The bars have notches cut in one end. These notches are faced with the steel shoe *D*. The notches fit over corresponding wedge shaped blocks in the right-hand support, and are held down on them by the spiral springs *E*. The shifter lever of the machine is between the two sliding bars and carries a pin that works in a slot in the sliding bars. The bars are strengthened by the steel plates in their middle portion as shown. The action of the device is as follows. When the shifter lever *F* of the machine is in the position shown, both belts are on the loose pulleys. If the lever is moved to the right, the sliding bar nearest to the operator moves to the right, and the notches ride up on the wedge shaped blocks, lifting one end and causing the pin in the shifter lever to slide into the vertical slot in the bar. In the meantime the pin on the opposite side of the shifter lever has moved through the horizontal slot in that bar, shown by the dotted lines, without moving the belt shifter fingers on that bar. When the shifter lever is returned to the central position, it shifts the belt of the bar, nearest to the operator, to the loose pulley, because the pin is now working in the vertical slot. Continued motion of the lever to the left will cause the same operation to be repeated with the other shifter bar. Stops in the left hand portion of the bars keep them from moving too far to the right or left. This shifter has been working in the shop where it was made for some time, and has not given any trouble.

Norristown, Pa. WILLIAM L. AMBLER.



Arrangement for Shifting Two Belts with One Lever.

OBTAINING ANGULAR MOVEMENTS WITH THE INDEXING HEAD.

In the February, 1907, issue of MACHINERY appeared a table giving the movements of the indexing head of a milling machine for a series of angular measurements in degrees. The explanation of how to obtain the movement corresponding to a certain number of degrees did not seem as plain to me as it could have been made. I therefore present the following, in order to make the relationship between the movements of the index head and the angular movements as clear as possible.

As a matter of fact, we can obtain in the first place any movement in whole degrees, since the indexing of 360 is obtainable by simple plain indexing on any of the standard heads. This division is made by taking two holes in an 18-hole circle. Should it be desired to index, say, 27 degrees, we would multiply 27 by 2 and obtain the number of holes necessary for such a movement. As 54 is a greater number than the number of holes in the circle, we would have as the movement of the index crank 54/18 = 3 turns to make a 27 degrees division or indexing. Half degrees are obviously obtainable from the same source; as it requires a two-hole movement for a whole degree, it would be necessary to make but a one-hole movement to obtain the half degree. By substituting the 27-hole circle we may obtain a division of 20 minutes for a movement of each hole. Any row of holes that is divisible by 9 will give divisions of degrees and fractions thereof. Thus a 54-hole circle will give divisions as low as 10 minutes or one-sixth of a degree. This plate is furnished on some heads. By means of the differential index we may still further split up the fractions of a degree, but quarters or sixths of a degree are pretty close, and should be fine enough for even the closest jig work. Of course there are some jobs that one would encounter that might possibly call for much finer divisions, but they would then have to be accomplished by some other means than the one just considered. The above is by no means new, but was suggested by the table mentioned above.

The universal milling machine has become quite a factor in the production of small jig work, and is very handy on such work. When properly adjusted and carefully used very accurate results may be obtained by its use. However, good

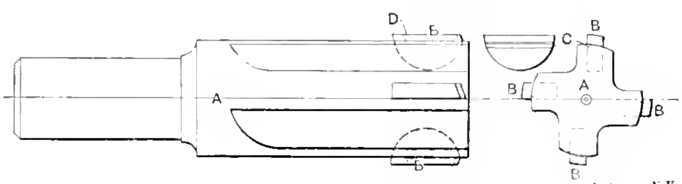
results must not be assumed to be possible from a machine that has been abused, and which is out of true; nevertheless, many unreasonable people think that they ought to be able to do so. Then, again, what is the limit that we may put on the accuracy of such machines? They are certainly far from being perfect even when just out of the inspector's hands. There is a tendency for some fussy individuals to split thousandths to an exaggerated degree even in the plain machines used in manufacturing. This is wandering some from my original topic, but it may be well worth saying.

Hyde Park, Mass. JOHN EDGAR.

INEXPENSIVE TOOLS WITH INSERTED HIGH-SPEED CUTTERS.

We are at the present time in need of cutting tools out of high speed steel, aud we would make them of this material if the price of the steel were not prohibitive in a good many cases. To overcome the objection of cost I have adopted a principle by meaus of which high speed tools can be made at a small fraction of the cost of solid tools. The principle is plainly shown in the cut, in which *A* is the body of a four-lip drill, made out of soft steel, and *B*, half-round disks inserted at the end of the flutes for cutters. The manner of inserting the blades is similar in principle to the Woodruff key system. The cutters *B* are cut off from round high speed steel bars, which have been turned to the exact diameter of the cutter, and are then split in halves with a hacksaw because of the stock saved by using this tool in preference to a saw in a milling machine. The cutters must be made to fit close in the milled slots, and for final binding a notch *C* is filed lengthwise in the cutters about the same height, or slightly below, the outside diameter of the body *A*. When the cutters are hardened and driven home, the soft metal of the body *A* is forced into the notch *C*.

The grinding and relieving is made in the same way as with a solid drill. When the cutters are ground back to about the distance shown by the dotted lines at *D*, the cutters are driven out and new ones inserted. This drill answers admirably for turret work where a boring tool follows



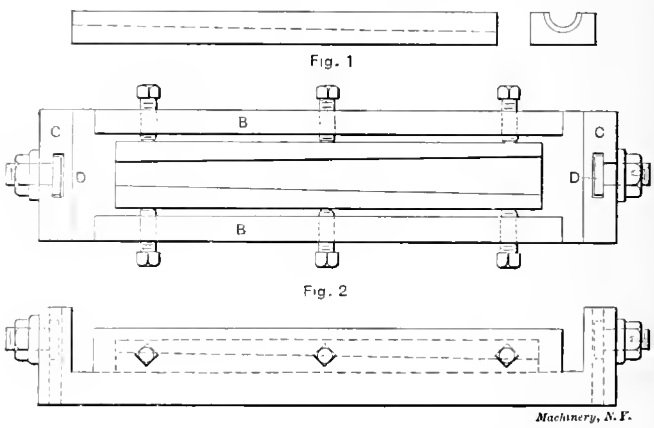
Inexpensive Inserted Blade Four-flute Drill.

for truing up the hole. For drill-press work another set of cutters can be set in back of the first set, so that when the first set of cutters is partly ground away, the second set will steady the drill. The same principle applied to a boring bar has several advantages, as there can be more than two cutting points put in the bar without materially weakening the bar, as is usually the case in small bars with the customary flat cutter and a slot through the bar. Coarser feed can then be used than with a two-point cutter. Another advantage is that on account of the small size of the cutters, it is possible to harden them very hard without risk of breakage, which would hardly be possible with drills of the larger sizes. The tools mentioned have been made, and have given perfect satisfaction, and there is no reason why this principle can not be applied to numerous other tools such as counterbores, milling cutters, and large reamers.

Lawrence, Mass. CHARLES THIEL.

FIXTURE FOR PLANING CONCAVE TAPERS.

Some time ago we had to make a number of semi-circular concave steel pieces as shown in Fig. 1, as well as quarter-circular concave pieces. These pieces were to be made so that if four quarter-circular or two semi-circular pieces were put together, they would form a round taper hole, the large end of which was to be $1\frac{3}{4}$ inch in diameter, and the small end $\frac{7}{8}$ inch in diameter. The extreme length of these pieces was 32 inches. They had to be made very accurate, and when put together must show a good fit on a tapered arbor. In order to plane these pieces a simple fixture was made, as shown in Fig. 2. The body of the device was a casting 40 inches long and $4\frac{1}{2}$ inches wide with two ribs *B B* and uprights *C C* at the ends. In these uprights two vertical T-slots were cored. The body was planed on the bottom between the ribs, and a number of holes drilled and tapped in the ribs for set screws to hold the work to be planed. Two 1-inch T-bolts with heads to fit in the T-slots *D D* were turned and threaded. The bolts were provided with very large centers in the threaded ends. These bolts were placed in the T-slots, a heavy washer slipped on, and the whole fastened by a nut. The steel pieces to be planed concave were now marked on the ends with their respective radii, and fastened by means of set screws in the fixture. The dividing heads were placed on the planer bed with the fixture between centers, the centers of the dividing head entering into the centers of the T-bolts. Then the fixture was adjusted between the centers. The T-bolts were set so that when the fixture was swung around, the radii at both the large and small ends would conform with the surface gage needle. The nuts and



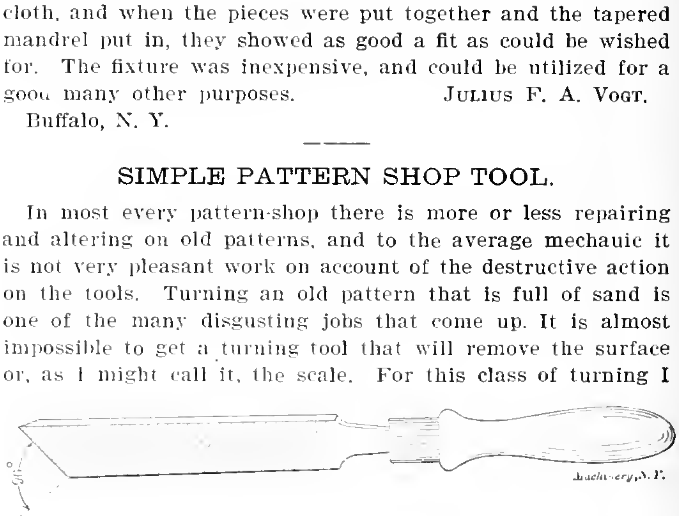
Fixture for Planing Concave Tapers.

T-bolts were then tightened. Now the end of the large radius was raised to the amount of the difference between the small and large radius, by adjusting the foot-stock end of the dividing head, and the work was ready to be planed. It will be seen that when turning the work between the centers, very accurate work could be done, and almost any taper within the range of the fixture could be planed. For final finish in this particular case the planed pieces were only rubbed with emery cloth, and when the pieces were put together and the tapered mandrel put in, they showed as good a fit as could be wished for. The fixture was inexpensive, and could be utilized for a good many other purposes. JULIUS F. A. VOGT.

Buffalo, N. Y.

SIMPLE PATTERN SHOP TOOL.

In most every pattern-shop there is more or less repairing and altering on old patterns, and to the average mechanic it is not very pleasant work on account of the destructive action on the tools. Turning an old pattern that is full of sand is one of the many disgusting jobs that come up. It is almost impossible to get a turning tool that will remove the surface or, as I might call it, the scale. For this class of turning I



Simple Pattern Shop Tool.

have two turning tools, made right and left, from flat, single cut files. The end is ground at right angles to the cut or tooth of the file, as shown in the cut, care being taken so as not to draw the temper in grinding. An old file will answer the purpose, but a new file is worth half a dozen old ones. Pattern-makers and millrights know what a job it is to turn an old or new split wood pulley. This tool will do the job easily. MILLWRIGHT.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

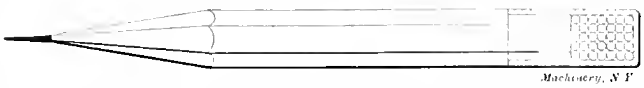
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

CUTTING FIBER.

In a number of factories where I have been employed, fiber was used in the manufacture, and the cutting was done in the pattern-shop, either on the band saw or circular saw, destroying the cutting edge in a very short time. If rotary shears are at hand the work of cutting fiber into strips of any length and width can be done with ease, and accurately as to measurements, without in the least injuring the cutters. The edges are left clean as if cut with a sharp tool. A pattern-maker will excuse a nail cut into once in a while, but never the cutting of fiber. P. M.

TO PREVENT LEAD PENCIL FROM BREAKING.

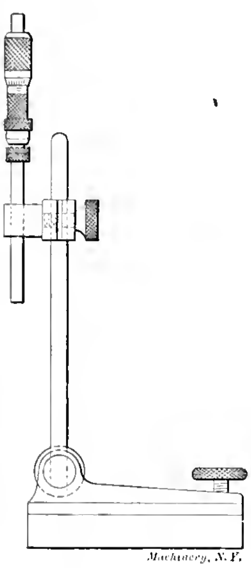
A small shell partly filled with a piece of lead, steel or shot, and forced on the end of a drawing pencil, may appear



to be a queer contrivance; but this end being the heaviest will naturally fall to the floor first, and will prevent the lead from breaking. Gordon F. Monahan.

Bridgeport, Conn.

INSIDE MICROMETER FOR SETTING CALIPERS.



The cut herewith shows an application of inside micrometers which is very handy. The hole for the scriber in the scriber clamp of a surface gage is reamed out to fit the rods used with inside micrometers. This forms a convenient holder for the micrometer when used for setting outside calipers to it. The calipers can be set easily and accurately at the same time, and where extreme accuracy is not necessary this arrangement is more handy than that of using large-sized micrometers. The writer has found that an accuracy of within one-quarter of 0.001 inch is obtainable in this way. Mistakes, in fact, are more easily guarded against than is the case when using the micrometers directly. Sirius.

GRADUATED STOP-COCK FOR OIL.

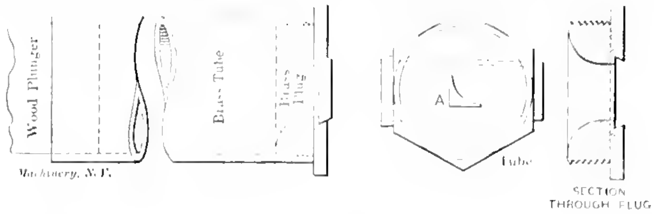
Having much fine planing to do on the milling machine, for which a very close regulation oil was necessary, one of our fellows conceived the idea of the graduated oil-cock, shown in the cut, which enabled him to regulate the flow

very closely and without the usual "turn and try." As the nature of the work was such that he could only continue at it intermittently, he would close the cock entirely when necessary to stop, and upon resuming would open it full for an instant to fill that portion of the pipe between the cock and outer end, and then turn to that graduation, which he would remember had before given the proper flow.

Springfield, Ohio. A. B. Christman.

TOOL FOR SHAPING WAX FILLETS.

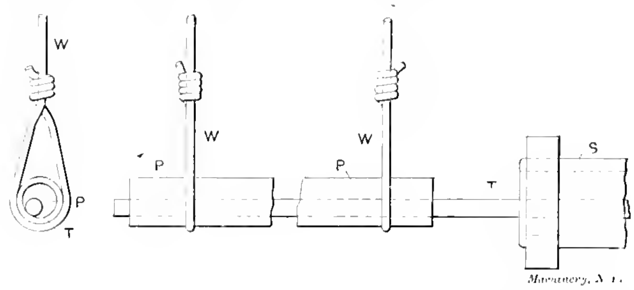
In the cut is shown a wax fillet tool that shapes the wax to a correct fillet instead of round as in all others that I have seen or read of. The brass tube is $1\frac{1}{4} \times 8$ inches, threaded at one end to receive a brass plug. This plug has a dovetail cut in it, as shown in the detailed view. In this



dovetail may be fitted brass plates, as many as are required for the various sizes of fillets. These are cut out as shown at A. By placing the fillet plate required in the brass plug, and heating the tube in the regular way, a much better fillet is made than with the round wax. Pattern-Maker.

STOCK SUPPORT FOR SCREW MACHINE.

Probably not one screw machine in a thousand has a stock support arranged as is the one shown in the cut, but for light stock it has advantages in the matter of economy of

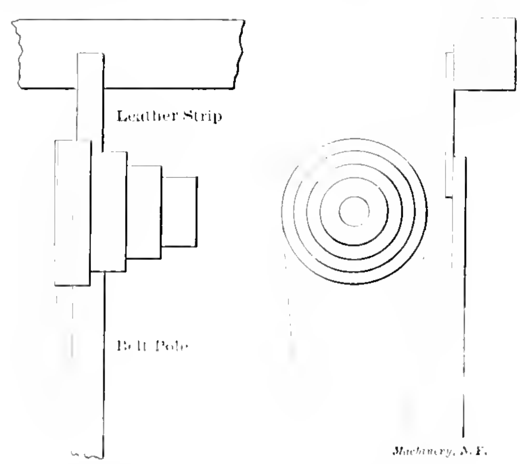


floor space, and can be swung up out of the way occasionally. In the cut, *S* is the spindle of a screw machine; *P*, a pipe; *W*, wires suspended from the ceiling, and *T* the screw-stock.

Springfield, Ohio. A. B. Christman.

BELT SHIFTER.

The cut herewith shows a handy and cheaply made belt shifter for the lathe or milling machine. It consists simply of a stick fastened to a beam by a strip of leather, about midway between the two largest steps of the countershaft



cone. In shifting the belt, the operator reaches through the belt and, grasping the stick, pulls it around against the belt to shift it to the desired step of the cone. For medium size cone pulleys the strip of leather which is fastened to the ceiling and to the stick should be 10 to 15 inches long, of single thickness, and about $2\frac{1}{2}$ inches wide. The pole is hung about $1\frac{1}{2}$ inch back of the largest diameter of the cone pulley. This shifter does away with the need of going after the usual belt pole. When correctly hung, it will shift the belt the whole length of the countershaft pulley. It is used quite extensively in the shops of the W. P. Davis Machine Co. Rochester, N. Y. C. Shaw.

Detroit, Mich.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

BECKER-BRAINARD UNIVERSAL INDEX AND SPIRAL HEAD.

The design of this head is the result of a desire to fill the need for a device that will answer the requirements of the heavier duty now imposed on the milling machine, and still retain the accuracy expected from such a tool. It has also been attempted to retain all the conveniences found in older designs of spiral head, and to add to these others that will increase the usefulness and convenience of the tool.

The prime considerations have been those of stiffness and accuracy. The spindle and worm-wheel are supported in a heavy block housed between two rigid uprights, in which the block swings in a vertical plane. Any angular adjustment required may be firmly held by tightening the nuts on clamping studs *M M* (see Fig. 6), which draw the outside plates securely against the uprights, making a rigid fastening for the head under the heaviest cuts, even when the work is not otherwise supported. The increase in strength thus obtained has in no way impaired the ease of handling.

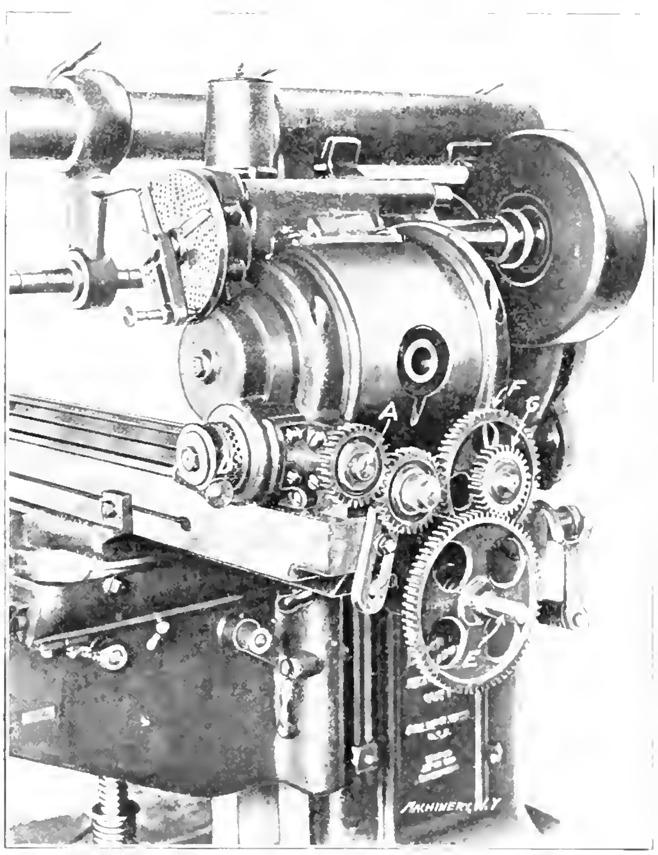


Fig. 1. Univeral Indexing Head in Place on Milling Machine.

The leading feature of the design so far as accuracy is concerned, is the large size of the worm-wheel which has been obtained. This is the largest that the respective swing of each size of head will allow, and the arrangement of the parts is such that in each case it is larger than that of any other head so far offered. Fig. 2, showing the back plate removed, gives a good idea of the unusual diameter of the dividing wheel. This adds greatly to the life of the worm and wheel teeth, as well as to the accuracy, since the wear due to the strain imposed by spiral milling is perceptibly reduced. The coarse pitch it is possible to use with the usual 40 teeth in a dividing wheel also allows of stronger gearing. Another feature is a provision for taking up wear in the worm and worm-gear so as to do away with all inaccuracies due to back lash. The worm gear, as may be seen in Fig. 6, is made in two sections, one of which may be rotated on the other to take up the wear. This method has long been used, and is a most accurate arrangement for making the required adjustment.

Elaborate provision is made for differential indexing. Unlike the arrangements commonly employed, this design provides for differential indexing under the following conditions: with the head in any position on the machine platen, with the work spindle at any angle with the cutter arbor; with work such as bevel gears, having conical surfaces instead of cylindrical; and in cutting helical grooves such as required in spiral gears, for instance. For all these conditions the full range of plain and differential indexing may be employed. Figs. 4 and 6 show best how this is accomplished. The change gears used in differential indexing are mounted on the rear side of the head, as shown in Fig. 4. As will be seen, they have no connection with the table at all, as is the case with ordinary index heads fitted for differential indexing. Shaft *B* carries on one end a gear meshing with the dial driving gear and on its other end the first of the train of change gears used, these being connected with stud *C* in the rear cover plate of the dividing head. Stud *C* carries on its interior end a bevel gear meshing with bevel teeth cut on the hub of the index wheel. It will be seen that this gearing connects the dial with the spindle in such a way as to give it a differential movement, of any degree required for the desired indexing. This is done in such a way as to make it possible to swing the spindle into any angular position desired, since the gears are all mounted on the swinging head.

To make the differential indexing universally applicable to helical work as well as to straight, was another problem this head has been designed to solve. The cutting of spirals makes it necessary that the plate be geared to the lead screw by suitable change gears. The connection between the lead screw and the index plate must be broken when making divisions, in order that the index plate may be free to make the differential movement with the index crank. This breaking of the connection is accomplished by means of an adjustable clutch (shown at *D* in Figs. 1, 3 and 6), which is withdrawn during the indexing operation. After the division has been made, the teeth in the clutch will be found to be in such a position in relation to the corresponding spaces of its mate that it is impossible to engage them. In order to bring the teeth and spaces opposite each other, half of the clutch is made adjustable, so that it may be rotated the required amount to bring the two portions into proper position for engagement. To effect this, one member of the clutch is connected to its shaft adjustably, by a worm meshing with a worm-wheel keyed to the shaft. This worm may be operated by hand by the knurled knobs shown. When these knobs are rotated, the clutch is slowly adjusted about its shaft, though still positively connected with it. By means of this, the lead screw and the indexing dial are again brought into connection with each other, after the indexing, without disturbing the setting of the work. But there is also another difficulty to overcome. The connection between the index crank and the dial through the worm, worm gear, spindle and change gears of the differential mechanism, would form a locked train when the index

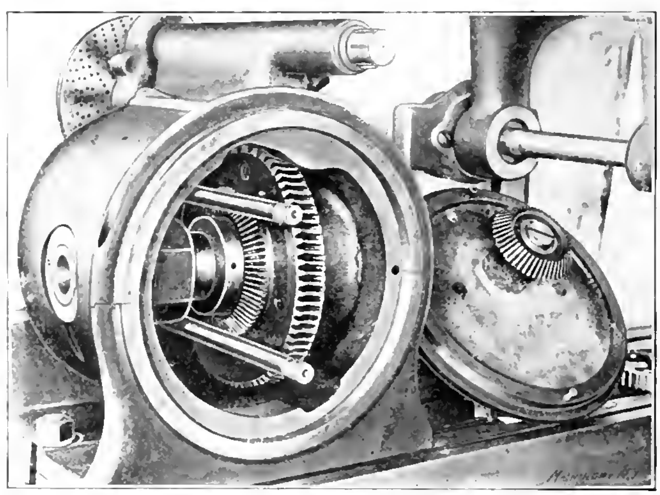


Fig. 2. Back Cover Removed, showing Clamping Bolts and Dividing Head.

pin is in mesh with a hole in the plate; so this must be released during the spiral cutting operation. This is accomplished by means of a knurled knob *H*, see Fig. 3, back of the index plate, which operates a friction clutch, so that the dial may be released from, or connected with, the differential gearing, as may be required. These various provisions make the differential indexing universal throughout the whole range of work of the machine.

Frequently it is desired to roll the work on its axis by a small amount without shifting the dog or loosening the position of the index pin, or sometimes the amount of adjustment may be such that if it is attempted to do it by the crank, the pin will not come exactly over the hole, as is necessary. If the attempt is then made to move both plate and crank in conjunction it will probably be found that the spacing of the holes in which the back pin enters is such that the required

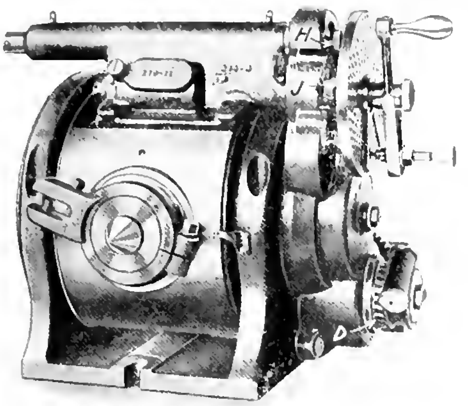


Fig. 3. Front View of Head.

adjustment cannot be exactly obtained. In this head the back pin is done away with, and the plate is held during the plain indexing by a friction clamp on the hub of the plate gear, which is thus gripped or released by a suitable bolt, *J*, conveniently located. By this means work may be set regardless of the position of the plate, which may be securely held in any desired location to bring the work to the position required.

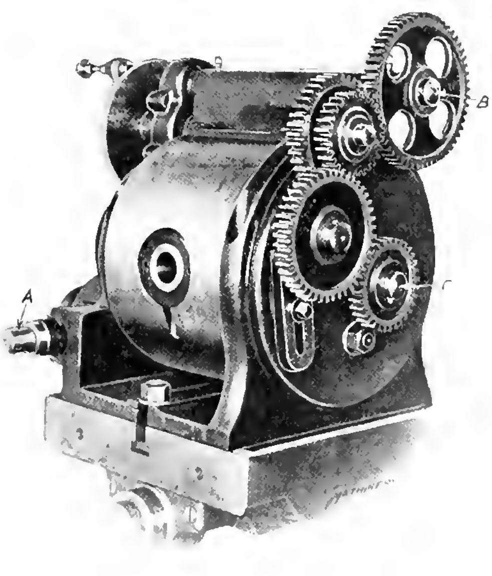


Fig. 4. Back View, showing Differential Gearing

It is believed that the doing away with the back pin, and the substitution of this more flexible clamping device, will be appreciated by milling machine operators.

Another convenience is an adjustable dial on the spindle nose for obtaining angular divisions directly in degrees, for work requiring no great accuracy. This is much preferable in ordinary cases to the cumbersome method of indexing degrees on the dial plate. A single reversible plate is used for all divisions, it not being necessary to provide a variety of these, with adequate differential indexing.

In recapitulation, the following results have been obtained in this design. It is of stiff and rigid construction, with a large worm and worm-wheel, giving accuracy and durability as well; differential indexing may be accomplished in any position of the head on the platen, on conical work as well as cylindrical work, and in the case of spiral milling; the spindle

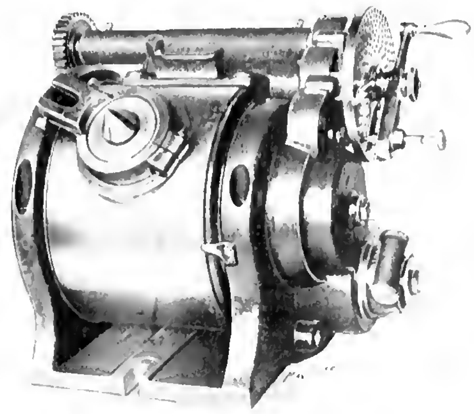


Fig. 5. Head Arranged for Differential Gearing with Angle Adjustment.

and work may be rotated independently of the lead screw when the change gears are set for spiral milling, making the setting of the work easier than would otherwise be the case; means are provided for taking up wear in the worm-gear or dividing wheel; but one reversible index plate is required for all the divisions within the range of the machine, and an adjustable dial is provided on the spindle nose for obtaining.

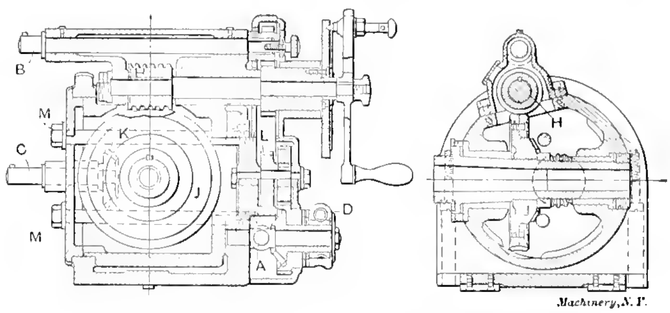


Fig. 6. General Construction of the Becker-Brainard Index Head.

angular divisions directly. This device is furnished with the universal milling machines built by the Becker-Brainard Milling Machine Co. of Hyde Park, Mass.

CUTLER-HAMMER LIFTING MAGNET.

The Cutler-Hammer Clutch Co., Milwaukee, Wis., has been experimenting on the design of electric lifting magnets for some years, in a quiet way. The company has now placed on the market the design illustrated in the three accompanying half-tones. This design is the result of these experiments, and of thorough testing in actual practice in factories, steel works and manufacturing plants.

Like all magnets of this kind, the construction is very simple, being composed of a steel core and frame work with enclosed coils of wire carrying the exciting current. There are a number of features, however, which are original with this design. A concave contact surface has been generally used as being the most efficient for handling loose materials of various kinds, such as punchings, scrap, etc. When, however, this same magnet is to be used for a load consisting of one or two large objects with plane surfaces, this concavity becomes objectionable, since an air gap intervenes between the inner pole and the object to be lifted. To obviate this difficulty an auxiliary pole piece is provided in this design. It is inserted in the concave face of the magnet with a stem passing through the central aperture in the frame. It is so designed that the inner pole is extended downward to the level of the outer pole, thus eliminating the air gap, and insuring intimate contact of both poles with the object to be lifted. The central aperture in which this auxiliary pole is fitted serves another purpose—that of ventilation. In magnets of the usual construction the concave pole face forms an air gap in which heat accumulates very rapidly, and from

which it is difficult for it to escape. The fact that there is a hollow central core through the frame obviates this trouble, making it possible to keep the windings cool at all times. The pole shoe of the magnet is the part subjected to the greatest wear and tear. This is removable, being fastened

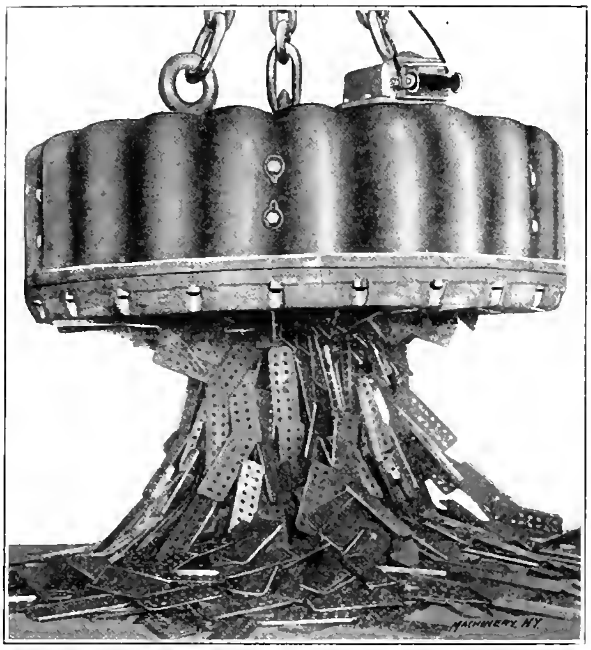


Fig. 1. Cutler-Hammer Magnet Lifting Punchings.

to the under side of the apparatus with through bolts and cap screws.

It will be noticed that the periphery of the frame is corrugated. This is done to furnish a greater radiating surface, and to protect, as well, the heads of the through bolts which fasten the removable pole piece to the magnet frame. The magnetizing coil, on which the efficiency of the magnet depends, is carefully built up of alternating layers of copper and asbestos, and is insulated from the cast steel frame by thick sheets of mica. No combustible material of any kind is used, so there is no danger of damaging the magnet if, by accident, it should be left connected with the circuit over night, as has actually happened. Under test, the coils of these magnets have been heated to 470 degrees F. without injury.

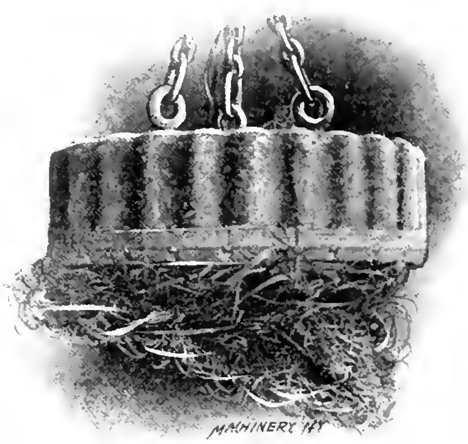


Fig. 2 Fifty-inch Magnet Handling Scrap.

This freedom from injury by heat is also of advantage in lifting and transporting forgings, castings, etc., which are as yet too hot to be touched by hand.

The half-tones shown illustrate two sizes of the Cutler-Hammer lifting magnet. Figs. 1 and 2 show the 50-inch size, and Fig. 3 the 10-inch size. The 50-inch size under favorable circumstances will lift as much as 20,000 pounds. Under other conditions the capacity of the same magnet may drop to 1,000 pounds or even less. This all depends on the nature of the load offered to it. Perhaps as unfavorable conditions as could be imagined were met with in a competition conducted by the Youngstown Steel & Tube Co. This was to determine the best form of lifting magnet for unloading pig iron from cars. The Cutler-Hammer magnet unloaded a steel gondola containing 109,350 pounds of sand cast pig iron in 2 hours 5 minutes. This was done entirely by one man, the crane operator. The average lift was 785 pounds, which was better by 43 per cent than the average made by a heavier competitive magnet. The Cutler-Hammer magnet was purchased and is now in use. The conditions which made this task difficult were the irregular surfaces presented by the sand cast pig iron, and the fact that the material was lifted from a steel gondola.

In Fig. 1, a 50-inch magnet is shown lifting a mass of steel punchings. In this case the auxiliary pole piece mentioned is used. The magnet was not lowered to the punchings, but was brought to within about 3 feet of them, when they arose to meet it as shown in the cut. In Fig. 2, a magnet of the same size is seen lifting plate and sheet scrap of weight not known. This scrap was originally in a pile about 4 or 5 feet high, and was crushed into a compact mass, as shown, by the weight of the magnet. In Fig. 3 the 10-inch size is shown lifting a Bliss car lighting dynamo weighing 800 pounds. The magnet itself weighs about 75 pounds.

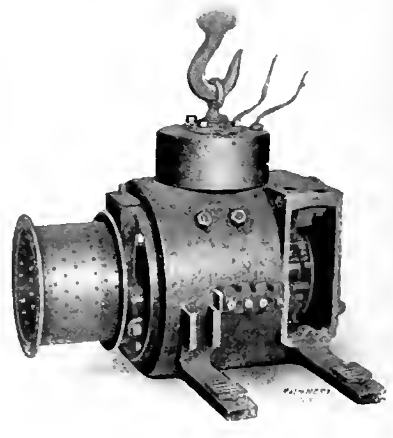


Fig. 3. Ten-inch Magnet Lifting a Weight Ten Times its Own.

The principal points on which the builder claims superiority above all competitors are first, that the weight of a Cutler-Hammer magnet will be guaranteed not to exceed that of any comparable magnet; second, that its lifting capacity will exceed that of any other with which just comparison can be made; and third, that the operating cost per ton of material moved will be less than with any other magnet.

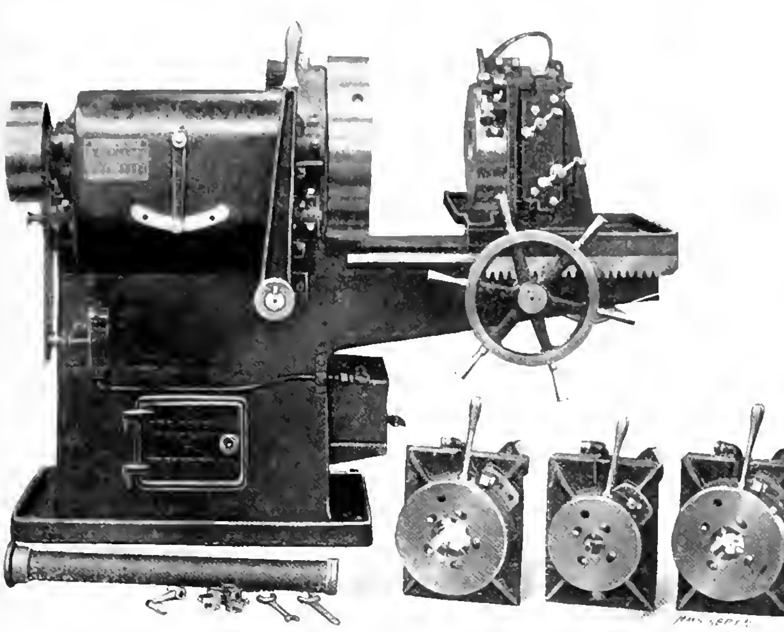
STOEVER LEVER PIPE THREADING MACHINE.

This machine, built by the Stoever Foundry & Mfg. Co., of Myerstown, Pa., is designed to cut off and thread pipe from 1/4 inch to 2 inches in diameter, inclusive. As shown in the half-tone, the bed and head-stock are cast together in one piece, insuring a rigid support for the bearings. This is particularly necessary in a machine of this kind, as the operation of the chuck brings a constant strain on the front bearings of the main spindle, which is not properly taken care of where these bearings are in independent castings, bolted to the bed.

The spindle has nine speeds, obtained from a single speed pulley, through sliding gears and clutches. This gives a sufficient range for cutting both steel and iron pipe of the sizes within the capacity of the machine. A speed plate is mounted on the head-stock, showing what speed should be used for each size, so the operator has no excuse for limiting the output through ignorance. The chuck is operated by a lever while the spindle is in motion; but little pressure is required, owing to the design of the linkage employed. The chuck presents a smooth surface, the actual gripping parts being entirely enclosed. Three jaws are provided, adjustable universally at any one of three points on the periphery of the chuck, one of which is within reach no matter in what position the spindle stops. All of the mechanism of the chuck is made of steel. The spindle gearing is completely enclosed, but can be exposed for inspection by removing the cover. A set of bushings is provided for supporting the various sizes of pipe. These extend clear through the spindle, with a bearing at each end, so that there is no trouble on the score of

having to center the pipe to enter the jaws when work is inserted from the rear end. An improved pipe and nipple holder is provided.

The die-head is mounted loosely in horizontal guides on the slide so that it can adapt itself to any eccentricity in the work. These horizontal guides are long enough, also, so that the head can be pushed entirely to one side, in which case the cutting-off tools can be brought very close to the gripping chuck, cutting off work flush with the jaws. In this position, also, pipe can be inserted in the machine from either end equally well, without requiring it to be dragged over the cutting edges of the chasers. A steel cam is used for adjusting the interchangeable steel chasers; hardened steel parts are used throughout in this mechanism to reduce the wear. The front face of the head swings open, so that the chasers may be removed by simply picking them out and inserting others in their place; the whole interior of the head is thus exposed for cleaning or inspection. Two cutting-off tools are used, both being operated by the same handle. A balanced feed is provided, so that both will always be cutting. The machine may be equipped in two different ways, either with a single head and chasers of various pitches, which are changed as the work requires, or with a head and inserted chasers for each pitch. This latter plan, though requiring a more extensive equipment, is the best for jobbing shops, where each operation may be on work of a different size. The length of the horizontal ways in the holder is such that two heads may be mounted at a time, it not being necessary to remove the one in place, if a short job has to be done on another size.



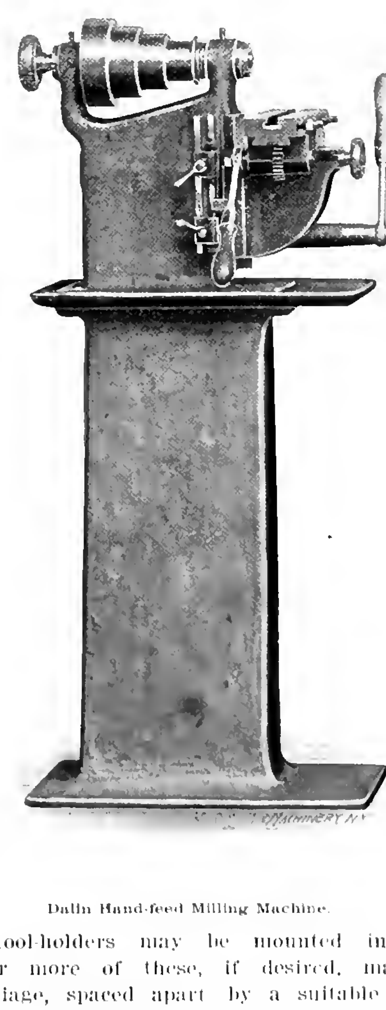
Stoever Lever Pipe Threading Machine.

The oiling system is carefully planned. The pump is driven by a steel chain from the constant-speed pulley. It is of the geared type, and will deliver oil when running in either direction. The oil flows back from the dies and cutting tools to the bed of the machine, and then through strainers into the tank below. The machine is made with a cabinet base in which dies, nipple holders, wrenches, etc., are kept. A large oil pan is also cast around the base. The weight of the belt driven machine, with one die-head, dies, countershaft and bushings, is 2,500 pounds.

NO. 1 DALIN MILLER.

The hand miller shown in the accompanying half-tone is built by Dalin Bros., Rockford, Ill. It is designed for small work, and is especially adapted to the demands of interchangeable manufacturing, being well built, carefully fitted, and very heavy and rigid for a machine of its size. The table has a long bearing, giving a good wearing surface. The vertical movement of the knee on the column can be limited in either direction by the stops shown, clamped in the T-slot on the side of the column. Fine pitch screws are provided for close adjustments, and the abutting surfaces are so placed as not to be subject to error from the accumulation of chips. Stops are also provided for the traverse of the table. The spindle is regularly fitted with a drawing-in sleeve and a half-inch collet or chuck for straight-shanked arbors and end mills. The machine is driven by a 4-step cone for a 1½-inch belt. If desired, it will be provided with a 3-step cone, and the spindle may be bored to a No. 7 Brown & Sharpe taper if the customer so requires. The machine is sold with or without base.

The height from the table to the center of the spindle is 4⅝ inches. The cross adjustment of the saddle is 2½ inches. The table, which has a working surface of 3½ x 12 inches, has a travel of 7 inches. The weight of the machine, with countershaft and base, is 295 pounds. If required, a vise will be provided, with jaws 1 inch deep, 3½ inches long, and with an extreme opening of 1½ inch.



Dalin Hand-feed Milling Machine.

NEW DESIGN OF THE LO-SWING LATHE.

The accompanying half-tones illustrate changes recently made in the design of the well-known "Lo-Swing" lathe, built by the Fitchburg Machine Works, Fitchburg, Mass. The improvements relate principally to the design of the carriage and tool-holders. The whole machine was described in the November, 1905, issue of MACHINERY. The changes are best seen by referring to Fig. 3, which shows a view of the lathe from above, with the tools operating on a piece of work. Two rigid and compact carriages have been provided, retaining the useful features of the feed mechanism of the previous machines. These carriages are provided with longitudinal ways at the top, on which the tool-holders may be mounted in any position. Two or more of these, if desired, may be used on each carriage, spaced apart by a suitable distance to give the shoulders required on the work. The provision made

for supplying oil to the point of the tool is unique. Oil is conducted to a passage in each carriage by a flexible piping system from the circulating pump. From this passage in the carriage, short sections of flexible tubing are used to supply the lubricant to each individual tool-holder. Plug valves are provided for each outlet. This arrangement is entirely out of the way, and very convenient.

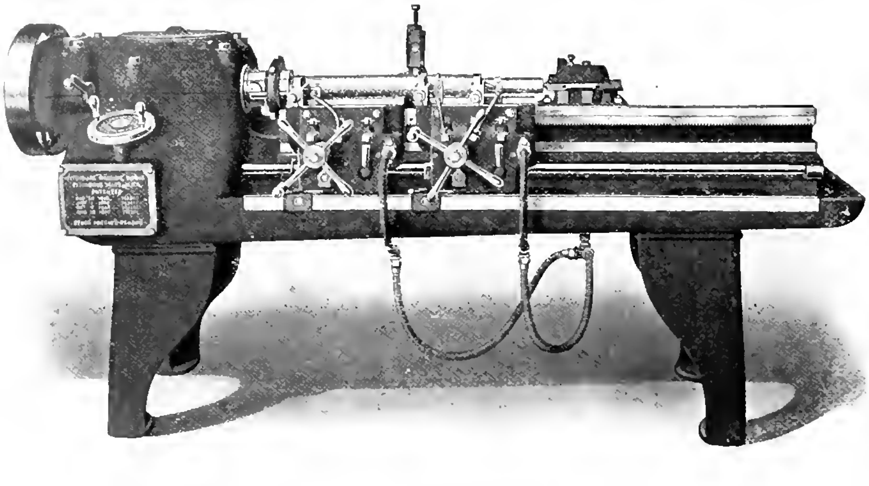


Fig. 1. New Design of Lo-swing Lathe.

A new attachment used with this machine provides for the turning of tapers. This is shown in Fig. 2. It consists of a tool-holder with a slide at right angles to the axis of the work, actuated by means of a flat tapered bar or templet, placed directly back of the tool, but fastened to the bed of the lathe so as to always hold the same relation to the work. This templet is planed to half the included angle of the taper desired, and is arranged to be swung out of the way when other cuts are being taken. The taper tool is fitted to receive the follow rest, which on long work precedes the cutting tool, bearing on a previously turned straight furnace. The tool-holder and its guiding frame are easily attached to either carriage, and since it is only $\frac{3}{4}$ inch wide, ample room is left for several other tools if necessary.

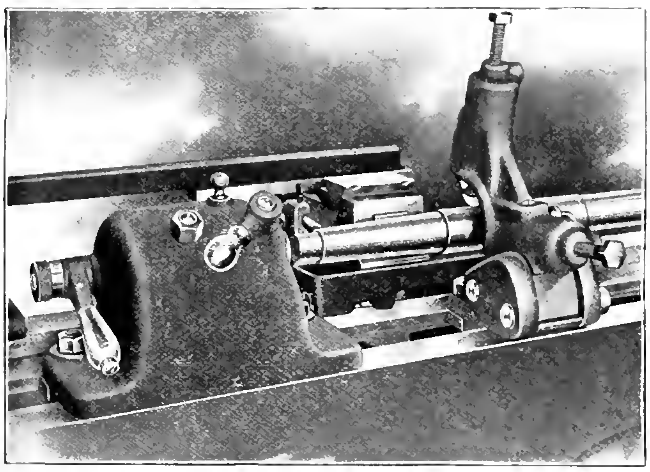


Fig. 2. Taper Turning Attachment for Lo-swing Lathe.

The general plan on which the "Lo-Swing" lathe is designed has been before described, but it may be worth while in this connection to explain it again in a few words. It is built for specialized turning of shafts, pins, studs, forgings, etc., not over $3\frac{1}{2}$ inches in diameter, and with any number of diameters and shoulders. It is designed to do this work with the greatest accuracy obtainable in lathe work. As the work turns on centers, it is readily transferred; so it is used, not only for straight turning, but for any piece on which there is straight or taper turning to do in combination with other special operations, such as threading, chucking, etc. Its advantages for this work are: the fact that several tools may be used at once, provision being made for this by the use of the specially adjustable tool-holders just described; the fact that there is a minimum number of joints between the tool and the bed which supports it, giving the cutting point a very rigid support; and, finally, the machine is designed to furnish convenient means for making rapidly all the changes required, such as altering the adjustment of the tools, changing the feeds, etc.

The decrease in the number of joints and sliding surfaces between the point of the tool and the bed of the machine is especially noticeable. Another point is the fact that the bearing has been brought well under the cutting edge; this could be done on account of the small swing to which the lathe has been restricted. Even when cutting clear down to the center, the overhang of the tool is inappreciable. In the case of an 18 or 20-inch lathe of the usual design, especially if it is furnished with a compound rest, the point of the tool may be anywhere from 8 to 15 inches from the guiding surface of the Vs. There is thus seen to be a great difference between the degree of rigidity obtained in standard lathe design, and in this specialized form for small diameters.

FOSDICK BORING, DRILLING AND MILLING MACHINE.

The machine herewith illustrated is designed for boring, drilling, milling, or tapping, at any angle. It is called by its builders, the Fosdick Machine Tool Co. of Cincinnati, Ohio, their style D horizontal boring, drilling, and milling machine. The machine has a bed plate, tongued and bolted to a main bed, on whose wide upper surface is carried the column, which has a horizontal travel on the ways shown. This column carries the saddle, which is counterbalanced, and can be adjusted by the pilot wheel, or raised and lowered by power. Suitable feeds in either direction are provided for the spindle. These feeds can be used not only for the horizontal travel of the spindle, however, but for the vertical travel of the head on the column, and the horizontal movement of the column on the bed. All these movements can be instantly reversed. The pilot wheel shown can also be used for operating any of these adjustments by hand. These various movements make it possible to provide power feed for milling in any direction, as well as for drilling and boring. For heavy milling, the column can be fed backward and forward on the bed. This places the strain of the cut on a screw of suitable diameter and

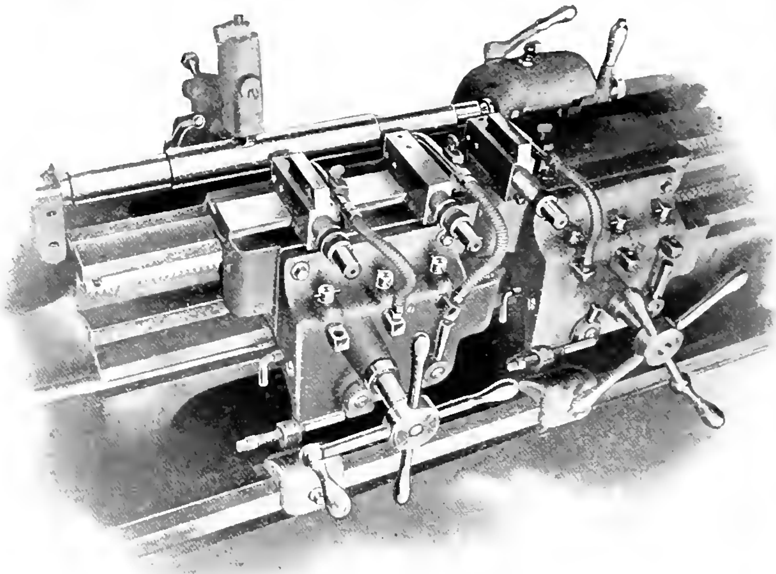
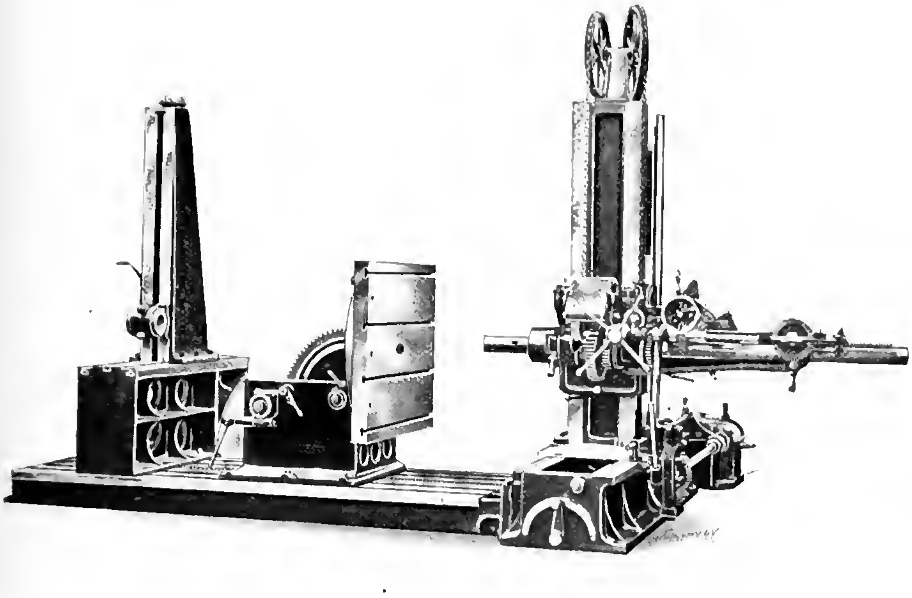


Fig. 3. View showing Carriages and Tool Blocks.

lead, having ball thrust bearings. This feed can be controlled by the lever shown on a semi-circular guide on the front of the machine.

The spindle is connected to a constant speed drive, which can be driven either by a belt or may be geared direct to a constant speed motor. A speed box with positive changes is used, which gives six variations; these may be easily and noiselessly obtained while the spindle is running. This, in combination with the two changes in the head, gives 12 changes of spindle speed of from 4 to 260 revolutions per minute. A friction clutch placed between the back gear and the speed changing device provides for starting, stopping and reversing the movements of the whole machine. This clutch has a toggle friction motion, and is powerful enough to carry the greatest loads it will be called on to sustain. The spindle bearings are of large diameter and length, and are fitted into adjustable taper bronze bushings with provision for taking up wear. The spindle sleeve has a threaded collar of large diameter so arranged that it may be used for securely tightening the spindle bar centrally in any desired position.



Boring, Drilling and Milling Machine with Universal Table.

The bed plate carries a universal table, which may be swung to present the work at any angle. An outboard bearing is also provided for boring bars. The universal table or the outboard bearing may be moved toward or away from the spindle by a rack and pinion movement, operated by a ratchet. A horizontal movement in the other direction is provided for the outboard bearing through a rack and pinion, while the vertical movement is controlled by a crank and screw. All the various movements of the column, spindle, head, outboard bearing, etc., are provided with scales to facilitate setting.

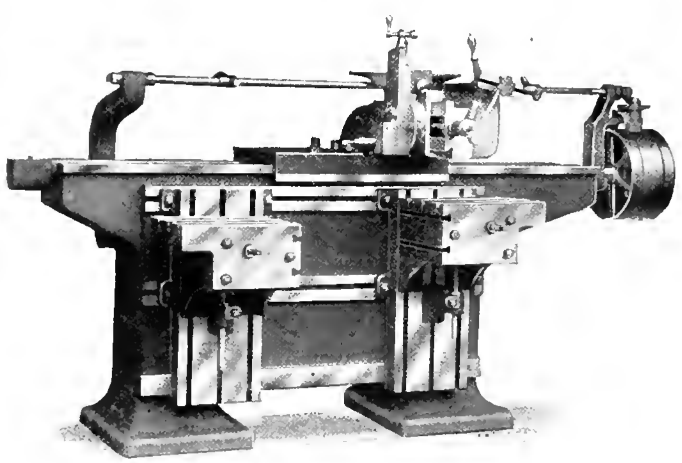
This machine is built regularly in two sizes, of practically the same construction, but with different work holding capacity and traverse of the feeds. The No. 2 machine has a spindle with a No. 6 Morse taper socket and a traverse of 30 inches. The vertical adjustment of the head and column is 54 inches; the horizontal adjustment of the column and the bed is 62 inches. The center of the spindle can be raised to a distance of 72 inches above the base, or lowered to within 22 inches of it. The base is 42 inches wide by 127 inches long, and the universal table has a clamping surface 40 x 46 inches. The total height of the No. 2 machine is 9 feet 6 inches, and the net weight is 20,000 pounds.

CINCINNATI OPEN SIDE SHAPER.

This machine, shown in the accompanying half-tone, is one of a line of which the smallest size was illustrated in the January, 1907, issue of MACHINERY. As there described, these machines are especially adapted to certain classes of work which cannot be easily handled on the ordinary shaper. For instance, there is practically no limit to the diameter of shaft which can be key seated. The usefulness of the ordinary shaper in this direction is limited by the size of the opening through the column under the ram. Again, it has the advantage of having a uniform deflection for the tool throughout the length of the stroke, the amount of over-hang being constant during that time. In the regular shaper the tool and arm spring upward, and the work deflects downward more at the end of the stroke than it does at the beginning, giving the well-known "fan-tail" cut, which is one of the objections to the shaper for accurate work. The range of the machine is also considerably increased. Castings of great size can be brought up to it and worked on by it without interfering with any portion of the machine.

The size shown in the cut planes 15 inches wide by 60 inches long. The maximum distance from the head to the table is 23¼ inches. There are two tables, each 15¾ inches wide with a vertical adjustment of 19 inches. They are 15 inches deep and rigidly constructed. The use of two of them, independently adjustable, makes it easy to hold irregular work that would otherwise have to be supported on blocking at one end.

The head is traversed by the method adopted by the builders is their previous machine, a bronze nut and steel screw being used, directly keyed to the driving pulleys without the intervention of gears. The reversing action depends on the turning of the shifting rod. This is accomplished by cams on the saddle, coming in contact with dogs, which may be adjusted to any position of the rod; or the rod may be turned by hand from the saddle if desired. This shifting rod is supported on ball bearings, as are also the elevating screws for the table. This machine is built by the Cincinnati Shaper Co., Cincinnati, Ohio.

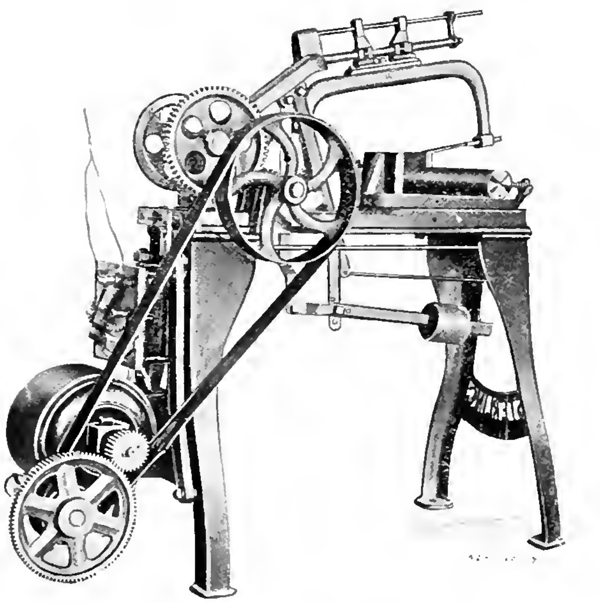


Richards, or Open Side Shaper.

STERLING MOTOR DRIVEN HACK-SAW MACHINE.

The hack-saw shown in the cut is built by the Diamond Saw and Stamping Works, Buffalo, N. Y. As shown, arranged for motor drive, it is especially useful in stock rooms and tool and machinery warehouses, where there is no line shaft power available; it is useful also where electrical drive is used for other purposes in the plant. The motor is mounted as a unit with the speed regulating rheostat, on a special base secured to the rear legs of the machine. Either a direct current or an alternating current motor will be supplied. The direct current motor will be wound for 110 or 220 volts, and under special conditions for 500 volts. The type used provides for slow speed, rigid construction, and a considerable overload capacity. It is entirely dust and moisture proof, and has large oil wells with ring oilers. It is provided with a fiber

pinion and is noiseless in operation. The rheostat provided permits of a regulation of the stroke from 45 per minute for tool steel up to 55, the latter being used for machinery steel and cold rolled shafting. The alternating current motors are supplies for circuits of 110 or 115 volts, with 25, 60, or 133 cycles. They are constant speed self-oiling induction motors,



Sterling Motor-driven Hack-saw.

without brushes or commutators. Although they are designed for single phase currents, they may be run between two branches of a three-phase installation.

These machines have a special attachment by which long bars of angle iron or other kinds of stock may be cut off at an angle of 45 degrees or more, if desired. These machines are built in lots of 200 each, so that the manufacturers are able to take advantage of improved methods of producing them economically, giving the producer the advantage of a good machine at a comparatively low cost.

RADIUS MICROMETER.

The accompanying illustrations, Figs. 1 and 2, show two forms of a neat measuring instrument devised by Mr. W. A. Farrar, Whitman, Mass., which he names "radius micrometer." The tool shown in Fig. 1 consists of two micrometer heads mounted in a bar, which is provided with carefully reamed centers at the ends. The micrometer heads are so mounted that the ends of the spindles just coincide with the axial

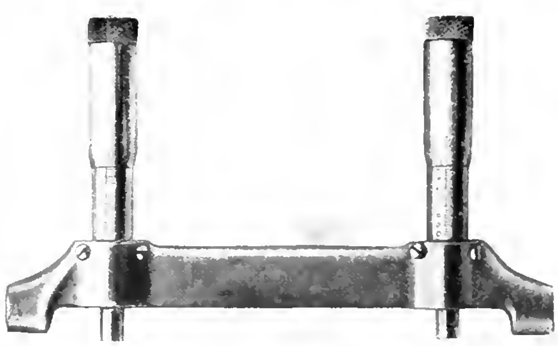


Fig. 1. Radius Micrometer for use on Centers.

line joining the centers, when the barrels register zero. The construction shown in Fig. 2 is on the same principle, the taper shank being substituted for the centered bar. This shank is offset in the part supporting the micrometer, so that the measuring point coincides with the center line when the barrel stands at zero, the same as in the double-head tool. Figs. 3, 4 and 5 show two forms of the tool in use on the lathe.

Within its range, the radius micrometer enables a turning or boring tool to be set precisely to turn or bore any required diameter. The tool also may be used to adjust the cutters held in a boring bar, and it may be used for a wide variety

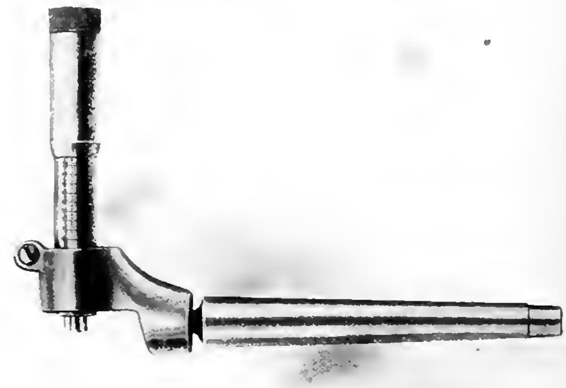


Fig. 2. Radius Micrometer, with Taper Shank.

of general work, as, for example, turning cams. The height of the cam may be measured when ordinary calipers are useless, because of the absence of metal at a point opposite the throw. The tool may also be used to measure the variation of lathes in relation to the ways, etc.

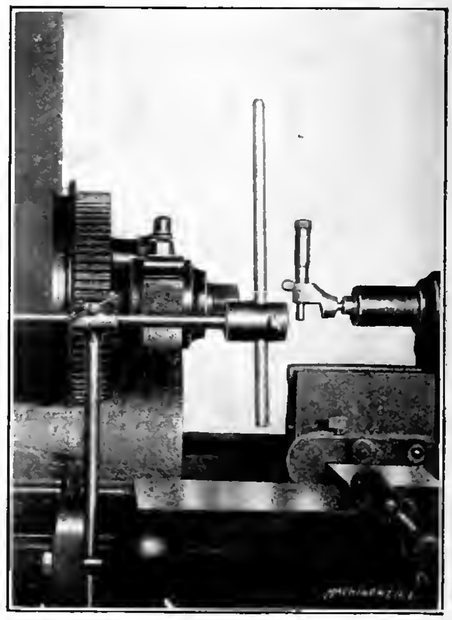


Fig 3. Setting a Boring Tool to the Correct Diameter.

Fig. 3 illustrates the method of setting a boring tool, using the form of radius micrometer shown in Fig. 2. The micrometer is mounted in the tail spindle and adjusted to read the required radius of the hole or one-half its diameter. An auxiliary attachment is required, shown at the left, this being in the form of a standard clamped to the ways and having an adjustable rod. In this view both the pointer and the micrometer are shown in a vertical position, both being turned upright so as to show clearly. The adjustable rod, shown

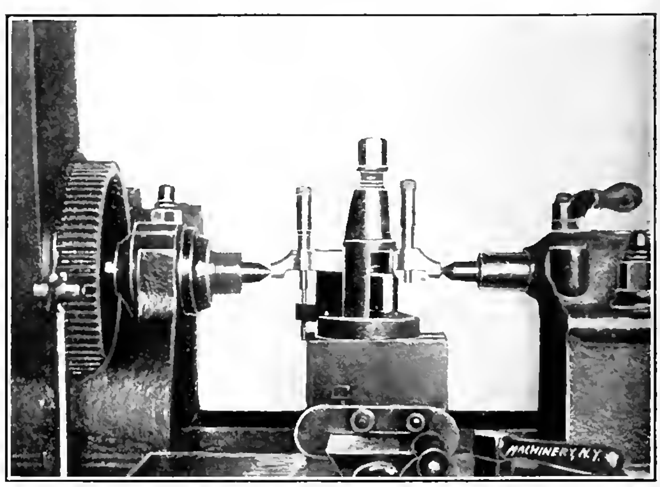


Fig. 4. Measuring the Vertical Alignment of Lathe Centers.

standing in a vertical position, is set so as to just touch the end of the micrometer spindle. After adjusting the point of the adjustable rod to touch the end of the micrometer spindle,

the tail-stock is moved back on the ways and the boring tool is put in place in the tool-post. When it is adjusted so that the cutting edge touches the end of the measuring rod, it is set to bore the radius indicated by the radius micrometer. If several cuts are required to bore the hole to size, the ordinary stop used in screw cutting may be adjusted to regulate the final cut.

Fig. 4 shows the method of using the double radius micrometer illustrated in Fig. 1 to measure the height of the lathe

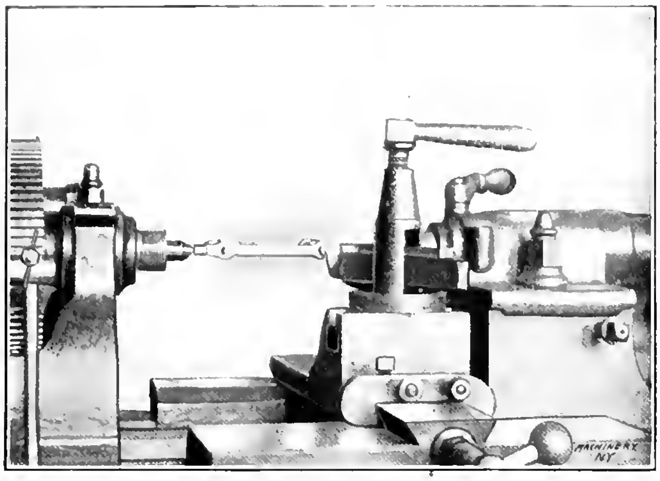


Fig. 5. Setting a Tool to Diameter, or Aligning Centers Laterally.

centers. A holder carrying a steel point is held in the tool-post, and the carriage is moved from one micrometer spindle to the other to ascertain the condition of alignment. When both micrometer barrels read the same, then the centers are in vertical alignment.

Fig. 5 shows the method of using the same instrument to set a tool to turn a desired diameter, or to secure lateral alignment of the centers. It is obvious, of course, that the tool is convenient for setting the tail-stock so as to turn tapers. Mr. Farrar states that there are many other uses of the tool which will suggest themselves to users.

COMMUTATOR TRUING DEVICE.

The Patterson Tool and Supply Co., Dayton, Ohio, is placing on the market the useful device shown herewith. It consists of a pedestal with ways formed on its top surface to carry a tool slide. The manner in which this device is used is obvious. It is blocked up beside the commutator to be trued, on the floor

Portable Tool Post for Truing Commutators.

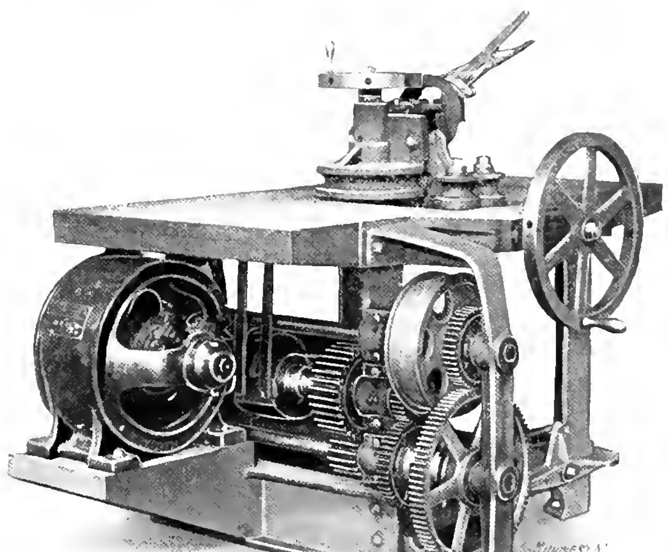
or on the base plate of the dynamo or motor, and is then clamped in position. The slide being lined up with the armature shaft, the tool is placed in the tool post, which is fed into a depth sufficient to just finish out the inequalities of the commutator. The tool is then fed steadily by hand, by operating the longitudinal feed screw of the machine. This longitudinal feed is 15 inches in length. The cross adjustment is 5 inches, and the vertical adjustment for bringing the tool to the center line 6 inches; the tool post is for tools with shanks $\frac{3}{4}$ x $\frac{3}{4}$ inch section. The weight of the device is about 75 pounds.

STOEVER AUTOMATIC PIPE BENDING MACHINE.

This machine, built by the Stoever Foundry and Mfg. Co., of Myerstown, Pa., is designed to bend pipe of from 1 inch to 2 inches in diameter, with a radius of bend varying between the limits of $2\frac{1}{2}$ inches as a minimum for the 1-inch size, to a maximum of 12 inches.

The pipe is bent by carrying it around a circular former of the proper radius, fixed to a spindle on top of the table, as shown in the half-tone. This former or roll is made in two pieces, the joint being at the center of the groove in the roll. The lower half is fastened firmly to the spindle; the upper half is keyed to the spindle, but can be raised or lowered by means of the hand wheel shown at the top of the spindle. This dividing of the main forming roll is necessary to release the bend after it has been formed, particularly in the case of 180 degrees or "return" bends, when made cold.

The lever shown operates a vise, which can be attached to whatever former is in place on the machine at the time. This vise has jaws equipped with interchangeable steel grips or bushings, to fit various sizes of pipe. The large hand



Stoever Automatic Pipe Bending Machine.

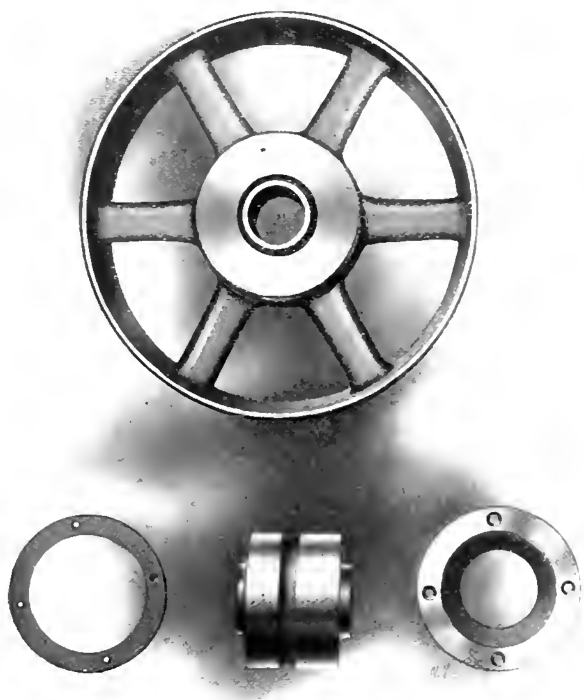
wheel shown at the front side of the table operates a slide, which may be adjusted toward or away from the central former. This slide holds two rollers, one directly in line with the main forming roll and serving to press or force the pipe onto it, while the other acts simply as a guide roller for holding the unbent portion of the pipe in the proper position. The operation of bending is, then, to introduce the pipe between the two rollers on the slide until it lies in the groove of the main former; here it is grasped at the proper point by the vise, after which the vertical spindle is started, being rotated the number of degrees required to give the bend desired.

The spindle is driven by power. The machine shown is motor driven, although the belt pulley is also in place in the foreground of the cut. The belt driven machine has but one speed. With the motor drive a variable speed motor is usually used, so that a variety of speeds can be obtained to suit the work in hand. A reversing mechanism is interposed between the motive power and the spindle, operated by a treadle within convenient reach of the operator. This serves to control the machine, and permits the spindle to be returned to the starting position rapidly, by power, after a bend has been made. Adjustable dogs are provided on the vertical spindle for stopping automatically the movement of the spindle in either direction at predetermined points, to give the degree of bend required.

In using this machine no filling of the pipe is necessary. It is placed in the machine in its normal condition, and the normal section is retained in the completed bend. Sixteen complete bends have been made in ten minutes with this apparatus. In daily runs, 300 bends have been made in 9 hours a number of times. In the work referred to, the bends were made in 2-inch pipe to a 4-inch radius, 180 degree curvature, the length of the legs being 5 or 6 feet. It will be noted from the cut and the description given, that the machine is intended for manufacturing service particularly. It is a special machine, like some forms of turret lathes and engine lathes, and when set for a single piece of work should be used on that work for some time.

JOHNSON & BASSETT SELF-OILING LOOSE PULLEY.

The subject of loose pulleys has always been a sore one. Much thought has been given to remedying the difficulties and annoyances consequent on the use of those of the common



The Johnson & Bassett Self-oiling Loose Pulley.

type. Of the various designs resulting from this extended thought, that shown in the accompanying half-tone and line cut is perhaps as promising as anything we remember to have seen. The arrangement provides for a loose pulley, having a reservoir of oil which is automatically, and yet by simple means, conducted to the bearing surface, whence it is returned

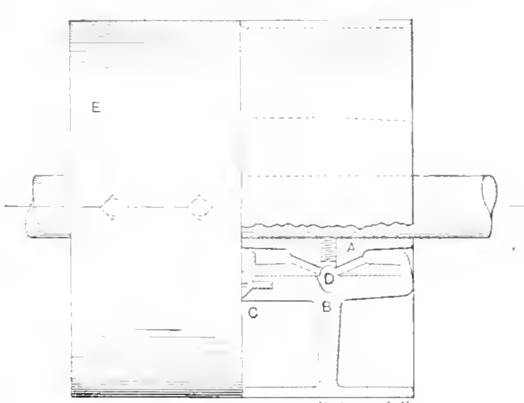


Fig. 2. Section of Pulley, showing Oil Ducts and Reservoir.

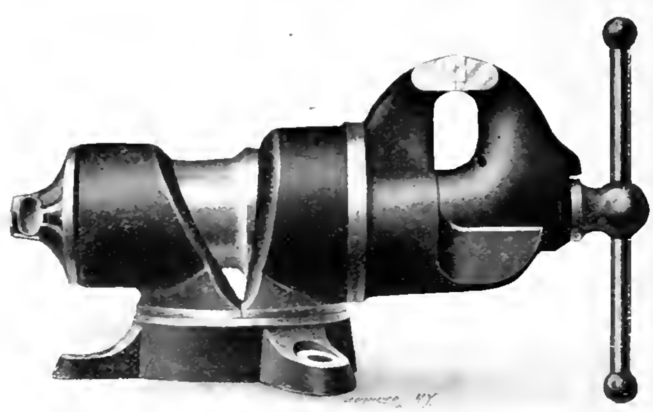
to the reservoir as fast as it escapes at the end of the bearing. The way in which this is done will be understood by referring to the cuts and the accompanying description.

The pulley does not run directly on the shaft, but on a bearing of its own secured to the shaft by set screws. This is shown at *A* in Fig. 2, and directly under the assembled pulley in Fig. 1. When the pulley *B* is slipped over this bearing, it bottoms against an internal shoulder at one end of the hub of the pulley, while endwise movement is prevented at the other end by a washer or collar *C*, which is screwed to the hub of the pulley. A channel is turned in the inner periphery of the hub and on the opposite side of the bearing, as may be seen at *D*. This furnishes the oil reservoir referred to. Deep grooves in the sides of the bearing *A* are connected with this channel by the slanting oil ducts shown. The effect of this arrangement is plainly evident with a little consideration. As the oil contained in the reservoir escapes through the bearing surface, it gradually oozes out into the side channels in the bearing, whence it is returned to the central reservoir, by centrifugal force if the shaft is running, and by gravity through whichever of the oil ducts may happen to be downward at the time, if the shaft is standing. From the reservoir, the oil repeats the cycle.

No collar is necessary to position this pulley on the shaft, since it is held by its own hub. Running as it does, on its own bearing, it can be applied to worn shafts, damaged by running with ordinary loose pulleys. The bearing is of large diameter and the surface is sufficient to hold the oil either running or standing, so that tight belts do not squeeze the oil out. The higher the speed the better the lubrication, owing to the part centrifugal force plays in distributing the oil where it is needed. The pulley is neat in appearance, and is in no sense an experimental device, having been thoroughly tested under severe conditions for the past two years. It is regularly made in various diameters of from 6 to 14 inches, with larger sizes to order. Johnson & Bassett of Worcester, Mass., are the manufacturers.

PITTSBURG VISE OF UNUSUAL SIZE.

The Pittsburg Automatic Vise and Tool Co., of Pittsburg, Pa., has built what it believes to be the largest vise ever constructed. This tool weighs 695 pounds, is 36 inches long, 18



A 695-pound Vise.

inches high, and has a jaw opening of 15 inches. It is so constructed as to secure the greatest possible strength; for instance, the jaws at the neck are over 4½ inches thick, while the slide bar is 7 inches in diameter.

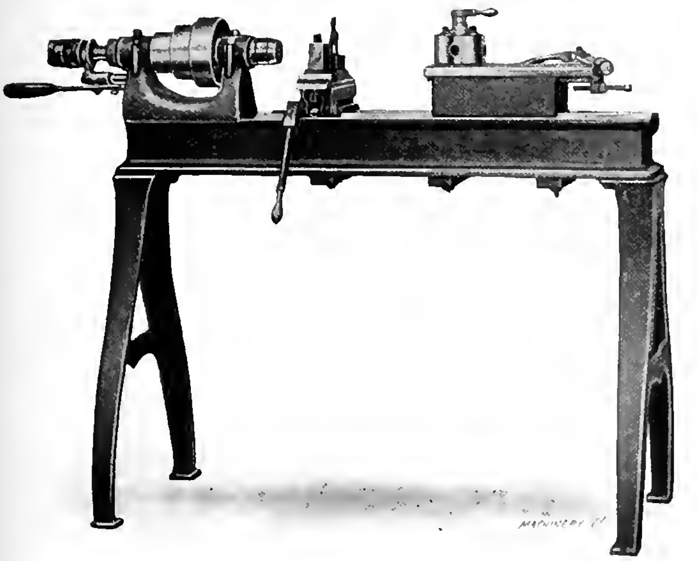
This tool is of the same design as the regular line of double swivel vises made by its builders. The whole vise may be swung in its base about a vertical axis, and the jaws may be set at any angle in the axis of the tightening screw. The setting up of the jaws on the work clamps the whole structure immovably, without requiring any special movements for this purpose. Careful fitting and smooth finish make it possible with even the large vise shown to swing the jaws around, or shift the angle of the vise itself, without requiring the workman to exert himself in the least. This tool fills the needs of shipbuilding yards, railroad and forge shops, and other works where parts of great size are handled, and for holding which provision has to be made. As an instance of the way in which it may be used, work too heavy to be lifted into a vise can be readily stood on one end on the floor and be grasped by the jaws of the chuck, which are turned at right angles for the purpose, thus getting a grip the full length of

the jaws. The heaviest work can then be performed without loosening the grip.

As a contrast to this heavy tool, mention might be made of another vise of the same design which this firm has recently added to its line. This has jaws 1¾ inch long, opening 3 inches and weighing about 3½ pounds. This is intended particularly for emergency work on motor boats and automobiles. The base in which it is set may be permanently fixed to the deck, floor, running board or seat of the machine, where its small size renders it unobjectionable. When a breakdown occurs and it is desired to use the vise, it is simply set into this base, and the tightening of the work clamps the whole structure. The parts are so designed as not to be affected by an accumulation of mud, dirt or water. By the use of extra bases, the vise can be utilized anywhere—in the work-shop, store or home. It will be seen that there is a ratio of about 200 to 1 in the weights of these two tools.

WELLS TURRET LATHE.

The F. E. Wells & Son Co., of Greenfield, Mass., are placing on the market the new lathe for manufacturing use shown in the accompanying half-tone. It is designed to meet the need for a reasonably priced tool for rapid and accurate work in the manufacture of small parts. The general design follows the lines of the other lathes built by the same makers, a noticeable point being the fact that the head-stock is cast solid with the bed. The spindle is supplied with an automatic chuck operated by a lever, so that it can be opened and closed while running at full speed. This allows small pieces to be handled rapidly. The nose of the spindle is threaded, so that geared or scroll chucks up to 8 inches in diameter can be used for handling larger pieces, such as castings, etc. When the split chucks are being used, this thread is covered by a cap. When required, a wire feed can be supplied. The turret slide is operated by a lever. The turret may have four or six holes as desired. The cut-off slide has a tool on each side of the machine, is of new and substantial design, and has tool-posts for properly carrying either straight shank tools or circular forming tools. These lathes swing 11 inches, and are made with 3, 3½, and 4-foot beds.



Turret Lathe for General Manufacturing.

WELLS BROS. STANDARD AND LIMIT GAGES.

In Fig. 1 are shown standard internal and external gages for testing Briggs pipe threads on pipes, fittings, etc. They are designed particularly for reference, and are to be used by the users of pipe and fittings. Some way of testing is necessary in all material threaded with the Briggs standard, since the pipe and the fittings are seldom made by the same firms, and it is often necessary to know whether the parts supplied come to the standard size without testing them in the parts they are to go in. These gages are intended for this use. They have a uniform taper of ¾ inch to the foot to agree with the standard to which they are made. The ring gage has a thickness equal to the length of the threaded end of the pipe, and is used to test pipe ends by being screwed on as far as possible by hand, when the end of the pipe should be exactly flush with the small end of the ring. The plug gage is made three threads longer than the ring gage, with the large end the same size as the large end of the ring. When used to test pipe fittings, it is screwed in as far as possible, when the large end should come flush with the outside of the fitting. It will be seen that in this way the fitting is tested three threads deeper than the pipe end, so plenty of margin is allowed for forcibly screwing-in with the pipe wrench to make a tight joint. The plug and ring screw together until their large ends are flush. They are made with cuts milled through to clean out the chips from the thread being tested. Since they are tapered, it would be impossible to screw them to a bearing without this provision.

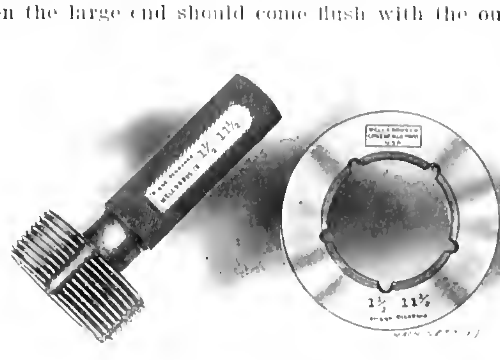


Fig. 1. Plug and Ring Gages for Testing Pipe Threads.

Fig. 2. Solid Limit Gages for Threaded and Cylindrical Work.

In Figs. 2 and 3 are shown limit gages for small and large work respectively. Those at the right of the cut in each case are for threaded work, while the other is for plain cylindrical work. In the thread gages the points are off-set half the pitch of the thread to allow the work to enter with the center lines square with the gage. The gage points provided are set on the common plan of having the outer pair for a "must-go-through" maximum limit, and the inner pair for a "must-not-go-through" minimum limit. Ordinarily, on work of medium size, the working points are set so there is a difference of about 0.002 inch in diameter between the two limits, the first one being 0.001 inch over size, and the second 0.001 inch smaller than standard. The only difference between the limit gages for screw threads and those for cylindrical work is in the working surface, the former having points for measuring on the angle of the screw thread, while the latter has flat working surfaces. These gage points can be removed at any time, and reground if worn. They may then be read-

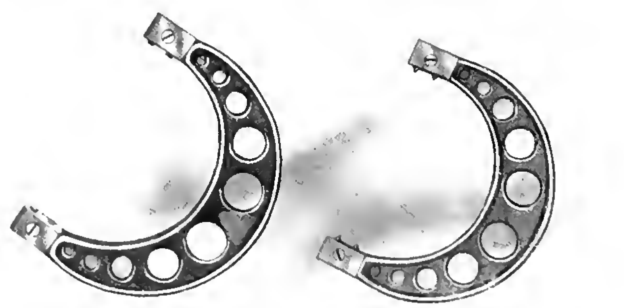
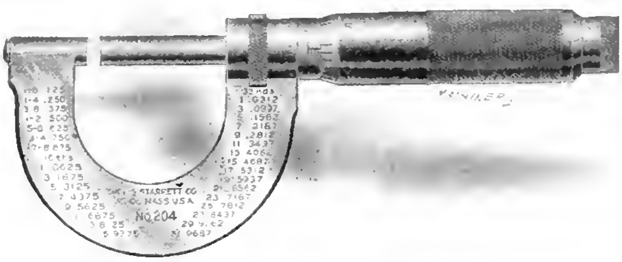


Fig. 3. Calliper Limit Gages for Large Diameters.

justed to size by comparing them with the setting disks furnished for each pair of working points; these are provided for both the threaded and the cylindrical form. These gages are made in all sizes from $\frac{1}{4}$ inch to 10 inches inclusive, the style of Fig. 2 being used up to $2\frac{1}{2}$ inches in diameter, and that of Fig. 3 for larger sizes. Wells Bros. Co., Greenfield, Mass., is the maker.

THE STARRETT QUICK ADJUSTING MICROMETER.

The new micrometer shown in the cut was recently brought out by the L. S. Starrett Co., Athol, Mass. It has the interesting feature of quick adjustment. By pressing the finger on a plunger in the end of the thimble, a split nut on the micrometer screw is opened, permitting the thimble and spindle to be instantly adjusted to any required point within the capacity of the instrument; then the removal of the pressure on the plunger closes the nut and permits the exact adjustment to be made in the usual manner. Inasmuch as 40 turns

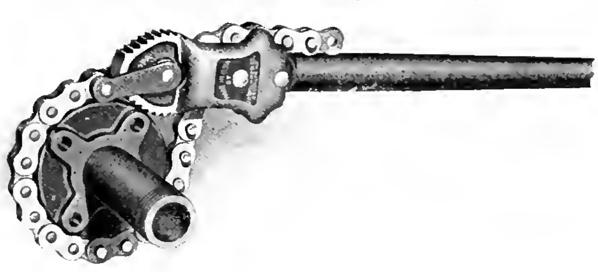


Starrett Quick Adjusting Micrometer.

of the thimble are required to move the spindle of the ordinary micrometer 1 inch, it is estimated that the quick adjustment feature saves at least 20 seconds on each extreme movement of the spindle. The micrometer has the ratchet stop, lock nut and patented sleeve by which adjustment for wear is readily made.

"AGRIPPA" PIPE AND FITTINGS WRENCH.

J. H. Williams & Co., of Brooklyn, N. Y., have made for several years the well-known Vulcan pipe wrench. They have recently placed on the market a tool operating on the same principle, for use where limited space will not permit employing the wider, or double jaw wrench. They call this a fittings wrench, since it is especially adapted for use on narrow flanges, short nipples and other parts with contracted surfaces. The tool is made throughout of wrought steel, and has a drop-forged, saw tempered jaw, permanently fastened in

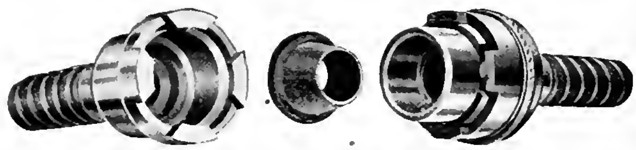


The Agrippa Pipe and Fittings Wrench.

a milled seat in the handle. The chain is longer than in similar wrenches for pipe work only, and is hand made. It swings from the center of the jaw and can be used on either side. All parts are interchangeable. While this tool is only recently offered for sale, it has been thoroughly tested in some years of use. It is made in seven sizes, with a capacity for pipe and fittings from the $\frac{1}{8}$-inch to the 12-inch size, inclusive.

DALLETT AUTOMATIC HOSE COUPLING.

This coupling is the result of a continuous series of experiments and tests, extending over a period of four years, made by the Thos. H. Dallett Co., of 23d and York streets, Philadelphia, Pa. The makers believe that the coupling resulting from these tests and experiments is as superior to that in present use as are the pneumatic tools of the present day to those of ten years ago. The cut shows the two halves of a Dallett coupling, and the gasket used between them. To connect this coupling, the parts are pressed together and given one-eighth of a turn; the locking ring springs into place of itself. It is then impossible to pull the coupling apart, or disconnect it accidentally. When the connection is to be broken, the locking ring is pressed back and the coupling



Dallett Automatic Coupling, Taken Apart.

turned back. In making the connection, the tapering end of the gasket enters the conical opening in the male part, being a loose fit therein; when the pressure comes on the coupling, this tapered end of the gasket is expanded against the wall of this opening, making a joint which increased pressure will only make the tighter. As soon, however, as the pressure is released, the gasket is again loose, so no matter how long a coupling is connected, it will not adhere when the joint is again separated. This gasket is made of a rubber composition which will not be affected by oil or gasoline. It is held in the female half by a flange around the larger end, which fits into a recess. It is thus impossible for it to fall out or be lost, though when necessary a new one can be inserted in a few seconds. As will be noted, the two members are provided with locking lugs equally spaced around the circumference, and when they are snapped together, these lugs insure their being held squarely, thus obviating the tendency to leak, as is common in other couplings of this class, especially those provided with only two lugs. This coupling is made in various sizes to fit hose and threaded ends of from $\frac{3}{8}$ to $1\frac{1}{4}$ inch in diameter.

* * *

NEW APPLICATION OF COMPRESSED AIR.

One of the most remarkable applications of compressed air has recently been made by Mr. Phillip Brasher, Brooklyn, N. Y. He has found that the discharge of air into water below the surface breaks up the wave action of the water and leaves a practically smooth surface. In emergency cases he expects, says *Compressed Air*, that this principle may be applied to prevent the injurious action of waves on objects exposed to them. He expects that a disabled ship, drifting toward shore, by throwing out an anchor to which is fastened a distributing pipe for compressed air, and held far enough from the ship by means of a secondary anchor, could lie in perfectly smooth water until repairs were made, or the sea subsided. In the same way stranded vessels could be protected from the pounding of the waves until floated. Light ships could be surrounded by a circular pipe line and lie in the center of an absolutely calm surface. Some of the expectations, as for instance, that in the not distant future there will be harbors constructed in the middle of the ocean, in vicinities of more than ordinary roughness, by means of pipes suspended from a series of floats so placed that both floats and compressor plant will be protected from any danger of wave action, seem to be rather daring dreams of the enthusiastic inventor.

* * *

Fixing up a thing to be as good as it was before it was broken is merely setting up again the trap in which you have once been caught.

The answer to the question, "What caused it?" must be pursued with relentless energy. In the full and complete answer to this lies the way to success.

The utter absence of the need for hurry is measurably preferable to the most brilliant exhibition of it. The man who skips over an accident with the remark, "Oh, that is nothing; little things like that happen every day. We can't help it," is a dangerous man to have around.

Complaining about the stupidity of your help but proclaims your own.—*Paul Lüpke, in an address before the National Electric Light Association Convention.*

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

Commercial conditions remain much the same as for some time past, but a continuance of the general pressure is not over-confidently looked forward to. Productive plants of all kinds have so greatly increased their efficiency that to keep them simply running necessitates a much larger volume of work than formerly. In labor matters, the trend indicated by the general results of strikes in the engineering trade during the last few years is unfavorable to this method of attempting to improve working conditions. This, notwithstanding an apparently successful outcome of a strike at the works of Vickers, Sons & Maxim, Ltd., Erith, against the continuance of the premium bonus system, and also directed towards the curtailment of the functions of "speed-and-feed" men. The energies of trades unions appear likely to be increasingly directed into political channels with a view to the economizing of union funds, the more effective presentation of the labor point of view in legislative discussions, and the urging forward of industrial reforms. "Collective" bargaining respecting disputes or changes in trade customs is being almost forced into general recognition, the unwisdom of avoidable stoppages in large industries being more clearly seen than formerly.

Shipbuilding Records.

Though the shipbuilding returns of the first half of the present year do not compare so favorably as was anticipated with the same period of last year, individual concerns have made some remarkable records. John Brown & Co., Ltd., of Sheffield and Clydebank, recently launched the armored cruiser *Inflexible*, the completed cost of which will be about $8,650,000, and also delivered the Cunard liner *Lusitania* for her preliminary trials. The concern also has other large orders on its books. It has practically completed the purchase of a valuable ironstone field at Frodingham, and has also strengthened its shipbuilding connection by the acquisition of an interest in the firm of Harland & Wolff, Ltd., Belfast, which will necessitate the creation of about $7,500,000 additional capital. The latter firm is to build nine steamers for the Morgan combine at a cost of about $20,000,000. About $250,000 are being expended on immediate extensions. The combined firms will employ about 30,000 men, and will be able to turn out battleships complete with guns, mountings, and armor plate, in addition, of course, to the most modern types of commercial vessels. Harland & Wolff are also building large repair shops at Southampton.

Legislation Against Trusts.

Efforts are being made to legally restrict the monopolistic conditions laid down by certain machinery trusts, of which the shoe machine trust is typical. Clauses are being introduced into the new patent laws by which conditions of sale or lease which call for the user of a patented machine to use other articles or inventions, or to prohibit him from using any other than those dictated by the patentee, will be void. It is also intended to empower the Board of Trade to appoint an arbitrator in connection with the termination of existing contracts of the kind, to assess the compensation to be paid for the determination of the agreements in question. The Australian Commonwealth government also propose to put in force the extreme powers of their customs regulations in case more equitable terms are not speedily granted.

"Stringer-type" Composing Machine.

An interesting machine is being brought to the notice of the printing trade over here, in the shape of the "Stringer-type" matrix composing and casting machine. The machine is named after the inventor, Mr. H. J. S. Gilbert-Stringer, and its special feature is the ability to produce movable type ready for machinery purposes at the rate of 9,000 to 10,000 per hour by one operator. Certain of the linotype features are embodied as regards the keyboard and the arrangement of matrices, together with advantages associated with machines of the perforated ribbon or monotype variety. The characters are on the flat face of the matrices and not on the edge, hair lines practically being eliminated. The temperature of the metal is automatically adjusted, and the variation of the spacing between the words is similarly attended to. Safety stops are provided in the case of a matrix being incorrectly placed on its way from the magazine, or if too much is endeavored to be set in one line. The bottom end of each type has the fin caused by casting so automatically knocked off that the bearing surfaces left allow the length of the type to be kept within extremely fine limits. The frame of the mold is cooled by water circulation so that the type may easily be handled when cast at the highest speeds. Quite a number of other points appealing to the printer are claimed, but, apart from the good quality of work apparently obtained from it, the point most likely to attract favorable attention is the fact of one man performing the whole of the operations.

Trade Conditions and the Tariff.

Little has been heard of late in the way of holding up the principal industrial nations as models or warnings to the others. It is increasingly evident that much is to be learned from the practice evolved by force of circumstances in each country, and that a deficiency in one respect is often fully counterbalanced by special efficiency in another direction. What lecturing is taking place would appear mainly devoted to pointing out to American manufacturers directions in which their typical mass production methods fail to compete favorably with the productions of countries less favorably placed as regards supplies of raw materials, but in which latter countries artistic bent or technical skill adds considerably to the value of the finished product. Great Britain received a considerable amount of well-meant advice until fairly recently, the United States being prominently placed as the exemplar, but most of the admonitory statements now current are concerned with the presentation of the theory that unless a move is made in the direction of protective tariffs, Continental competitors, owing to their home market being largely preserved for them, have inducements to carry out an aggressive foreign trade policy, whereas the British manufacturer, through his Free Trade environment, is practically precluded from such a stimulus It may be more or less so, such statements are hard to prove or disprove.

Dr. Nicolson on Rational Machine Design.

Dr. Nicolson of the Manchester School of Technology has for some years been working with a view to the designing of machine tools being conducted on "rational" lines as distinct from the more generally followed plan of advancing tentatively from designs which, notwithstanding certain deficiencies, gave good service under working conditions. Some deductions from experiments made by him, and mentioned in a paper recently discussed by the Institute of Civil Engineers, appear to suggest that lathes should be capable of taking a cut equal to one-fortieth the height of centers, with a feed one-fourth of this. The ratio between the highest and lowest speeds on lathes designed to use carbon steel tools is indicated as 50 to 1 on 12-inch swing lathes, to 180 to 1 on 120-inch swing lathes. When employing high-speed steels the ratios are 10 to 1 on 12-inch swing lathes, to 120 to 1 on 120-inch swing lathes. He considers that the power available in high-speed lathes should be from three to seven times that required for lathes using tools of carbon steel. Dr. Nicolson also advocates front bearings of smaller diameter than often used on British high-speed lathes, a view dissented from by a number of makers, who draw attention to the weight of face-plates and heavy jobs often suspended from them. Another suggested innovation is the use of solid bush bearings without means of adjustment, but with arrangements for forced lubrication, to prevent metal and metal contact at the lower speeds, the spindles, as before mentioned, being of smaller diameter than now usual, and the front bearings only about half the present length. The form of bed strongly recommended for adoption is of circular or box form in place of the double H section with cross girts, commonly employed. Many practical objections may be urged against such a departure, but the author of the paper considers that such difficulties may be satisfactorily overcome, when toolmakers are

disposed to give such a form of bed a thorough trial, its bending and torsion resisting qualities being such as to justify reasonable expenditure in its development. In any case, Dr. Nicolson's ventilation on the subject is likely to lead to its more consistent treatment by designers and builders.

Commercial and Technical Education.

Commercial and industrial or technical education obtains fairly constant attention even though it be of a critical rather than constructional character. The Birmingham University authorities are forming an advisory board of engineering business men to assist in the inauguration of a scheme of training in the commercial side of engineering. At Oxford University it is proposed to found a chair of engineering. No attempt at practical training is proposed at present. In Lancashire some difficulty exists as regards placing students in positions after attending technical schools. Manufacturers have not yet become accustomed to the idea of frankly assimilating in their works organization technical school graduates, and consequently disappointment is expressed both by students and those responsible for the general oversight and administration of educational matters in the county. In a recent report of the Lancashire County Education Committee it was stated that the work sent in by students in the textile branches—who submit samples of work designed and actually woven by them—was considerably superior to all previous efforts, there being an entire absence of unworthy material. The weakest feature of the work was the coloring, which was crude in several instances. On the results of these competitions scholarships tenable for three years at the Manchester School of Technology are awarded, and also various prizes. Every effort is being made to train students to be of service to employers, but as previously mentioned, a mutual understanding is not as yet arrived at as to what is required from students after completing their courses.

JAMES VOSE.

Manchester, Eng., August 1, 1907.

MISCELLANEOUS FOREIGN NOTES.

GERMAN SHIP BUILDING INDUSTRY.—Like all other industries, the ship-building yards in Germany increased their business materially during 1906. The tonnage of new merchant vessels constructed was 387,820 tons, as compared with 277,731 tons in 1905. This represents an increase of 32.4 per cent. At the close of 1906 there were under construction in various German ship-building yards merchant vessels with an aggregate tonnage of 323,000 tons.

RŒCHLING IRON AND STEEL WORKS, Voelklingen, Germany, has put into operation a new Kjellin induction steel furnace, having a capacity of 24 tons. About 15 tons are poured at the end of each run, 9 tons being left for the beginning of the next run. The power consumption is 736 kilowatts per hour. There are two smaller induction furnaces in operation at these works and a fourth in construction, having a capacity of 150 tons. A high production economy is claimed for the new plant.

BRITISH AUTOMOBILE INDUSTRY.—According to the London *Times* the motor car industry in Great Britain is still in a state of remarkable progress. The business of 1906 doubled that of 1905, while in 1907 every indication points to a demand far exceeding anything yet experienced. The home product has succeeded in competing with the foreign vehicle. Not so long ago it was almost impossible to find a British car outside the boundaries of the United Kingdom, except those owned by British tourists. Now there is a distinct and growing demand for them in the British colonies, in America, and on the Continent. The exports for the first four months this year amounted to $1,243,525 in finished cars, and $796,940 in automobile parts. This is more than double the exports for the same period in 1906.

INDUSTRIAL CONDITIONS IN SWEDEN.—The industrial development of Sweden depends largely upon the development of the country's resources of power, obtainable from the waterfalls, and convertible into electrical energy. The value of these resources is becoming more appreciated than ever, and electrical machine companies are prospering. The largest of these is reported to have delivered, in 1906, 3,319 electrical machines, with a total of 87,720 H.P., and to have orders on hand for machines of more than 200,000 H.P. The machine-tool industry is in a flourishing state, but the production of the country in this line falls by far short of the demand, and high class American machinery finds a ready sale at the present time.

STANDARDIZATION OF MOTOR PARTS IN GREAT BRITAIN.—It is reported that the British Institute of Automobile Engineers has appointed a committee for inquiring into the possibility of a standardization of motor parts. It is appreciated that those accessories and component parts used in engines of all types, as well as nuts, bolts, bolt heads, and wrenches, could be made the same on all kinds of modern automobiles, not only in the United Kingdom, but on the Continent as well. One difficulty in the standardization is the fact that Continental motor makers use the metric system, while manufacturers in Great Britain do not. The fact that this subject is receiving attention is an important one as the first step toward agreements which are likely to be beneficial to the motor manufacturers in all countries.

THE PROPOSED WORLD'S FAIR IN BERLIN.—Some time ago it was announced in the press that an initiative had been taken in leading industrial and political circles for the arranging for a world's fair in Berlin, Germany, 1913. The immediate cause for the selection of this year was the twenty-fifth year anniversary of the German Emperor's ascension to the throne of the empire. On account of this proposition the German Commercial Union sent out a circular letter to the German chambers of commerce in order to learn their views with reference to a world's exposition, to be held at Berlin in 1913 or other year of the coming decade. In answer to this the chamber of commerce at Mayence has recently adopted the following resolution, which seems to voice the opinion generally entertained in Germany concerning world's fairs: "The chamber of commerce has resolved to answer that it can not recognize the holding of a world's exposition at Berlin in the year 1913, or in some other year of the coming decade, as in the interest of Germany's industries and commerce; that it deems it more advisable, instead of general world's expositions, to organize for all products of human activity international expositions of a special industry, as such only can have the effect of fructifying and stimulating the industries and trades."

* * *

THE KRONPRINZESSIN CECILIE.

The latest addition to the passenger fleet of the North German Lloyd Steamship Company, the *Kronprinzessin Cecilie*, arrived in New York harbor August 14, 1907. This boat is another evidence of the faith in the commercial possibilities of the large size, high speed, luxuriously equipped vessel. The use of reciprocating engines has been continued, this being in line with German engineering practice, which is inclined to regard the steam turbine as not yet out of the experimental stage. The vessel is propelled by twin-screws, each driven by two quadruple expansion engines. The cylinder diameters are as follows: High pressure, 37⅜ inches in diameter; first intermediates 49¼ inches; second intermediates, 74⅞ inches; and low pressure, 112¼ inches; the common stroke is 6 feet. The horse-power is 45,000. The comparison of this figure with the 70,000 horse-power of the *Lusitania* gives some idea of the cost of raising the speed of two vessels of comparable size from 24 knots per hour to the 25½ knots which the new English vessel is expected to make. The most impressive thing to the visitor on the *Kronprinzessin Cecilie*, aside from the great size of the vessel, is the perfection of detail which has been observed throughout the boat in the matter of fittings, furnishings and decoration. There is something very fine in the design and workmanship of even the most inconspicuous details of the interior decoration, and this rises to a high pitch of beauty in the case of the dining room and saloons, and the more luxurious of the staterooms and suites.

OBITUARY.

Henry W. Clarke, senior member of Hill, Clarke & Co., Boston, Mass., died July 27 at his home in Watertown, near Boston. Mr. Clarke was born May 10, 1822. He began his business career in hardware, being first employed by George H. Gray & Danforth, of Boston. In 1866 he became connected with the firm of Horace McMurtrie & Co., who were engaged in engineering enterprises and in selling machinery. The firm was later reorganized as Hill, Clarke & Co. Mr. Clarke was actively connected with the company until about two years ago. His son, Charles A. Clarke, is the present president of the company.

* * *

PERSONAL.

T. B. Burnite of the engineering and sales department of The John A. Traylor Machinery Company, Denver, Colo., has been appointed superintendent.

E. B. Boye, until recently manager of the Cleveland office of Messrs. Manning, Maxwell & Moore, has accepted a position with the Warner & Swasey Co., Cleveland, O., as its Chicago representative.

J. Cecil Nuckols, for the past three years advertising manager of The S. Obermayer Co., Cincinnati, O., has recently received the additional appointment of advertising manager of the Cincinnati Electrical Tool Co.

George H. Hall, who for the past four years was connected with the sales department of the Crocker-Wheeler Co., Ampere, N. J., has accepted the position of manager of the Boston office of the Diehl Mfg. Co., Elizabethport, N. J. Mr. Hall was formerly associate editor of MACHINERY.

F. B. Maltby, who has been connected with the Panama Canal work as principal assistant engineer to Mr. J. F. Stevens, has resigned to go with Dodge & Day, Philadelphia, Pa., in the capacity of chief engineer. Mr. Maltby is a graduate of the University of Illinois, class of 1882, and has had a wide engineering experience.

* * *

NEW BOOKS AND PAMPHLETS.

A COURSE IN STRUCTURAL DRAFTING. 64 pages, 6 x 9 inches, with 48 cuts, numerous tables and diagrams, and 15 large folding plates. Published by the Industrial Magazine, Collinwood, Ohio.

This book is, so far as we know, the first one treating the subject of structural drafting from the drafting room standpoint. It deals with the conventions used in making drawings, discusses the technique of the business, and gives a very lucid introduction to the subject of structural design. The scope of the work can be gathered from the following chapter headings: General Remarks, Terms Used, etc.; Riveting, Spacing; Bolts, Pins and Eyebars; Connection Angles and Anchors; Copying; Strength of Materials; Beams, Girders; Column and Sole Plates; Truss Outlines; Title Page and Cover; Drafting Room Practice. It is a pity that a book as excellent as this appears to be should not have had more careful proofreading. Errors are noticeable on almost every page. We trust that its popularity will be sufficient to require a new edition in the near future, at which time these defects can be remedied.

CATALOGUES AND CIRCULARS.

THE CUSHMAN CHUCK CO., Hartford, Conn. 1907 catalogue and price list of chucks and face-plate jaws, describing the different types and discussing repair parts, outfits for lathes, etc.

THE ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, O. Illustrated bulletin descriptive of universal insulator supports, touching upon application, construction, special work, cost, advantages, etc.

THE PITTSBURG AUTOMATIC VISE AND TOOL CO., Pittsburg, Pa., has issued a unique catalogue, in black and white, illustrating its special automobile and motor boat vise.

GOODELL-PRATT CO., Greenfield, Mass. Catalogue No. 8 for toolsmiths, illustrating and describing automatic drills, punches, hack saws, vises, etc. The company has added more than fifty new tools to its line since issuing its last catalogue.

LUCAS MACHINE TOOL CO., Cleveland, O. Pamphlet entitled "Pull," which states that the best way to get a "pull" is to push, and describes the four ways in which this company pushes its machines.

THE O. K. TOOL HOLDER CO., Shelton, Conn. Catalogue illustrating the lathe, shaper and planer tools, and drop forgings manufactured by this company. The various combinations of these tools and toolholders, their sizes and prices are included.

THE BURKE MACHINERY CO., Cleveland, O. Catalogue on machine tools, describing the various types of milling machines and attachments, drill presses, vises, tapping machines, etc., manufactured by this company. A price list is also issued with this catalogue.

J. T. SLOCOMB CO., Providence, R. I. Catalogue No. 11 illustrating and giving brief descriptions, with prices, of micrometer calipers and gages. The book also includes tables of decimal equivalents, drill list, and instructions how to read a micrometer.

INDEPENDENT PNEUMATIC TOOL CO., First National Bank Building, Chicago, Ill. Catalogue No. 8 illustrating and describing the complete line of Thor pneumatic tools and appliances. A number of interesting photographs show these tools at work under different conditions.

J. M. CARPENTER TAP AND DIE CO., Pawtucket, R. I., has compiled in convenient form the recently adopted standard of the American Society of Mechanical Engineers for machine screws and machine screw taps and dies. A copy will be sent to all users of machine screws, who apply.

J. L. OSGOOD, Buffalo, N. Y. Card illustrating and describing the Osgood "indestructible" file and tool handles. These are made with a thin steel tube forced into the handle and interlocked with the ferrule. The construction is such that the file tang is held in a wood seating the same as in usual construction, but the tube restrains the handle from splitting.

WESTINGHOUSE MACHINE CO., Pittsburg, Pa. Catalogue descriptive of the Westinghouse storage battery for stationary use. The company has spent many years in studying the various types of storage batteries, and has made many exhaustive tests, the result of its work being embodied in the type S storage battery here completely described and illustrated.

THE PITTSBURG AUTOMATIC TOOL & VISE CO., Pittsburg, Pa., has published a book in two colors describing and illustrating the Pittsburg two-way vise. It deals particularly with "high-speed" bench vises. The cover of the book is an attractive design in color showing a Pittsburg mill scene. Copies may be obtained by applying to any of the agents of the company or to the general office at Pittsburg.

THE L. S. STARRETT CO., Athol, Mass. Catalogue No. 18 containing 232 pages description of fine mechanical tools and illustrated with over 300 engravings. Many new and unique tools are shown and some additions to the sizes of former tools have been made. A number of improvements in design have been incorporated in certain tools and a few changes in prices. The new catalogue has been carefully revised and every tool is indexed both by name and number.

CHICAGO PNEUMATIC TOOL CO., Fisher Building, Chicago, Ill. Catalogues No. 23 and 24. Catalogue No. 23 contains more than 100 pages and is devoted exclusively to Franklin air compressors, containing descriptive matter and information. Catalogue No. 24 also contains more than 100 pages and is devoted to the company's line of pneumatic tools and appliances, including "Boyer" and "Keller" hammers, "Little Giant" drills, sand rammers and hoists.

GOLDSCHMIDT THERMIT CO., 90 West St., New York City, has recently issued pamphlets entitled "Butt-Welding Wrought Iron and Steel Pipes and Rods by the Thermit Process" and "Metals Free from Carbon Produced by Aluminothermic Method." The former contains a description of the process of butt-welding and equipment to be used. The latter is a reprint from *Electrochemical Industry* and *Electrochemical and Metallurgical Industry*.

AMERICAN LOCOMOTIVE CO., 111 Broadway, New York, has just issued the ninth of its series of pamphlets covering the standard types of locomotives. As the title indicates, this number of the series is devoted to six-wheel switching locomotives, and contains half-tone illustrations and the principal dimensions of twenty-six different designs of this type. The designs illustrated range in weights from 102,000 to 176,500 pounds, and are adapted to a variety of service conditions.

THE NEWALL ENGINEERING CO., LTD., Warrington, England. Catalogue of gages and measuring machines. This pamphlet, which contains about 70 pages, describes and lists one of the most complete and interesting line of gages that has ever come to our notice. The completeness of the line may be judged from the following list, giving some of the tools manufactured: Internal limit gages; fixed point external limit gages; adjustable external limit gages; double end external limit gages; limit reference bars; standard reference bars; internal micrometers; external micrometers; standard cylindrical gages; standard end measuring rods; standard snap gages; length micrometers; length gages; end measuring blocks; spherical end measuring blocks; standard screw gages; pipe thread screw gages; hardened screw gages; taper gages; surface plates; straight edges; and measuring machines. These are made in both English and metric sizes.

MANUFACTURERS' NOTES.

THE SCHWERDTLE STAMP CO., Bridgeport, Conn., in order to accommodate its growing business, is building a three-story addition to its plant, which will be ready for occupancy about October 1.

NORTHERN ENGINEERING WORKS, 26 Chene St., Detroit, Mich., has installed power station cranes, one of 20 tons capacity, for the Toledo Gas and Electric Co., and two of 20 tons capacity in the Murphy power plant at Detroit, Mich.

THE DAYTON PNEUMATIC TOOL CO., Dayton, O., owing to its increased business in the Buffalo district, has established an agency with Root, Neal & Co., 178-180 Main St., Buffalo. This concern will carry in stock a complete line of Dayton and Green pneumatic hammers, as well as repair parts and accessories.

THE PITTSBURG AUTOMATIC VISE AND TOOL CO., Pittsburg, Pa., has recently replaced the entire vise equipment of several of the larger plants of the U. S. Steel Corporation with the high speed Pittsburg vise. The company reports a very large volume of business from their exhibit at the Jamestown Exposition.

THE S. OBERMAYER CO., Cincinnati, O., has just completed a factory for the exclusive manufacture of Kantbebeat dry core compound. This factory has a capacity of 25 tons per day, and the company expects, from present indications, that the sales of this commodity will increase to a great extent.

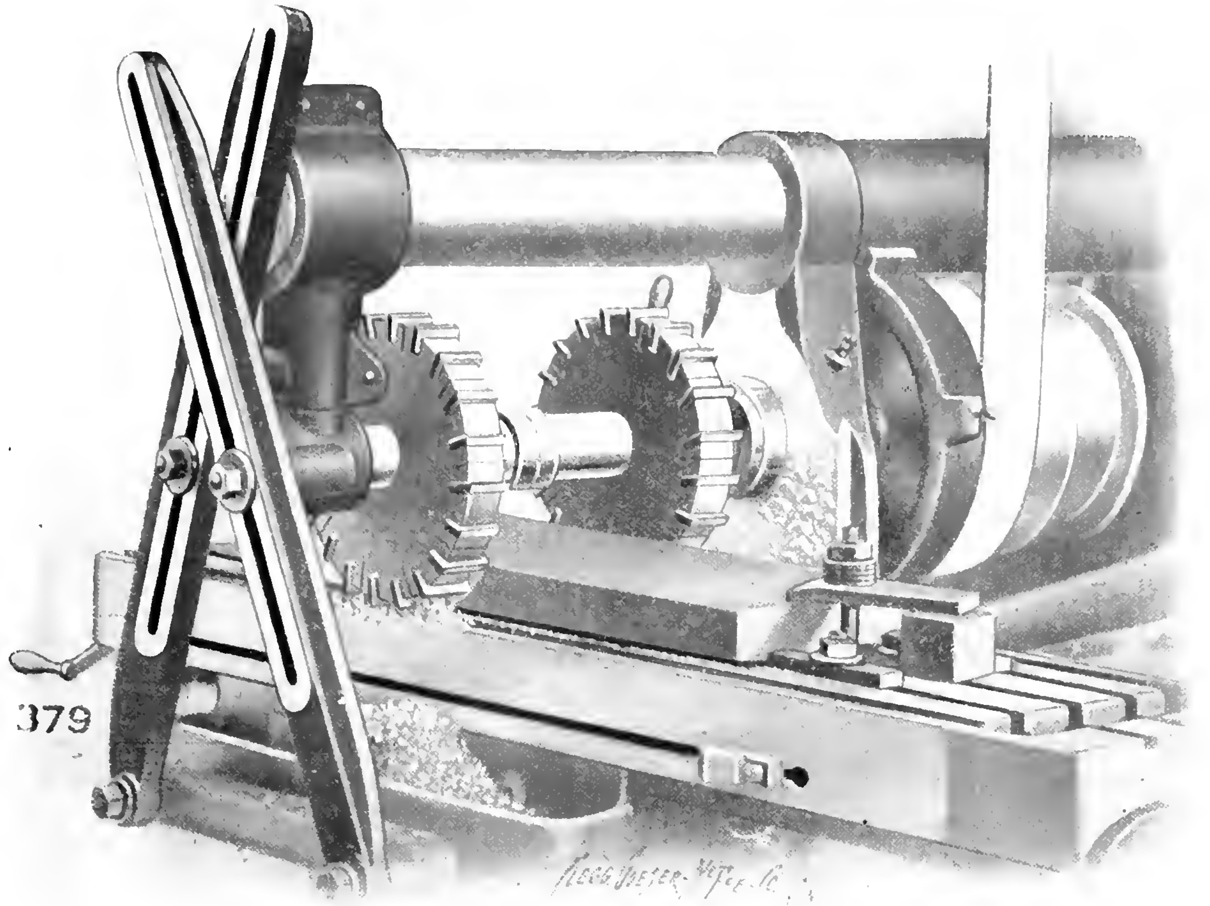
THE CARNEGIE LIBRARY (Technology Department), Pittsburg, Pa., is making an extensive collection of trade catalogues, and will be glad to receive catalogues from MACHINERY'S advertisers. These catalogues will be given a prominent place on the shelves, carefully indexed under both firm name and subject, and made accessible to the public. Catalogues should be addressed care of H. W. Craver, Technology Department, Carnegie Library, Pittsburg, Pa.

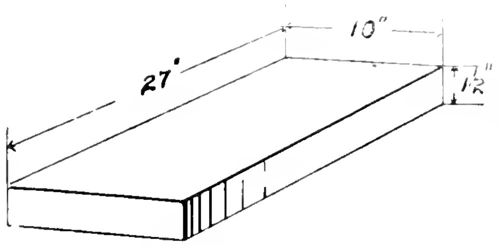
AMERICAN LOCOMOTIVE CO., 111 Broadway, New York City, has recently received an order for 101 four-wheel motor trucks for the Brooklyn Rapid Transit Co. The trucks will be built entirely to designs prepared by the builder, following closely the M. C. B. standards, and will embody as far as possible the practices of locomotive construction, thereby insuring strength combined with easy riding qualities, the two essential characteristics of the motor truck of the present day.

THE HOGGSON & PETTIS MFG. CO., New Haven, Conn., reports that a fire broke out in its japanning room on August 6. The damage, however, was confined to this department and interfered in no way with the manufacture of the Sweetland chuck. Although very busy in the chuck department, the company, having lately considerably increased its capacity, is able to make prompt deliveries. Important improvements are being made, which will appear from time to time.

ARMSTRONG BROS. TOOL CO., 113 N. Francisco Ave., Chicago, Ill., owing to the rapid increase of its business, has been compelled to make further additions to the large modern plant which it erected about two years ago. These consist of two buildings of steel and brick construction, one 50 ft. x 105 ft., the other 40 ft. x 105 ft., with brick smoke stack, 60 inches diameter, 115 feet high. In these buildings the company is now installing a modern power plant of 300 H. P., consisting of two 150 H. P. water tube boilers equipped with automatic stokers, direct-connected engine and generator, etc., and an up-to-date drop forge department of large capacity with steam drop hammers of the latest improved design and other high grade equipment, including a complete die shop with machine tools, especially adapted to that important work. The machinery is now being set in position and will be in operation about October 1.

Fast Feeds with Large Cutters





These grey iron castings are 1½" thick. The two edges are finished at one cut on a **No. 3 Plain Double Back Geared "Cincinnati" Miller.** Depth of cut is ¼" on each side; cutters 11½" diameter; 16 r.p.m.; feed .252" per turn—a table travel of 4" per turn.

On such work the outer arbor bearing carries the same load as the main bearing. Note how we support it by rigid bracing from the box section knee and the large diameter overhanging arm. The double back gears and large driving cone give the machine its great spindle power.

Do you use "Cincinnati" Millers?

WE ARE MILLING SPECIALISTS

The Cincinnati Milling Machine Company

Cincinnati, Ohio, U. S. A.

European Agents—Schuchardt & Schutte, Berlin, Vienna, Stockholm and St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Turin, Bilbao and Barcelona. Chas Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. *Canada Agent* H. W. Petrie, Toronto and Montreal

CONTENTS FOR SEPTEMBER.

The Turner Brass Works, formerly of Chicago, Ill., has completed its new factory at Sycamore, Ill., and is now occupying it. The main factory building has a floor space of 40,000 square feet, with power and heating plants additional. Improved machinery has been installed, the facilities being enlarged and greatly improved. The factory is located on the main line of the Chicago & Great Western Railway and the Galena Division of the Chicago & Northwestern Railway, both roads having side tracks to the factory. As soon as completely settled, all orders will be shipped promptly. All correspondence and orders should be sent to the main office, 50 Park Ave., Sycamore, Ill.

American Locomotive Co., 111 Broadway, New York, has received a number of large orders during the past few months for foreign shipments, especially for the far East, aggregating in all 251 locomotives. One order of 183 locomotives is said to be the largest ever received by a locomotive-building concern in this country for foreign shipment. These locomotives are for the South Manchuria Railroad Company. One of the most interesting facts in connection with this order is that all of the locomotives are of American design throughout. The Pacific, consolidation and ten-wheel engines are the heaviest locomotives of their class ever built for foreign shipment. Another order received by this company is three Mallet compound type locomotives for the Central Railroad of Brazil, weighing, locomotive and tender complete, 303,000 pounds. These engines are the only ones of their type built in this country for foreign shipment, and it is a noteworthy fact that the company who introduced this type into America is now building it for foreign countries.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

240 Discs Cut from $2\frac{5}{8}$" Bar

WITH A "VICTOR"

THE BLADE THAT DID THE WORK

That's the record of a Victor Hack Saw in a recent test. A bar of machinery steel $2\frac{5}{8}$" in diameter was cut through 240 times, making 240 thin discs, before the saw broke by the carelessness of the operator in starting 241st cut. Both the discs and the saw that did the work are shown here. The performance was made possible

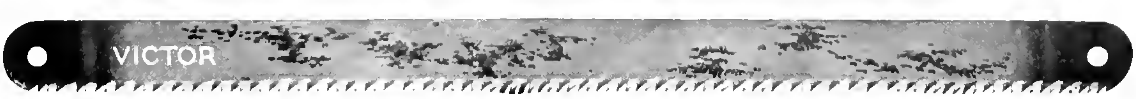
BY USING OIL ON THE BLADE

for the first 150 cuts, making saw cut a trifle slower but preserving the teeth so well that 90 more were taken, and a still higher record would have resulted except that the saw broke.

Do you know of any other hack saw made, that can equal this "Victor" performance?

The "Victor" is proving every day that its special steel, correct temper and hooked teeth make it 15% to 400% more efficient than any other hack saw in existence.

You can prove it to your own satisfaction by asking us for free sample blades and testing them in your shop. You might as well let the "Victor" make a few records for you. Write us to-day.



MASSACHUSETTS SAW WORKS

New York Store
126 Chambers Street

Chicopee, Massachusetts

London Store
8 White Street, E.C.

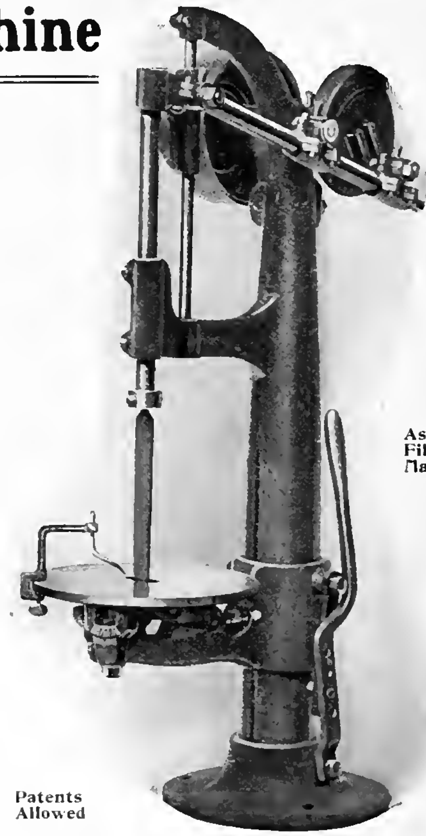
Don't Start up the Milling Machine

For that piece of work—the SIMPLEX FILING MACHINE will do it just as well, do it quicker and at a much lower cost.

There are a great many dfferent kinds of work that can be done on this BENCH FILER instead of the Miller—if you will take the trouble to fix up a few jigs and fixtures to hold your special line of work in position on the FILING MACHINE the same as in the Miller.

A lot of people are doing this every day, as well as utilizing the machine for Die Making and other work.

Glad to send a machine on 30 days trial.
Write for a list of firms who have "discovered" the Simplex Combination Bench Filer and Hack Saw.



The Simplex Mfg. Co., 90 West St., New York

Our Five Thousandth Shaper Has Just Been Shipped

There is a world of meaning behind that statement. It means 5,000 satisfied Shaper owners and operators. Five thousand pieces of satisfaction scattered all over the world, in the best manufacturing establishments, U. S. and Foreign Government Navy Yards and Arsenals, Railroad Shops, etc., is a pretty good advertisement in itself. The "Boss" likes our Eberhardts' Patent "High Duty" Shaper because it does more and better work (reduces cost); and the operator because it is easier to handle.

Five Thousand Shapers

EBERHARDTS G & E

If you want to meet a satisfied Shaper user, look up a man who has one of ours. We'll be glad to give you a list of users in your vicinity. We've been making High Class Machine Tools for over sixty years (Established 1840) and during that time our machines have been recognized as the standard for Shaper Excellence. Shaper satisfaction means G. & E.

Our New "High Duty" Shaper Catalog is now ready for distribution.

GOULD & EBERHARDT, Newark, N. J., U.S.A.

"CHAMPION"
14-inch Engine Lathe

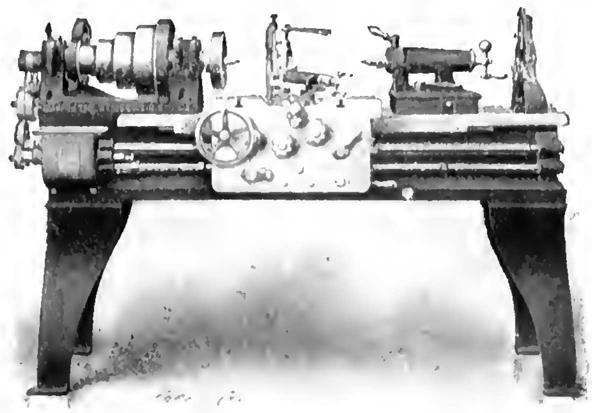
An up-to-date machine, new design, extra large ground spindle, wide face gearing, T-slots in carriage, rapid feed changes, wide belt. It is provided with an Index Dial for catching threads quickly, has automatic stop in either direction, and cuts threads from 2 to 96.

For other special features see our circular.

Champion Tool Works Co.

2422 Spring Grove Ave. CINCINNATI, O., U. S. A.

10, 12 and 14-inch Lathes



To do one thing, and do it well, is a good goal for anyone to strive after. Our goal is to make the

CLEVELAND OPEN SIDE PLANERS

as good as they can be made, to do all classes of work and do it well. They are not special tools in any sense of the word, but for general use with wide range due to the open side.

They have metal properly distributed, stiffness, accuracy.

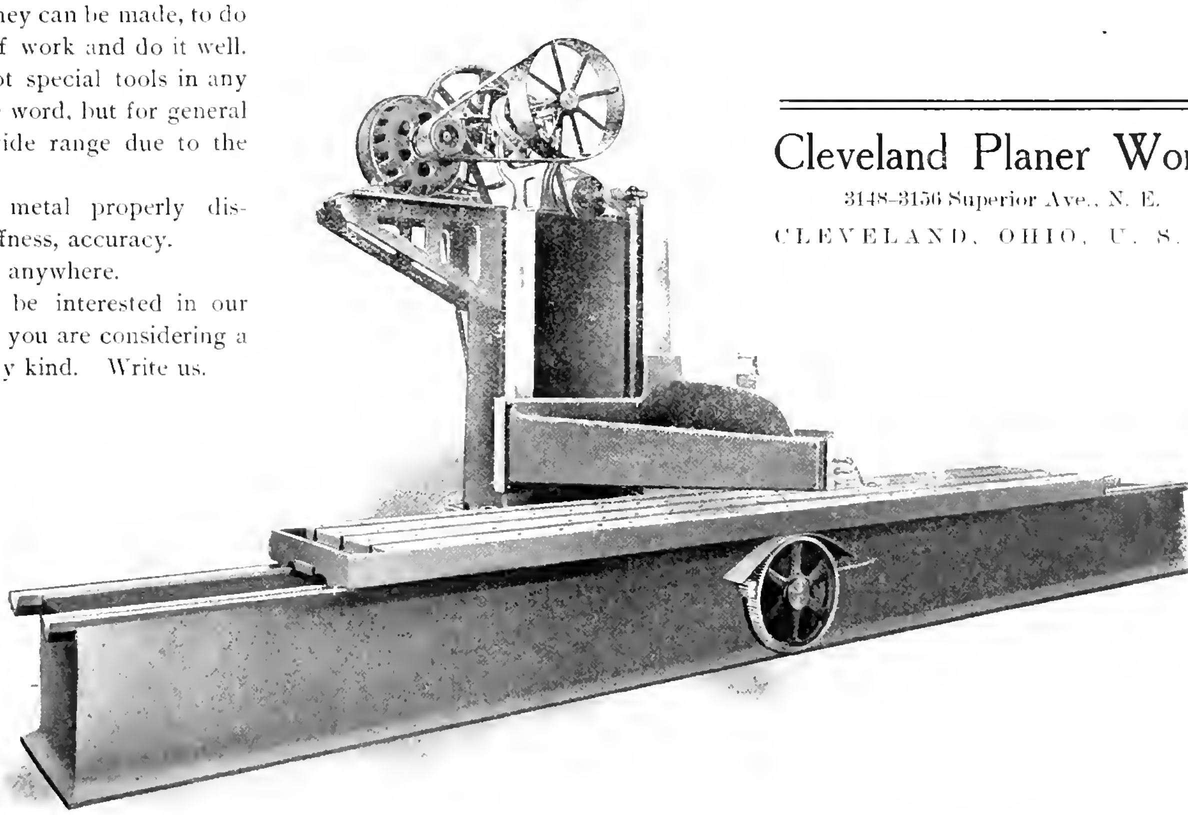
A good tool anywhere.

You would be interested in our literature, if you are considering a planer of any kind. Write us.

Cleveland Planer Works

3148-3156 Superior Ave., N. E.

CLEVELAND, OHIO, U. S. A.



36" x 36"—16 ft. Motor Drive.

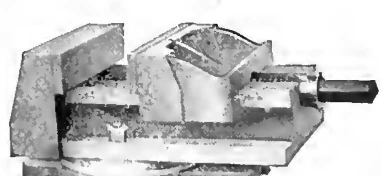
Plunket Improved Vises

Made with Plain or Swivel Base

Specially adapted for the hard service of the machine shop. Can be used with every style drill press, shaper and milling machine. Strongest construction, steel screw, steel faces to jaw, cast steel handle. Write for further information.

J. E. PLUNKET, Chicago, Ill.

33-35 W. Washington St.



SUBSCRIPTION OFFER NO. 4--THREE DOLLARS

YOU GET

The Complete Set of Data Sheet Supplements issued with MACHINERY, Nos. 1 to 80 inclusive, comprising 324 6x9 pages, arranged for notebook use—

MACHINERY, Engineering Edition, for one year, and the Adjustable Cloth Binder for the Data Sheets.

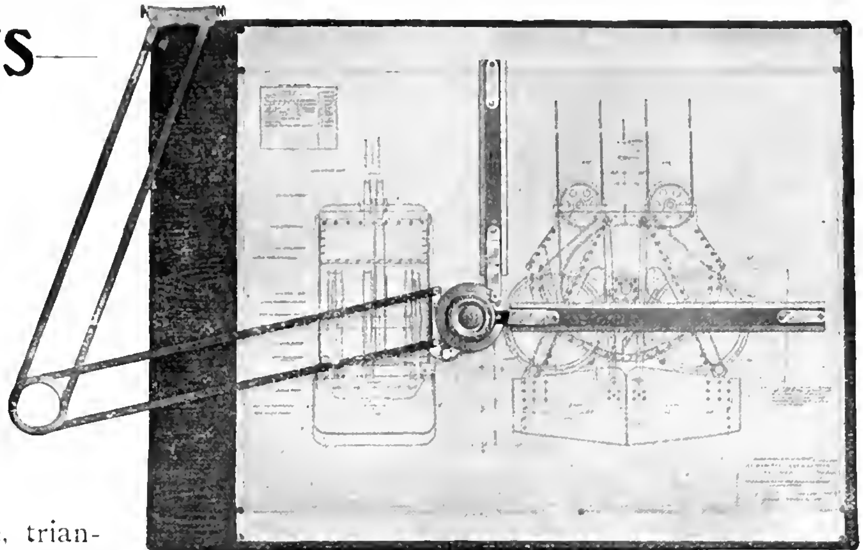
Just say Offer No. 4.

IN OLD DAYS—WITH OLD WAYS

Tee-square, triangle and scale it required **twelve** operations to draw two measured lines at right angles—

IN THESE DAYS—

With the UNIVERSAL DRAFTING MACHINE



It requires but **two** operations to do the same work.

The "Universal" is tee-square, triangle and scale in one, saves all the time and bother of changing from one tool to the other, leaves your draftsman's mind free to work out his plan or design, is virtually an insurance against error and will save fully 25% in time on your drafting work.

If this device is not already a part of your drafting room equipment—write for catalog and full description today.

Universal Drafting Machine Co., Cleveland, Ohio

The Akron Friction Clutch

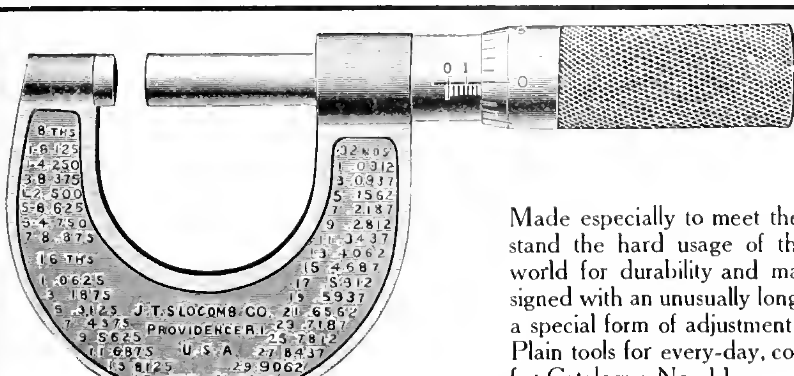
Compact—Simple—Powerful—Adapted for High Speeds

The construction of this clutch is of the highest grade, making it particularly suitable for driving machine tools or for similar service. It requires no attention—just oil it, that's all—the Clutch will take care of itself, stand rough usage and when necessary will slip under full load without damage. The compact form is another advantage, as it takes up little room on the shaft. It is easily and quickly adjusted, does not require a special pulley, is positive and noiseless in operation, and on very high or very low speed shafts succeeds where other clutches fail. All working parts protected from dust and grit.

If you are in need of a powerful and satisfactory clutch write for our booklet

Akron Clutch Co., - Akron, Ohio

Successors to Williams Electric Machine Co.



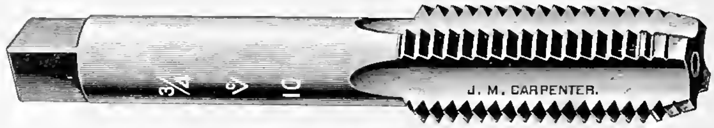
SLOCOMB MICROMETERS

Made especially to meet the requirements of machine shop work and to stand the hard usage of the shop, these Micrometer Calipers beat the world for durability and maintained accuracy. They are peculiarly designed with an unusually long bearing between the nut and the screw, and a special form of adjustment which permits this bearing to be maintained. Plain tools for every-day, continuous service. 13 sizes, 74 styles. Send for Catalogue No. 11.

J. T. SLOCOMB COMPANY, - PROVIDENCE, R. I.

AGENTS—Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne, Glasgow. Ludw. Loewe & Co., Berlin.

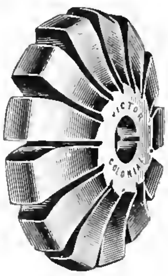
Buy by this Mark



It's Carpenter's Trade Mark, and goes only on the best taps and dies. For thirty-seven years it has been a guarantee of **superiority; take no other.**

Write for prices.

The J. M. Carpenter Tap & Die Company
PAWTUCKET, R. I., U. S. A.



VANADIUM STEEL

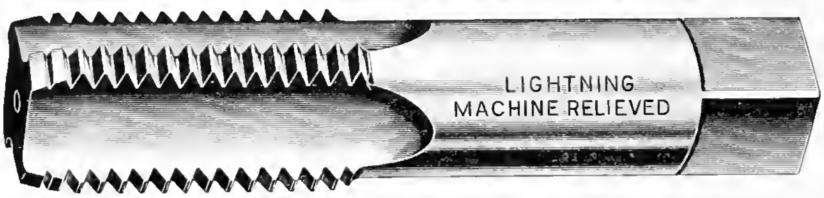
GRADE A IN NATURAL CONDITION SHOWS—

Tensile Strength - - -	110,000 lbs.
Elastic Limit - - -	80,000 lbs.
Elongation - - - -	25 per cent.

Specimens 1½ Rd Bend cold 180° without any sign of cracking. Compare this with any other steel.

SIZES NOW IN STOCK: Round ½ to 2½ in.

COLONIAL STEEL COMPANY, Pittsburgh, Pa.



Lightning "Machine Relieved" Taps

We have customers who have used the Lightning "Machine Relieved" Taps for over 20 years. Why don't they change? Because they know, as everyone knows that has used them, that they are the best and there is no substitute to be had. *Catalog 33-E, prices and samples on application.*

WILEY & RUSSELL MFG. COMPANY, Greenfield, Mass., U. S. A.

FIRTH STERLING STEEL COMPANY

McKEESPORT, PA.

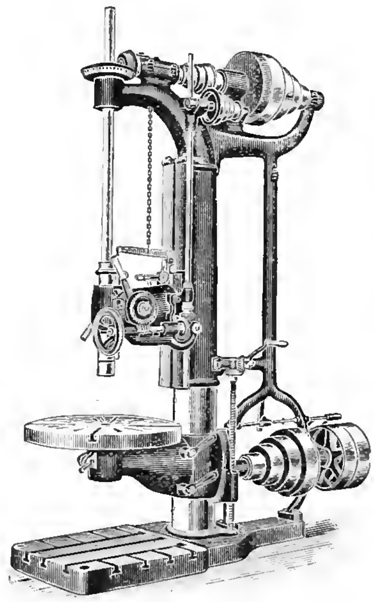
Manufacturers of High Grade Crucible Tool Steel

Have your tools made of BLUE CHIP STEEL and you will get satisfactory results

OUR LINE

32-in.
26-in.
24-in.
20-in.
14-in.
14-in. B
13-in. B
Standard
Drills

No. 1
No. 2
Friction
Drills

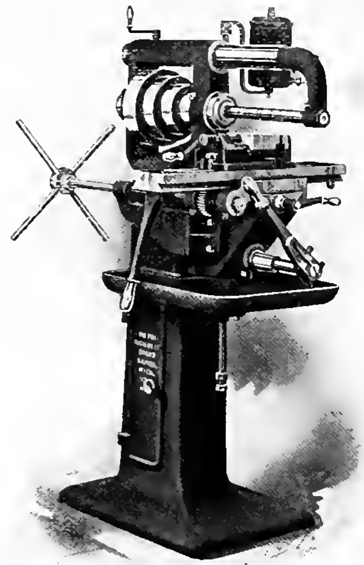


32-in. Drill

Mechanics Machine Co.,

Wyman and Mill Sts.,

ROCKFORD, ILLINOIS, U. S. A.



FOX HAND MILLER

A few machines for prompt delivery. This hand miller has been made with the same care as to details of construction and upon as careful a machine tool basis as the largest and most complex milling machine on the market. The spindle construction is in a class by itself. The machine is strong and rigid and has a large range and it won't give you heart disease to find out the price.

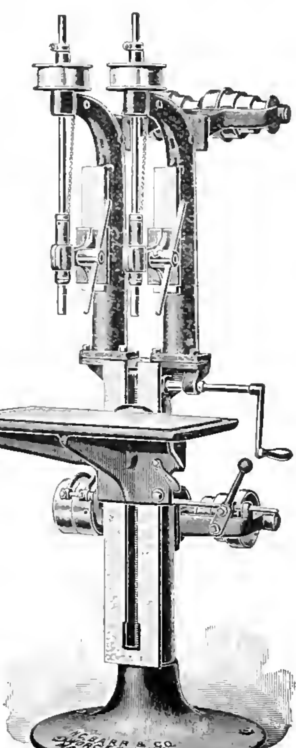
We also make Tube and Pipe Cutters, Drills, etc.

FOX MACHINE CO., 815-825 N. FRONT ST., GRAND RAPIDS, MICH.

The Drills that Barr Builds

WHICH is worth MOST, Promises or Performances? It is easy to claim more than one possesses. Have you been bitten by the microbe????? Style A, (illustration 2-spindle), styles B, C, D, E, F, G, lever feed or power feed, 2 to 6-spindles, drill No. 60 to 3/4" holes and POWER TO SPARE.

THIS is the largest and best line of light Drilling Machines IN THE WORLD.



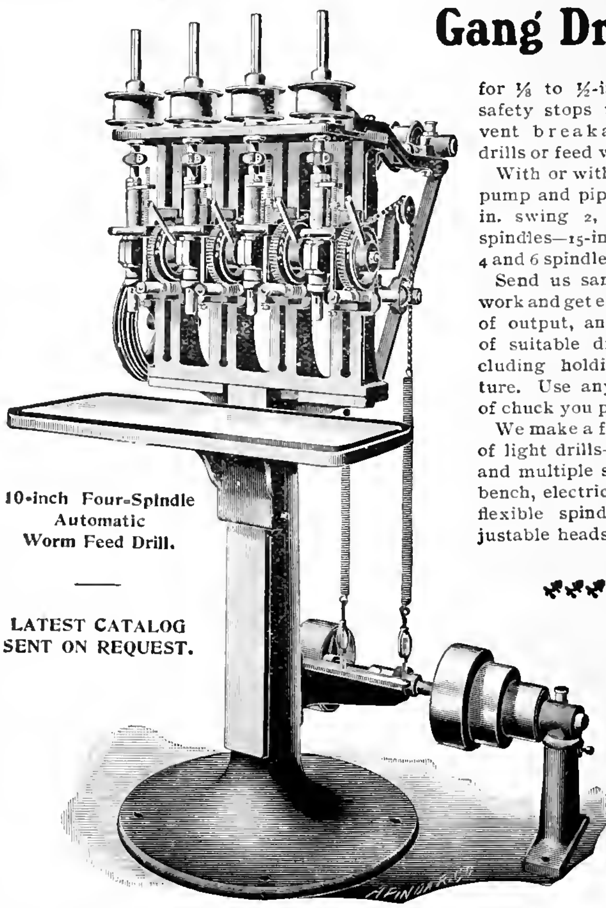
Write for special circulars.

Barr's line of Drills includes 60 styles and sizes.

H. G. BARR, Worcester, Mass.

AGENTS:—De Fries & Co., Dusseldorf, Germany and Milan, Italy.

Automatic Worm and Cam Feed Gang Drills



10-inch Four-Spindle Automatic Worm Feed Drill.

LATEST CATALOG SENT ON REQUEST.

for 1/8 to 1/2-in. with safety stops to prevent breakage of drills or feed works.

With or without oil pump and piping, 10-in. swing 2, 4 or 6 spindles—15-in. swing 4 and 6 spindles.

Send us sample of work and get estimate of output, and price of suitable drill, including holding fixture. Use any make of chuck you prefer.

We make a full line of light drills—single and multiple spindle, bench, electric drive, flexible spindle, adjustable heads, etc.

DWIGHT SLATE MACHINE CO.

1 SPRUCE STREET, HARTFORD, CONN.

TEMPER

in a Twist Drill is a good deal like temper in a man. If it is not even the drill will not stand up to the work it is called upon to do; it soon goes to pieces. But when the temper is just right the best results are obtained from either man or drill. In making "Diamond" Twist Drills special attention is given this essential feature with the result that they wear longer, do more work with less grinding and show less breakage than any other **Twist Drills.** Selected stock, proper milling, correct clearance and grinding, also help to make "Diamond" Twist Drills the best on the market.

W & B CO TRADE MARKS W&B

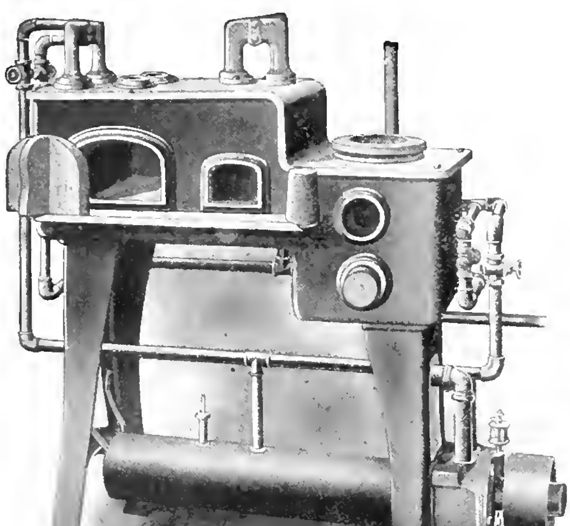
The Whitman & Barnes Mfg. Company

Factories: Akron O. Chicago, Ill. St. Catharines, Ont.
General Sales Office: Chicago, Ill. New York Office: 59 Center Street

Export Representative:
A. J. BARNES, 90 West Street, New York.

European Representative:
THEO. BUTLER, 149 Queen Victoria Street, London, Eng.

We'll Take the Risk.



Stewart Combination Gas Furnace.

If a Stewart Gas Blast Furnace doesn't make good, if you don't find it all we claim as a medium for heating, hardening or tempering high speed or other steel tools—we'll cheerfully take it back and stand all the expense.

Stewart Furnaces are adapted for the widest range of work. The temperature is at all times perfectly even and under absolute control. They insure accurate work in the quickest time, with least trouble and at lowest fuel cost. They require no chimney or special position, are very compact, make no dust or ashes, are always ready and there is no question about results—the Stewart never fails.

Take one on 30 days' trial—55 styles and sizes to choose from.

Chicago Flexible Shaft Co., 149 LaSalle Ave., Chicago, U.S.A.

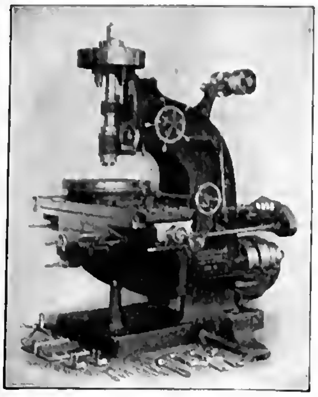
Foreign Agents—Niles Tool Works Co., London, England. Fenwick Freres & Co., Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

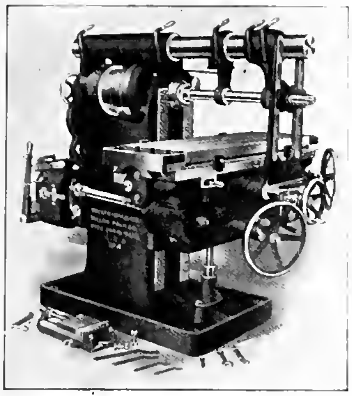
BECKER-BRAINARD

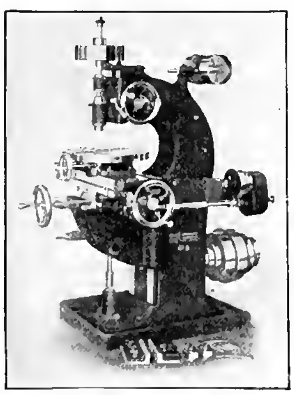
Milling Machines

AND

Milling Cutters





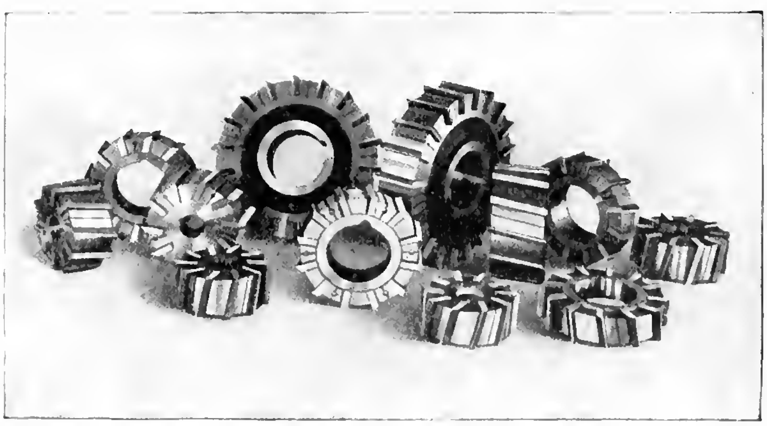


The Highest Efficiency of Production

is secured when the size and design of the machine is exactly suited to the work. We build two distinct types of Milling Machines—

The Horizontal and the Vertical

—and are therefore in a position to furnish whichever is best adapted to the work. We have reason to believe that our own experience will be of material assistance to the purchaser in selecting the machine best suited to meet his requirements. To this end we are always pleased to study specific cases, offer suggestions for improvement, determine the most desirable sizes of machines and design, and make special cutters to accomplish the desired result.



Becker-Brainard Milling Machine Company

HYDE PARK, MASS., U. S. A.

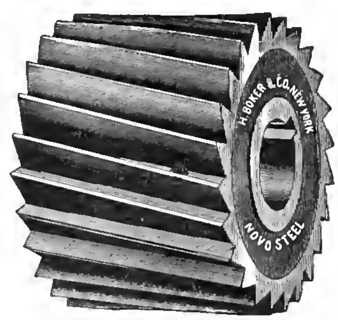
BRANCH OFFICES: THE BOURSE, PHILADELPHIA, PA. WILLIAMSON BLDG., CLEVELAND, O.

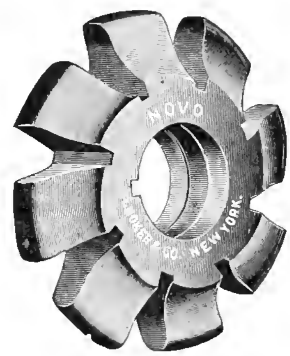
AGENTS: McDowell, Stocker & Co., Chicago. Chas. G. Smith Co., Pittsburg. J. L. Osgood, Buffalo. A. B. Bowman, St. Louis. A. R. Williams Machinery Co., Toronto and Montreal, Canada. Ludw. Loewe & Co., Berlin. Bevan & Edwards Propty., Ltd., Melbourne. Selig, Sonnenthal & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. A. H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao and Barcelona.

354

"NOVO" MILLING CUTTERS ARE ON TOP

We carry a complete stock of Novo Spiral Milling Cutters, Side Milling Cutters, Nicked Tooth Milling Cutters, Novo Gear Cutters, and Novo End Mills.



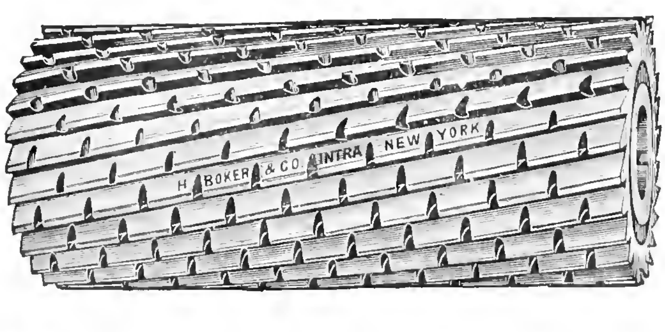


Novo High Speed Milling Cutters

DOUBLE YOUR OUTPUT

We absolutely guarantee all our Novo Milling Cutters. A Novo Milling Cutter will outlast at least two dozen of the Carbon Steel Cutters. Novo Milling Cutters will mill the hardest and sandiest steel or iron castings.

Send us a trial order. Write for price list with full particulars.



All Novo Milling Cutters furnished subject to trial and approval.

HERMANN BOKER & COMPANY

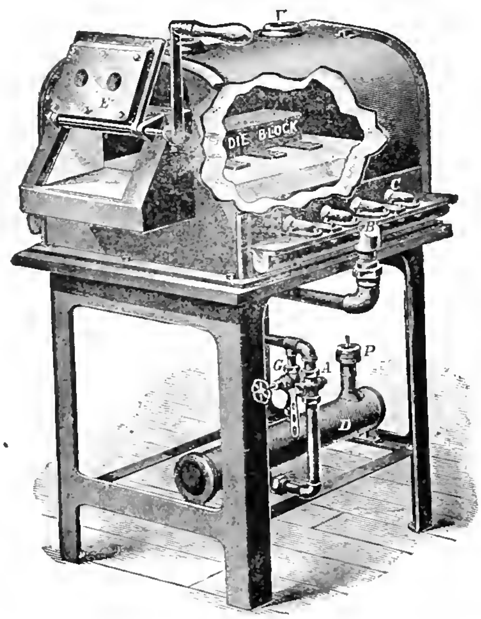
SMALL TOOL DEPARTMENT

Chicago Warehouse
57 N. Desplaines Street

New York City
101-103 Duane Street

OVEN FURNACES

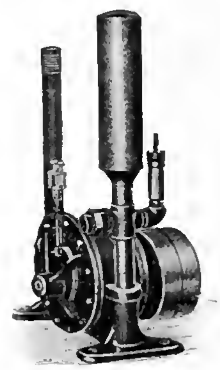
For Hardening and Annealing Metal Work



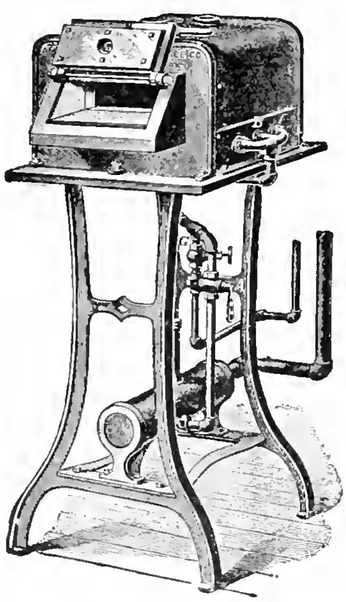
Oven Furnace No. 1

These furnaces are made in a wide range of sizes; are designed to heat square or oblong space of any desired dimensions to the required temperature and maintain a uniform heat under all conditions. The Oven Furnace is generally more satisfactory than a muffle furnace because there is a complete absence of oxidization. The No. 1 Furnace as shown, is adapted for general hardening and annealing—the No. 16-a smaller size, is much used in tool rooms for heating cutters, dies, lathe and planer tools and like work.

Air Blast under pressure of one pound to the square inch indispensable.



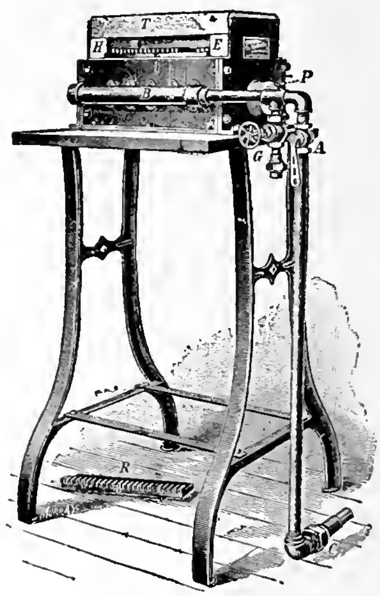
Positive Pressure Blower



Oven Furnace No. 16

"American" Gas Blast Forges

For the machine shop and tool room will heat the work quickly and uniformly, with little or no scale, and danger of overheating stock is practically eliminated. They are ready at all times, develop the required amount of heat in a few minutes and are both convenient and economical.



Gas Forge No. 7
For Cutlery, etc.

We shall be glad to forward Catalogue showing full line of Furnaces.

AMERICAN GAS FURNACE CO.

24 JOHN STREET, NEW YORK

AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm. Alfred H. Schutte, Cologne, Brussels, Milan, Bilbao. Glaenzer, Perreaud & Thomine, Paris, for France and Switzerland. Chicago, Machinists' Supply Co., 16-18 South Canal St. St. Louis, W. R. Colcord Co., 811-823 North Second St., W. H. Kelsey & Co., 646 Prospect St., Cleveland, Ohio., and Gas Companies in nearly all Cities and Manufacturing Towns.

DISC GRINDERS

Charles H. Besly & Co.

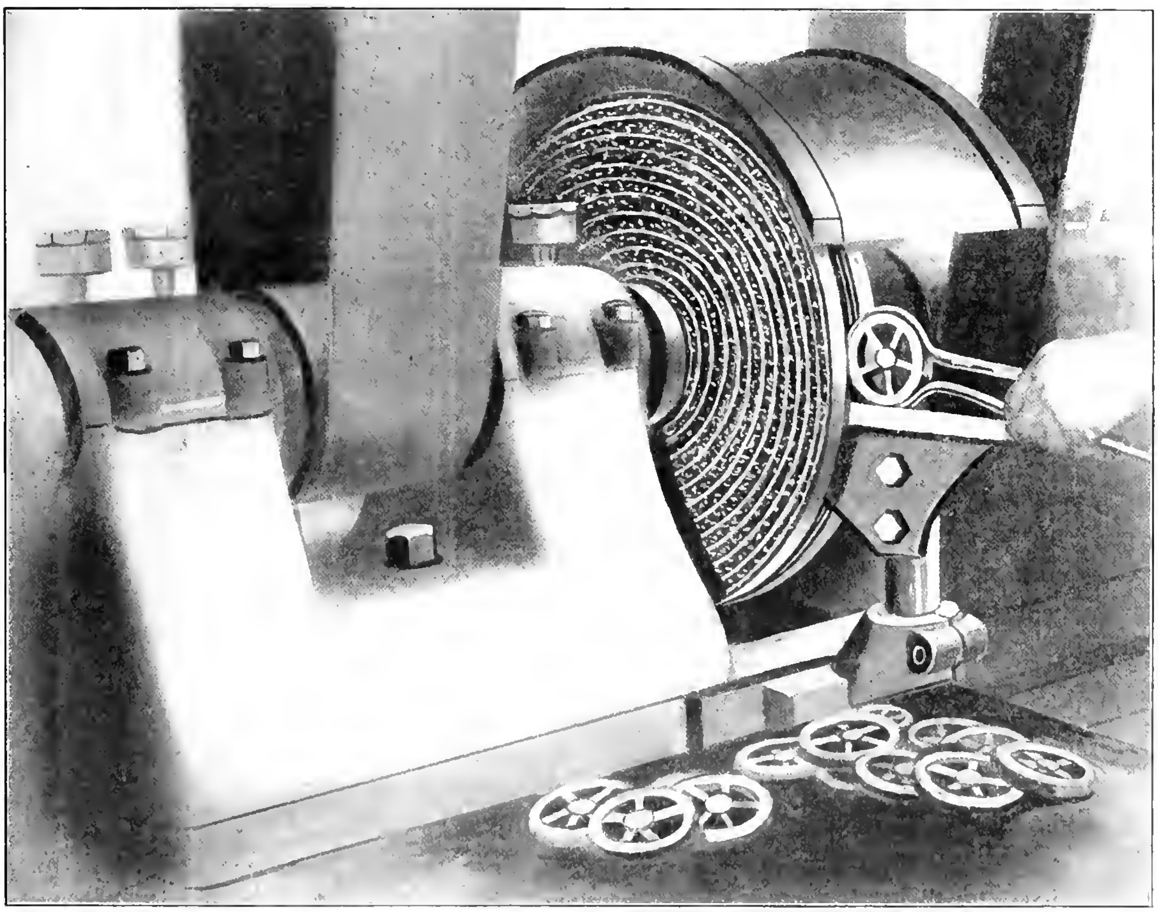
SPIRAL GROOVED DISCS
SPIRAL CIRCLES

HELMET TAPS ARE THE STANDARD

ORIGINATORS OF DISC GRINDERS

Economy and Accuracy go Hand in Hand

when your grinding is done on a Besly Spiral Grooved Disc Grinder. The advantages offered by this machine for flat surface grinding of all kinds—all materials—are unequaled and will save fully 50 per cent. over other methods, besides permitting the closest measurements.



The illustration shows a No. 6 Besly Grinder with double discs at work on 3-inch brass Magneto Gear Blanks for telephones. These blanks were ground at the rate of 250 pieces—500 surfaces—per hour; the circles used being No. 2350 Helmet Spiral Circles, grain 60, removing $\frac{1}{32}$-inch stock. As an example of accuracy these blanks were finished parallel throughout, within .0005 inch. The cost of circles did not exceed two cents per hundred surfaces ground.

It is quite possible we could handle your work with an equal or perhaps greater economy. Send us a sample and we will grind and return it free of charge, marking full data as to time, machine, circles, etc.

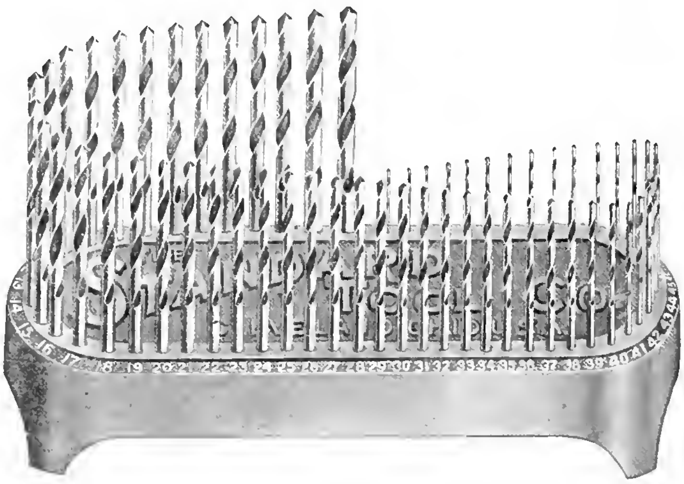
Charles H. Besly & Company

15-17-19-21 South Clinton St., Chicago, Ill., U. S. A.

THE STANDARD TOOL CO

Sets of Wire and Jobbers' Drills on Metal Blocks

NEAT
HANDY
COMPACT
VERY USEFUL



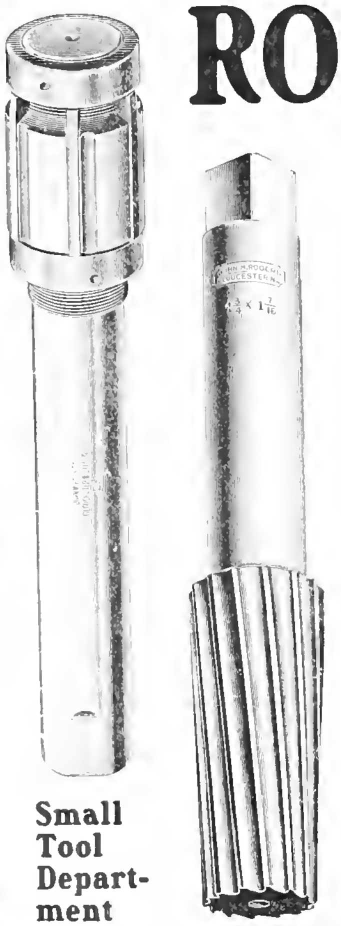
SERVES THE
PURPOSE OF
BOTH A GAUGE
AND HOLDER

General Offices and Factory: CLEVELAND, OHIO, U. S. A.

Eastern Salesroom, 94 READE STREET, NEW YORK

London Office, C. W. Burton Griffiths & Co. Burton Fils, France. J. Lambercier & Cie., Geneve.
F. W. Horne, Yokohama, Japan.

ROGERS REAMERS

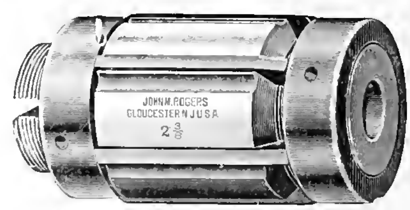


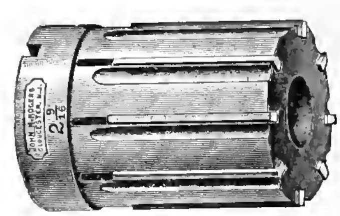
Small Tool Department

"Reliable as the Sun"

There is every reason why Rogers Reamers should be the finest for their purpose. They are made from selected, seasoned stock; the workmanship is the best experience, skill and money can produce; and every tool is tested before shipment.

Send for New List of High Speed Reamers.

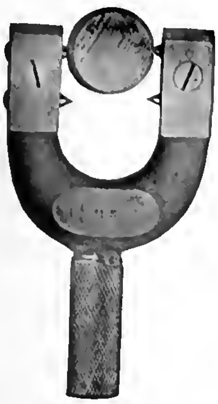




The John M. Rogers Works

Gloucester City, N. J.

Foreign Agents Chas. Churchill & Co., London, E. C. Selig, Sonneuthal & Co., London, E. C. C. W. Burton, Griffiths & Co., London, E. C. DeFries & Co., Dusseldorf, Germany. V. Lowener, Copenhagen, Denmark.



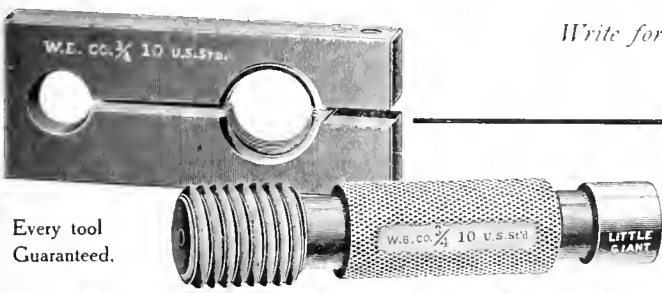
Little Giant

There is Practically No Limit to the Durability of our Limit Gauges

The working points may be removed and reground when worn, then adjusted to size and the usefulness of the Gauge prolonged indefinitely. Any size or any pitch of thread desired in U. S. S., V. or Whitworth form—also full line of Limit Gauges for Cylindrical Work.

STANDARD THREAD GAUGES--Internal and External.

Adapted for the most accurate measurements.

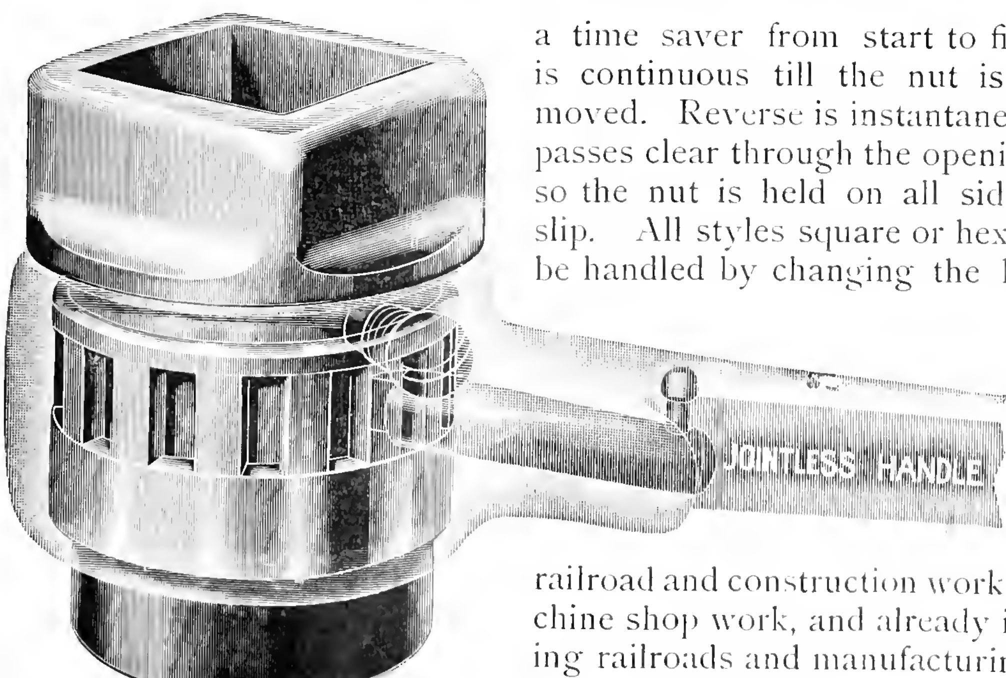


Write for Catalog showing Gauges in various styles and sizes for both Bolts and Pipe.

Every tool Guaranteed.

WELLS BROS. COMPANY
GREENFIELD, MASS., U. S. A.

The Favorite Reversible Ratchet Wrench

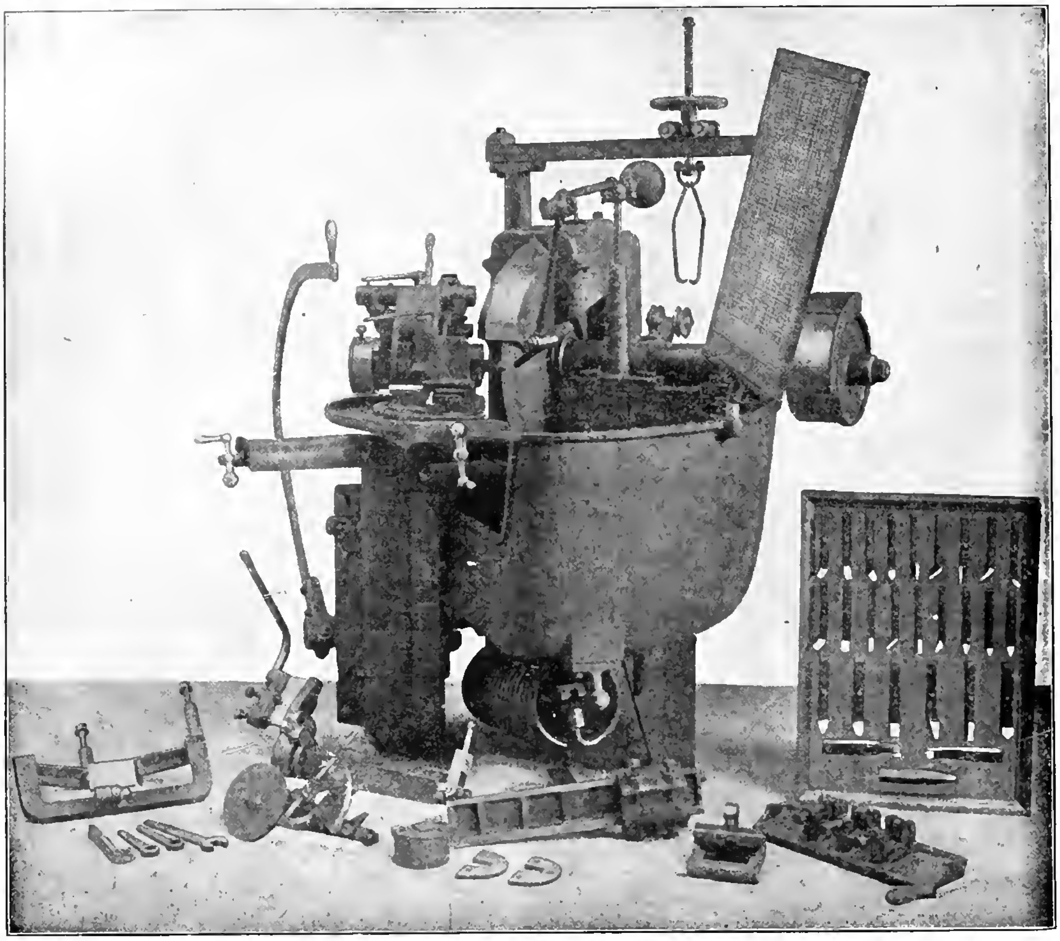


a time saver from start to finish. Motion is continuous till the nut is seated or removed. Reverse is instantaneous. The bolt passes clear through the opening in the head so the nut is held on all sides and cannot slip. All styles square or hexagon nuts can be handled by changing the heads. It is a durable, inexpensive tool, particularly adapted for the hard service entailed by railroad and construction work, or heavy machine shop work, and already in use by leading railroads and manufacturing concerns.

LET US SEND YOU OUR BOOKLET

Greene, Tweed & Co., 109 Duane St., New York, U. S. A.

WM. SELLERS & CO., Incorporated, Philadelphia, Pa.



Tool Grinding and Shaping Machine

For quickly and accurately doing all work after forging to finish tools to shape.

Does not require a mechanic for operator.

Manufactured in the following sizes:

No. 1 for shanks not over 2½" x 2".

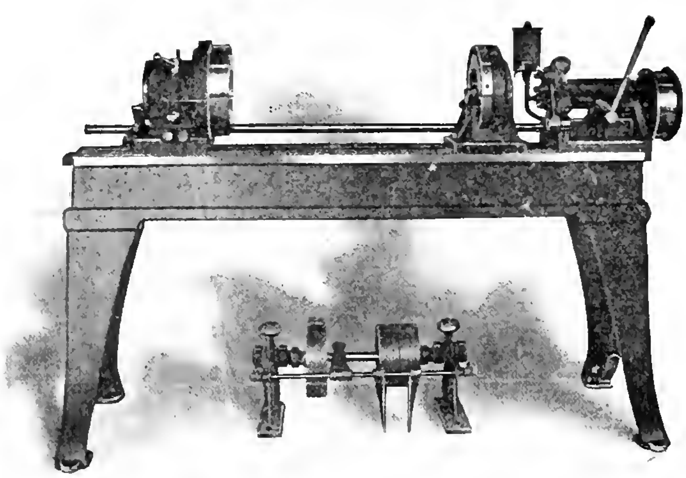
No. 2 for shanks not over 2" x 1½".

Descriptive pamphlet mailed on request.

THE WHITON

Revolving Centering Machine

For Accurately Centering Finished Shafts



The cut shows new Revolving Centering Machine—a large size of the well known machine of this type: It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

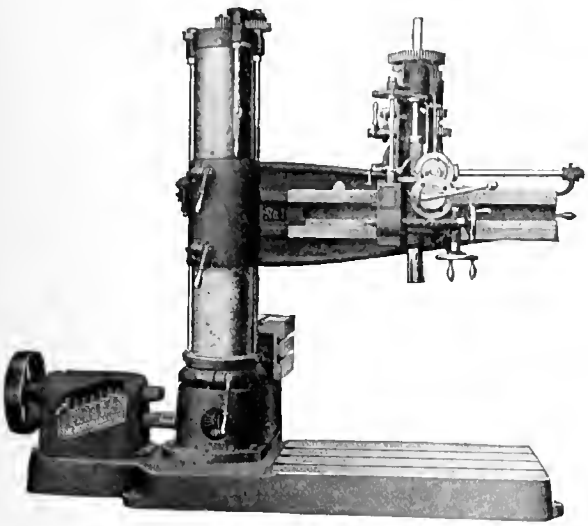
Constructed same as the smaller machine and embodies all the special features.

Circular and prices sent upon application.

The D. E. Whiton Machine Company,

New London, Connecticut

THE SPEED BOX



Improved Plain Radial.

The speed box supplied with

The New Bickford Radial

furnishes eight changes of speed with a single operating lever and without use of a single clutch.

The operator does not need to be a juggler to handle this lever but may operate it with his foot if his hands are otherwise engaged. This is another of those cost cutting features peculiar to BICKFORD RADIALS.

Shall we send our Radial Drill catalog.

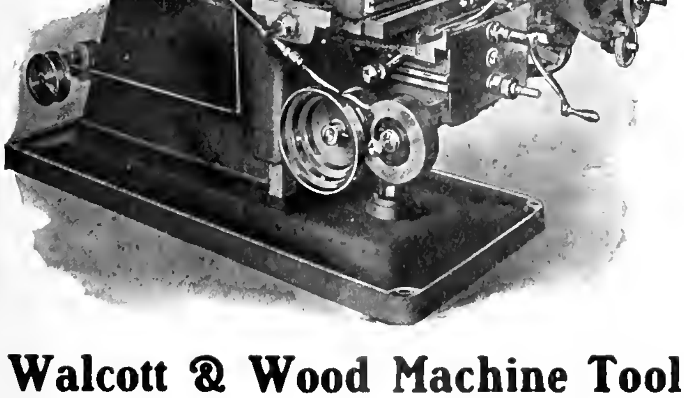
The Bickford Drill & Tool Co.

CINCINNATI, OHIO, U. S. A.

FOREIGN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, New York. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, New York. Charles Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow, Andrews & George, Yokohama, Japan. H. W. Petrie, Toronto, Canada. Williams & Wilson, Montreal, Canada.

Walcott Rack Cutting Machines

Insure accuracy and uniformity in cutting racks and ratchets of all descriptions, and reduce labor costs to the minimum.



The 36-in. x 8-in. Full Automatic Rack Cutter, as shown, is equipped with automatic feed, automatic indexing mechanism, improved method for holding cutters, and other special features, and has capacity for racks of any pitch up to 1 diametral pitch, 36-in. long, 8-in. width of face, and can be furnished half automatic when desired.

The 96-in. x 10-in. machine is a larger size.

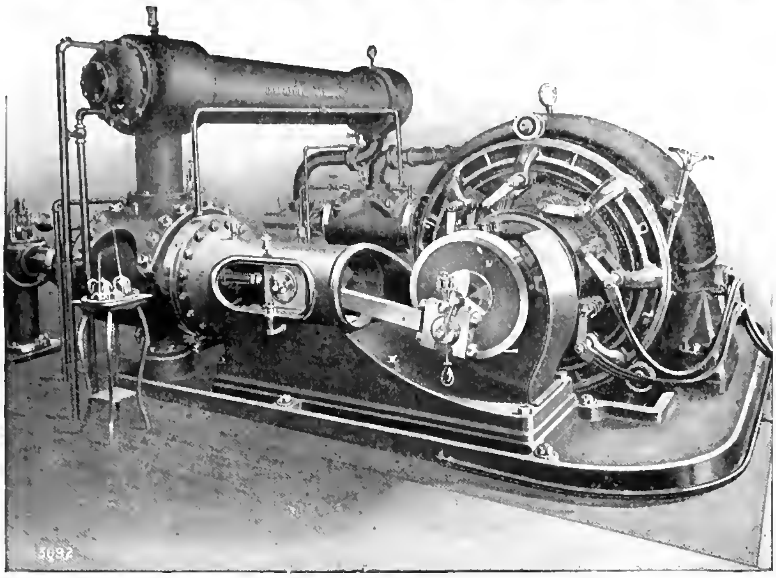
Full particulars on request.

Walcott & Wood Machine Tool Co., Jackson, Mich., U.S.A.

Succeeding GEORGE D. WALCOTT & SON.

AGENTS—Frevert Mchy. Co., New York. Chandler & Farquhar Co., Boston. Chas. G. Smith Co., Pittsburg. Strong, Carlisle & Hammond Co., Cleveland. H. A. Stocker Mchy. Co., Chicago.
FOREIGN AGENTS—Fenwick Freres & Co., Paris. Buck & Hickman, Ltd., London. Henrich Dreyer, Berlin, Germany.

ELECTRIC DRIVEN
COMPRESSORS



One of the Ingersoll-Rand Direct Connected Electrical Compressors in the Gould Coupler Co.'s Shops, Depew, N. Y.

The advent of cheap electric power where fuel is costly and water scarce has developed the electrical compressor. In many instances its adoption has marked the line between unprofitable and profitable operation.

Ingersoll-Rand electrical compressors are the highest refinement of electrical and pneumatic practice. They embody the Company's experience of thirty-five years, covering the building of nearly a million compressor horse-power. More than 90 per cent. of the electrical compressors in use today are Ingersoll-Rand machines—a fact establishing them as the recognized standards of electrical compressor economy.

AIR TOOLS

INGERSOLL-RAND CO.

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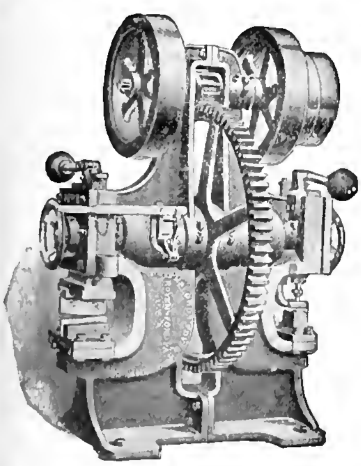
NEW YORK

Chicago, Cleveland, San Francisco, Montreal, London, Philadelphia, Houghton, Mich., Birmingham, Halifax, N. S., Johannesburg, Butte, Toronto, Berlin, Kenora, Ont., Melbourne, Salt Lake, Rossland, B.C., Kalgoorlie, St. Louis, Pittsburg, Los Angeles, Vancouver, Valpariso, El Paso, Boston, Denver, Mexico, Paris

K 27



No. 1 Automatic

Are you interested in the Best

PUNCH AND SHEAR?

Then ask us about the

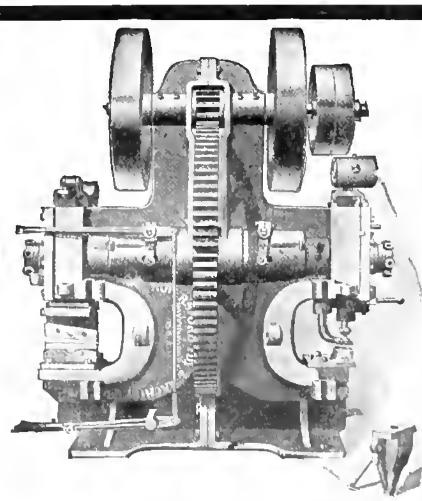
ROYERSFORD

BUILT FOR SERVICE.

VARIOUS SIZES. REQUIRES LITTLE FLOOR SPACE.

ROYERSFORD FOUNDRY AND MACHINE COMPANY,

ROYERSFORD, PA.



No. 3 Heavy Duty, 12-In. Throats

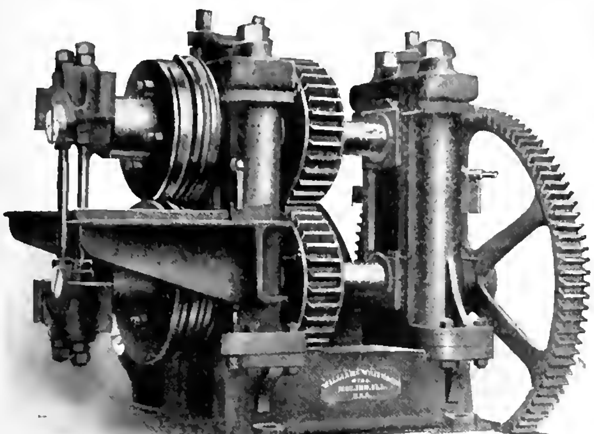
The King Machine Tool Company.

CINCINNATI OHIO U.S.A.

VERTICAL TURRET BORING AND TURNING MACHINES

MOLINE FORGING TOOLS

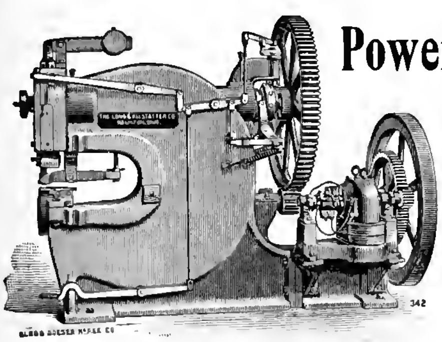
Upsetters **Bulldozers**
Eye Benders
Punches **Shears**
Power Hammers **Drop Hammers**



No. 1 TAPER ROLL

Tapers more Brake Levers and Plow Beams per day than any other machine.

Williams, White & Co., Moline, Ill.



Power Punching and Shearing Machines

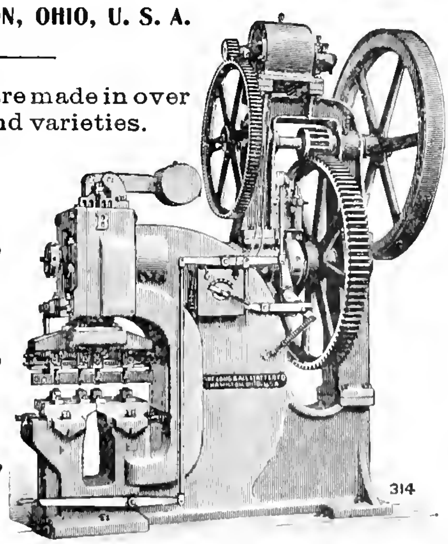
Belt, Steam and Electrically driven.

LONG & ALLSTATTER CO.

HAMILTON, OHIO, U. S. A.

Our machines are made in over 350 sizes and varieties.

SINGLE,
DOUBLE,
UPRIGHT,
HORIZONTAL,
GATE,
MULTIPLE,
FOR
Railroad Shops,
Locomotive Shops,
Bridge Works,
Etc.



VIM IS STRONGEST

Strength of leather is in direct proportion to the length of its fibres.

The above illustration shows a piece of VIM and one of oak leather broken under the same conditions.

The superior length of the fibres of VIM gives some idea as to why

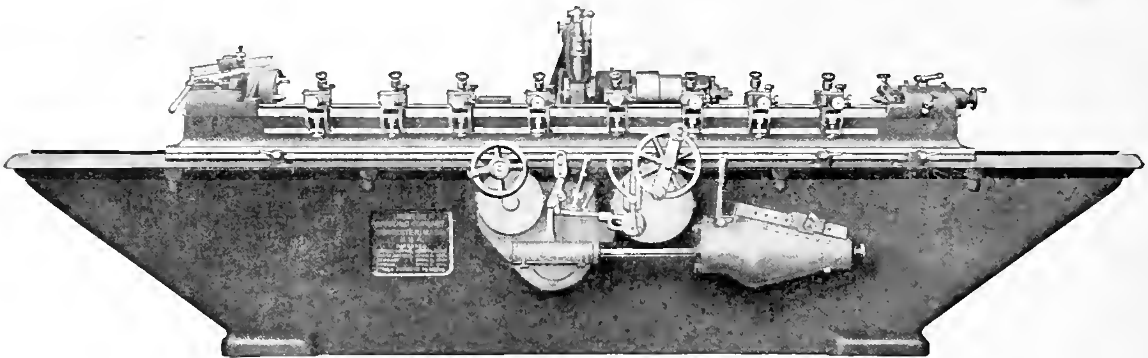
LEATHER
TRADE
VIM
MARK
PACKINGS

can be guaranteed to wear twice as long as oak.

But this is only one of the many reasons.

Get the others by sending for an illustrated catalog.

NORTON



About Speeds

An important feature of the **NORTON** Grinding Machine is the convenience of obtaining different speeds to suit the work.

Every speed of work, wheel and table can be changed at the machine without over-head cones.

All adjustments, operating levers and handles can be reached from one point in front of the machine.

All speed changes can be made without stopping either the work or the wheel.

The Grinding Wheel is always in plain view of the operator when he is in position to make all speed changes and adjustments.

For full details send for our latest Catalog—N 7, 1907.

NORTON GRINDING COMPANY

Worcester, Mass., U. S. A.

Ludw. Loewe & Co., Ltd., London, Berlin, European Agents
F. W. Horne, Yokohama, Japan

Chicago, 48 So. Canal Street

36 N.

CARBORUNDUM
NIAGARA FALLS

Carborundum will cut every other known abrasive—

No other known abrasive will cut carborundum—

This has been absolutely proved by tests made by some of the best known scientists of the world—

It simply emphasizes and confirms what we have been saying for years—

that

> Carborundum is the hardest abrasive in the world—
>
> Carborundum is the sharpest abrasive in the world—
>
> Carborundum is the longest lasting abrasive in the world—

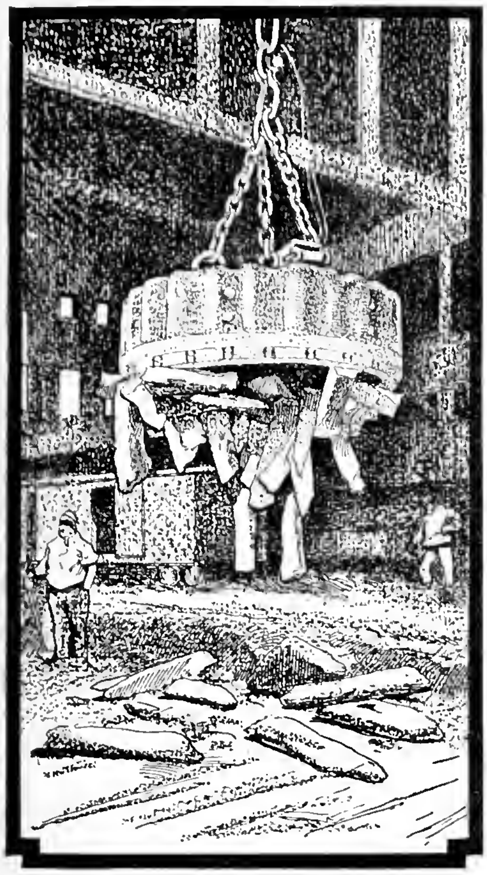
And all these things make Carborundum the most economical abrasive in the world.

There is a Carborundum grinding wheel for every possible grinding need—

Let our experts help you to get the right one for your purposes.

The Carborundum Company

Niagara Falls, N. Y.



LIFTING MAGNETS

After several years of quiet preparation we announce our readiness to fill orders for Lifting Magnets.

Cutler-Hammer Lifting Magnets are designed by engineers who for years have devoted themselves to problems involving electric and magnetic control. They possess **distinct advantages** not to be found in any other magnet now on the market.

Under rigid service tests the records established by these magnets have been so far in advance of anything previously accomplished that we are prepared to accept orders under the following:

"THREE-WAY" GUARANTEE.

1.—AS TO WEIGHT: The magnet we will build for you will be as light as is consistant with proper design and its weight will be guaranteed **not to exceed** that of any comparable magnet.

2.—AS TO EFFICIENCY: The lifting capacity of our magnet will be guaranteed to **exceed** that of any comparable magnet now in use.

3.—AS TO OPERATING COST: The operating cost per ton of material moved will be guaranteed to be **less** with our magnet than with any comparable magnet.

Send for illustrated booklet. When writing, state size of magnet desired and nature of material to be handled.

CUTLER-HAMMER CLUTCH CO.

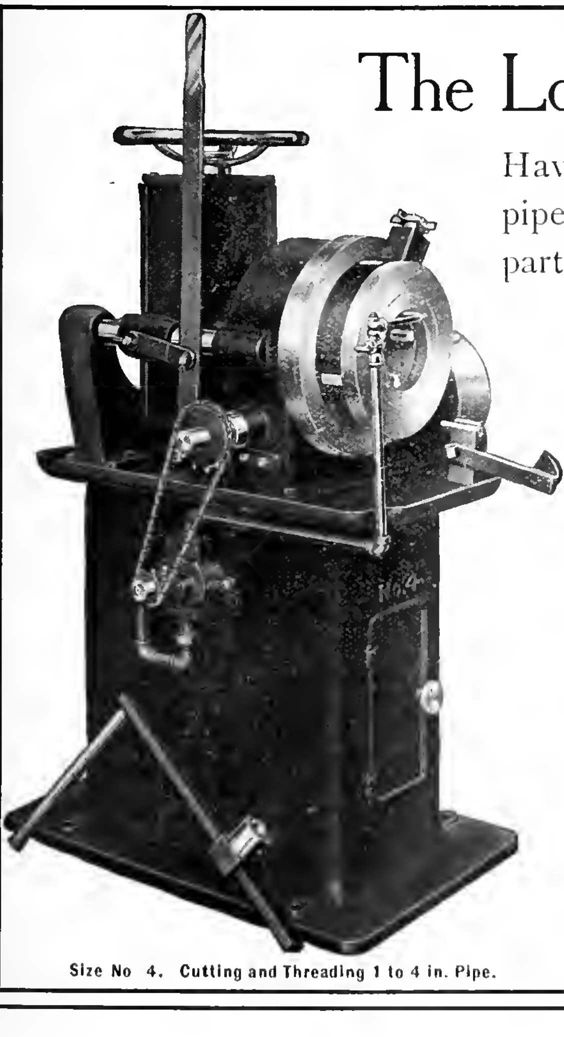
Makers of Lifting Magnets and Magnetic Clutches.

MILWAUKEE, WISCONSIN.

New York Office, 136 Liberty St. | Chicago Office, Monadnock Block. | Pittsburg Office, Farmers' Bank Bldg. | Boston Office, 176 Federal St.

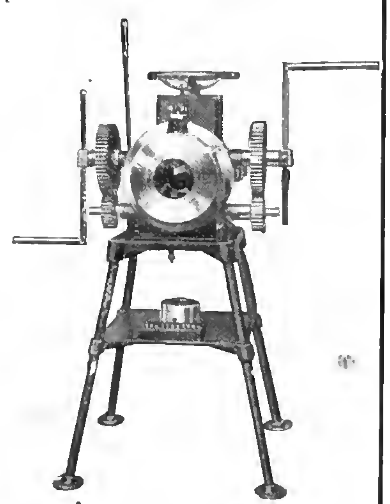
The Loew Victor Pipe Machines

Have advantages which put them in the lead for pipe work of all kinds. They are simple in design, particularly durable, and rapid, accurate workers.



Size No 4. Cutting and Threading 1 to 4 in. Pipe.

SPECIAL FEATURES ARE: The self-locking die head, the improved cut-off attachment, the absence of noisy gears, and the automatic device for releasing the dies and removing burrs from the thread.



Size .02 Hand Power Machine with Cut-off Attachment

Write for Catalog showing full line. The easiest hand operated Hand Power Pipe Machines on the market, and the best Pipe Machines for all classes pipe cutting and threading.

The Loew Mfg. Company, Cleveland, Ohio

Sterling Hack Saws

"BEST-BY-TEST"

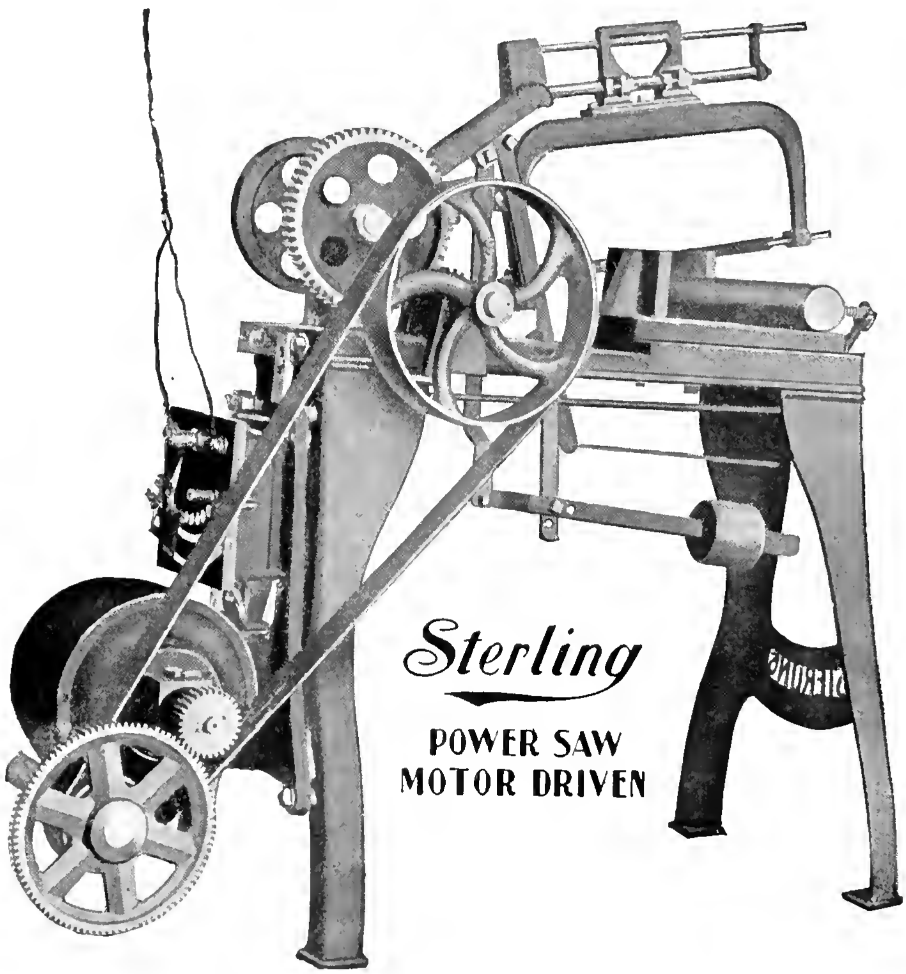
Hand Blades ½ in wide
Machine Blades ⅝-¾-1 in

Machine Features

1. Swivel Vise.
2. Tight and Loose Pulleys.
3. Driven by Milled Gears.
4. Gravity Feed.
5. Automatic Shut-off.
6. Attachment for cutting off long bars at 45° angle.

Motor Features

1. Armature speed 1150 R. P. M.
2. Starting Box—regulating speed from slow to fast.
3. Automatic Shut-off.
4. Fully enclosed—dirt-proof.
5. Location—Back of Machine away from saw cuttings.



Runs smoothly, noiselessly, continuously. Simply attach an electric wire. The saw does the rest.

The "Sterling" Power Hack Saw Machine

Is the latest development in Hack Saw perfection —soon pays for itself. Saves time, material and money.

Diamond Saw & Stamping Works, Buffalo, New York

—FOREIGN OFFICES—

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"OWEN"

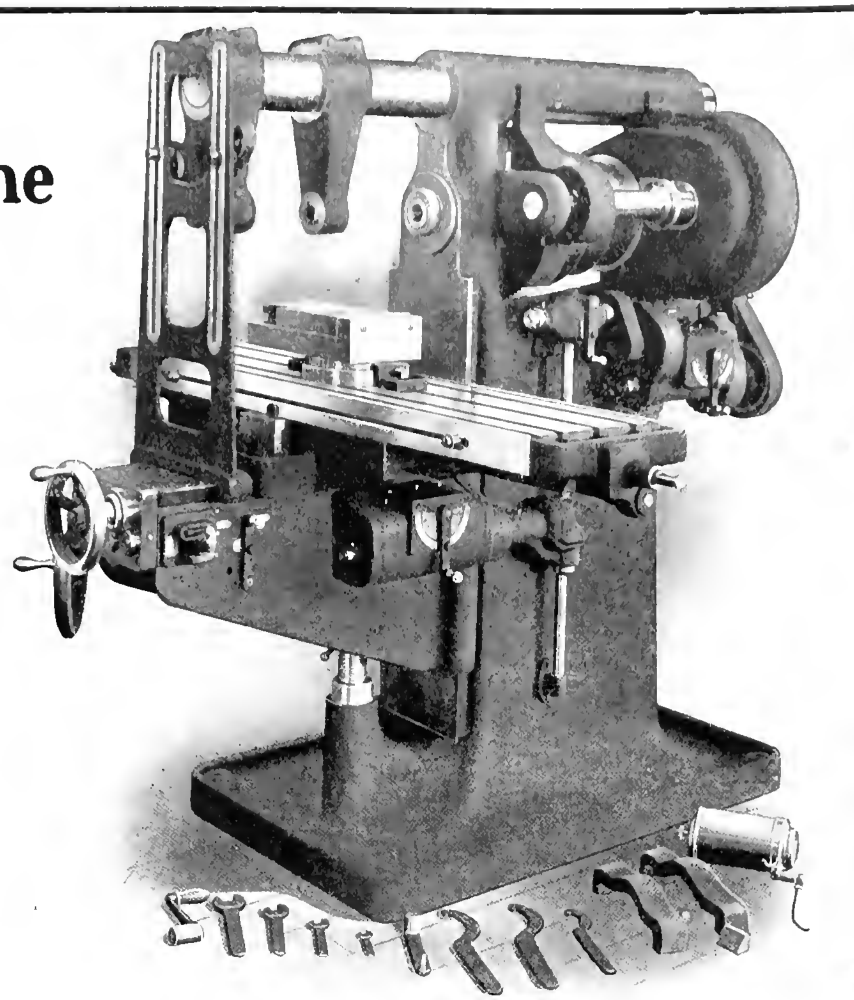
Milling Machine No. 3 B Plain

All the requirements for modern high speed milling. Heavy construction, no vibration even under the stiffest cuts. Rapid production, accurate work. 32 changes of feed instantly obtainable without stopping the machine. Gear drive, positive and automatic in all directions. All adjustments made from the front of the machine. Let us send you full description.

The Owen Machine Tool Co.

Springfield, Ohio, U. S. A.

FOREIGN AGENTS—Alfred Herbert, Ltd., Coventry, England. DeFries & Co., Akt. Ges., Dusseldorf, Berlin and Stuttgart, Germany; Milan, Italy; Barcelona, Spain. Louis Besse, Paris, France. Wilh. Sonesson & Co., Malmo, Sweden.

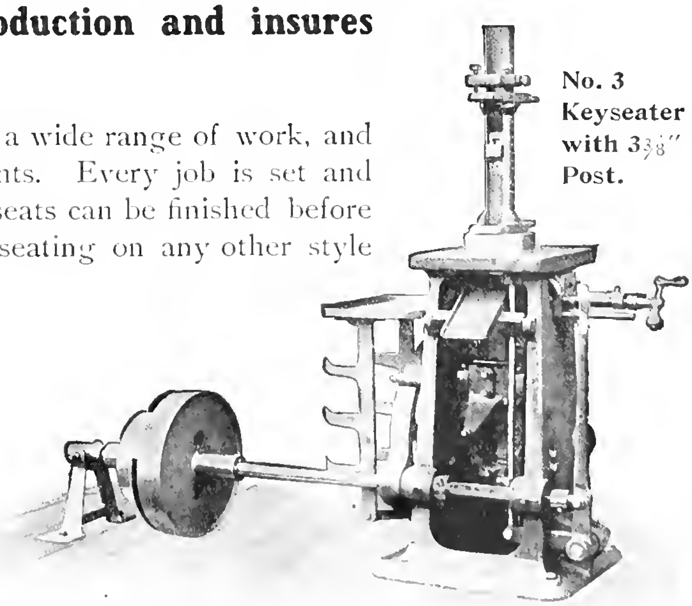


Mitts & Merrill's Giant Keyseater

Solves the time saving problem in keyseating, permits economy in production and insures accurate work.

The machine is built in six sizes covering a wide range of work, and is quickly adjusted to different requirements. Every job is set and fastened by its bore and two ordinary keyseats can be finished before one piece can be fastened ready for keyseating on any other style machine. Will cut perfectly true keyways whether the hole is straight or taper or whether the hub is faced true or left rough as it comes from the foundry. The support being absolutely solid, the tool cannot spring. Send for Keyseater book—mailed free.

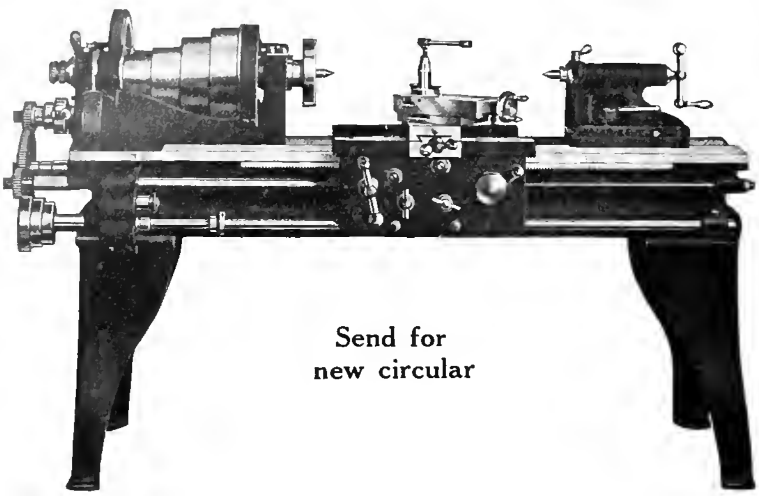
These machines are in use in the leading shops of America and Europe.



No. 3 Keyseater with 3⅜" Post.

Mitts & Merrill, 843 Water St., Saginaw, Mich., U.S.A.

FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, England. Adler & Eisenschitz, Milano, Italy. Alfred H. Schutte, Barcelona, Spain. Heinrich Dreyer, Berlin, Germany and Austria. J. E. Chabert & Co., 61 Ave. de la Republique, Paris, France. E. H. Hunter & Co., Osaka, Japan. Palmer & Co., Wellington, New Zealand.



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new circular

Robbins New Model Standard Engine Lathes

This cut represents our 15" lathe with compound rest.

These machines have all the advantages for economic production, without expensive complicated attachments.

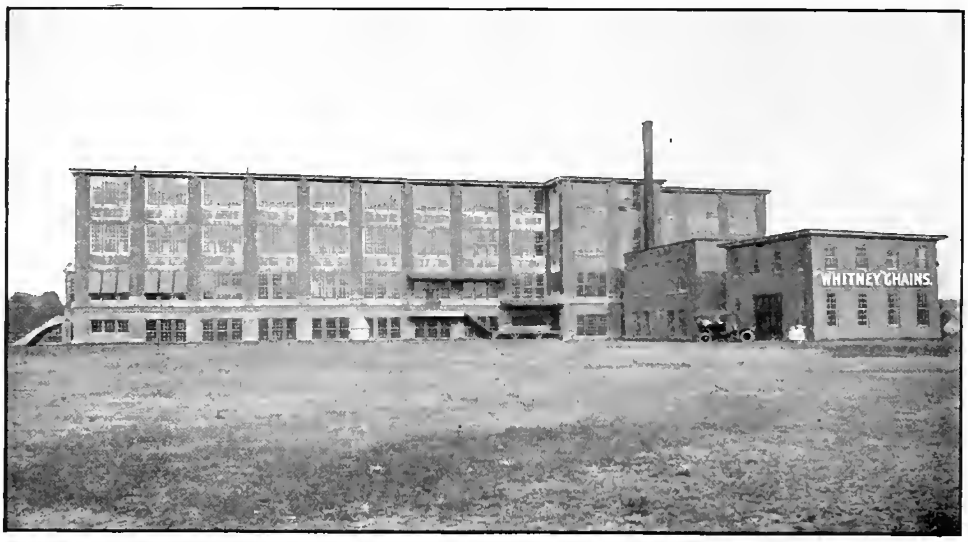
The head and tail spindles are cast crucible steel.

The head is powerfully back-geared, with four step cone for extra wide belt, and speeds arranged in regular gradation. The rest has extra long bearings on the ways and is securely gibbed to the bed.

The workmanship is of the best.

The Robbins Machine Company

149 Lagrange St., Worcester, Mass.



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High Grade Driving Chains for Automobiles, Machinery, Bicycles, etc. Keys and Cutters for The Woodruff Patent System of Keying. Hand Milling Machines (the most universal on the market) for key-seating, profiling, cam-cutting, gear cutting, and all regular hand milling operations. Twenty-Inch Water Tool Grinders. "Presto" Chucks, Collets and Friction Tapping Devices for the rapid change of drills, reamers, taps, etc., without stopping the drill spindle.

The Whitney Mfg. Company, - - - Hartford, Conn.

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MACHINE TOOLS

Complete line carried in stock for immediate delivery.
Write to nearest office for catalogs and prices.

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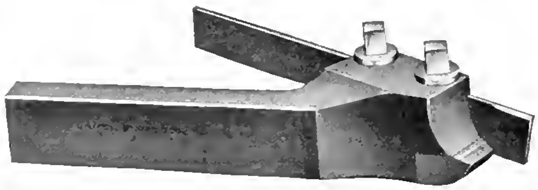
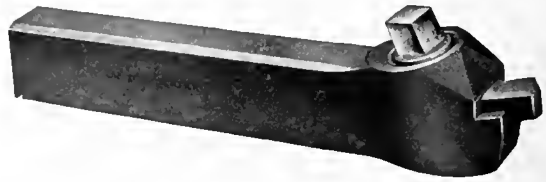
No matter which particular tool you want, you will find our tools unequaled for successfully withstanding a hard, long service. Every tool is guaranteed.



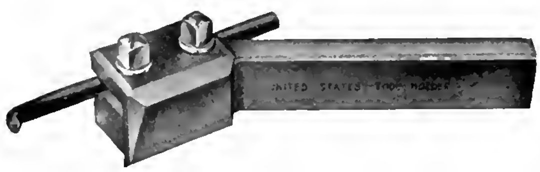
OFFSET CUTTING-OFF TOOL

The beveled blade has perfect clearance and V's clamped flush with the side of the shank.



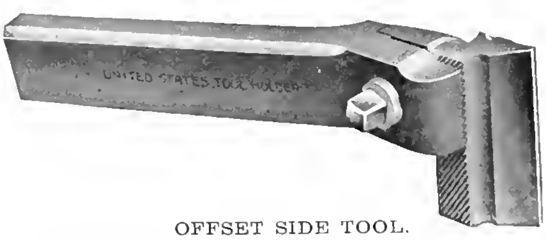
TURNING TOOL

The cutter is supported on the sides and bottom for heavy cuts. The clamp screw cannot-burr-on-end.



BORING TOOL

The cutters are not mashed down by a set screw, but are firmly held by the clamp. Drills, Taps, etc., can also be used.

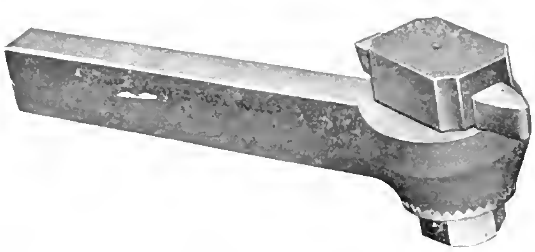


OFFSET SIDE TOOL.

The cutter is solidly supported, and proper clearance provided for rapid and economical work.

THREADING TOOL.

The Cutters are accurately ground to gauge, and have sufficient clearance and rake for perfect work.



PLANER TOOL

The solid shank and large cutter means extra heavy cuts. Note the close adjustment.

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The Fairbanks Co., Springfield, Ohio, U.S.A.

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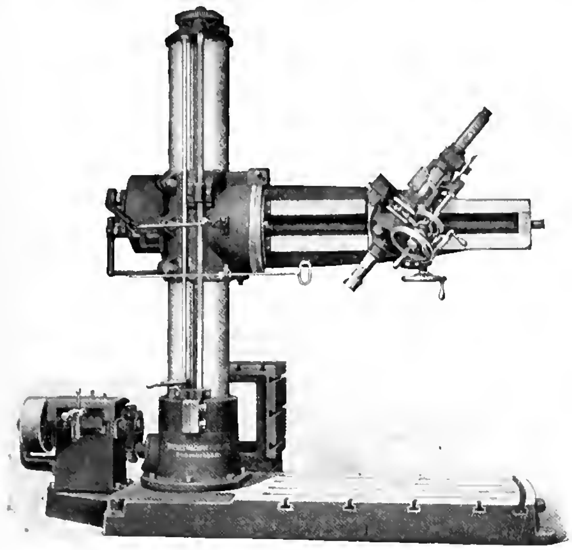
UNIVERSAL RADIAL DRILLS

ARE ALSO ADAPTED FOR THE HIGH SPEED TOOL STEEL.



THEY are not only *pleasing* in design, *simple* in construction and *embody* all the *modern improvements*, but have *a number of our original and patented features* not found in others.

We make them cone, motor and speed variator driven. We also build a full line of plain machines from 2½ ft. to 8 ft. swing.

Send for literature and prices.

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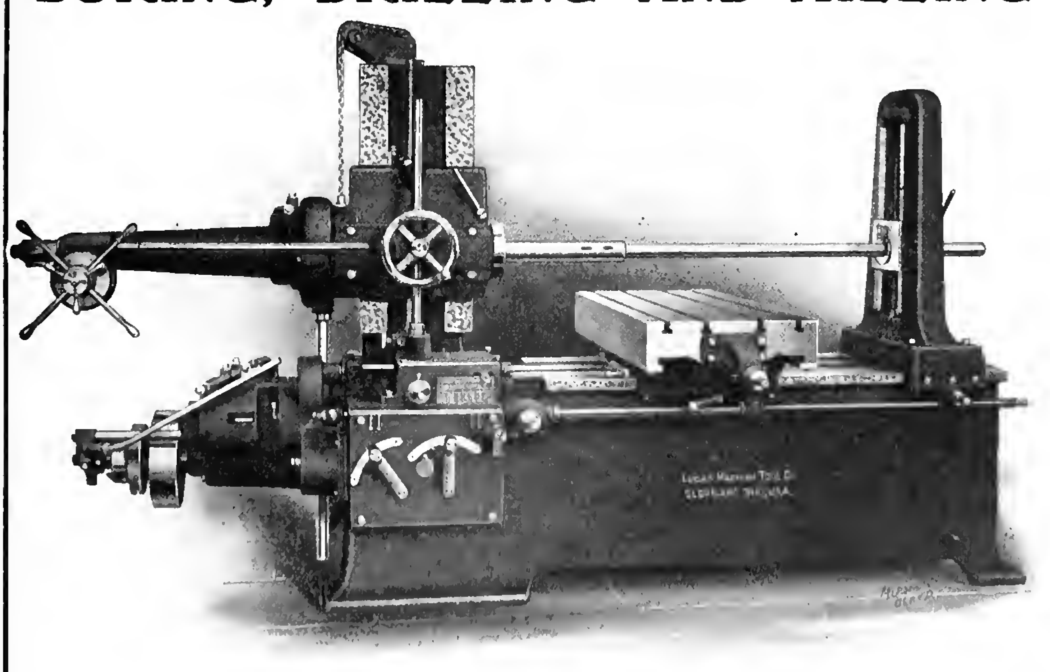
THE MACHINE FOR ALL THE PEOPLE ALL THE TIME

is the LUCAS (of CLEVELAND) "PRECISION" BORING, DRILLING AND MILLING MACHINE



For All People because it is VERSATILE; All the Time for the same reason: **Never stands idle;** takes less room than three individual machines, and *saves resetting*. **Makes Jigs,** or reproduces work **without Jigs.**

Precision Screws, Graduated Dials, Power Movements.

Made in a shop fitted up for high class work only, which you are invited to come and see.

Lucas Machine Tool Co., Cleveland, Ohio, U. S. A.

European Agents: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg.

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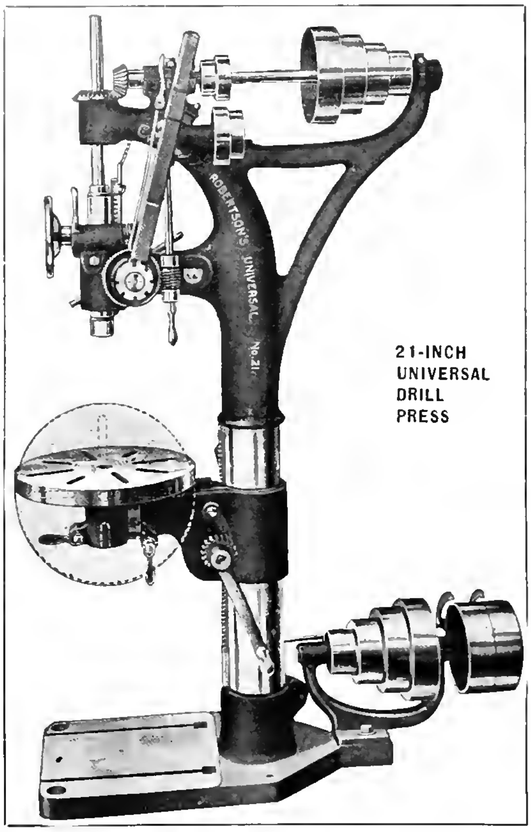
THE MONEY MAKER IN MACHINE SHOPS

SOLD BY ALL THE LEADING DEALERS



DRILLS HOLES ANY ANGLE FROM 0 TO 90 DEGREES

Made only by THE ROBERTSON MFG. CO., Buffalo, N. Y.

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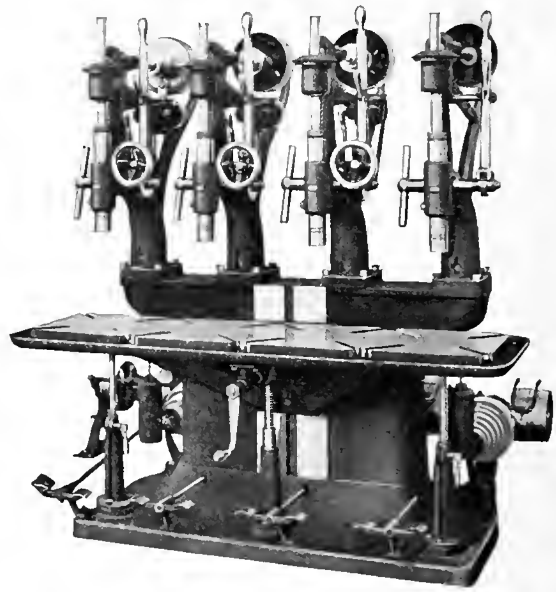

But reams, taps, faces, bores and does a variety of operations you are in the habit of buying expensive machinery for.
Any number of spindles, two to six.
Any arrangement with o· without Back Gears or Power Feed to suit your work.
Any swing, 14 up to 31 inches.

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European Branch, 149 Queen Victoria Street, London, E. C.

Duplicate Drilling, Reaming, Tapping, Etc.

can be accomplished on this

New Cylinder Turret Drill

in less time, with less power and with less labor than on any similar machine.

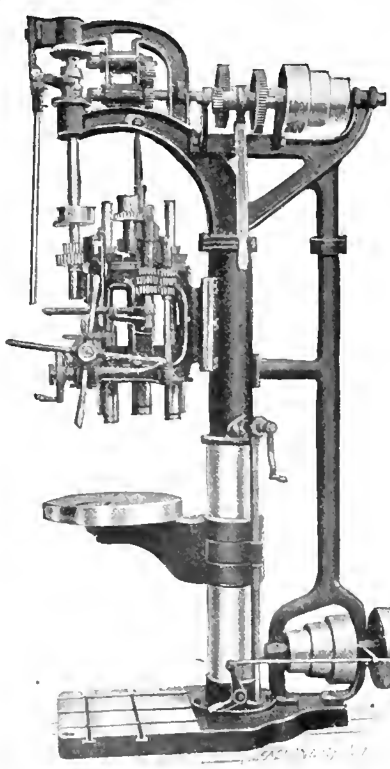
All operations performed without changing the tools or the work.

Permanent alignment maintained.

Strain passes from turret to the frame of machine as soon as the power is applied.

Feed can be changed instantly. Turret turns either way.

An ideal tool for high speed steels.



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National Separator and Machine Co.

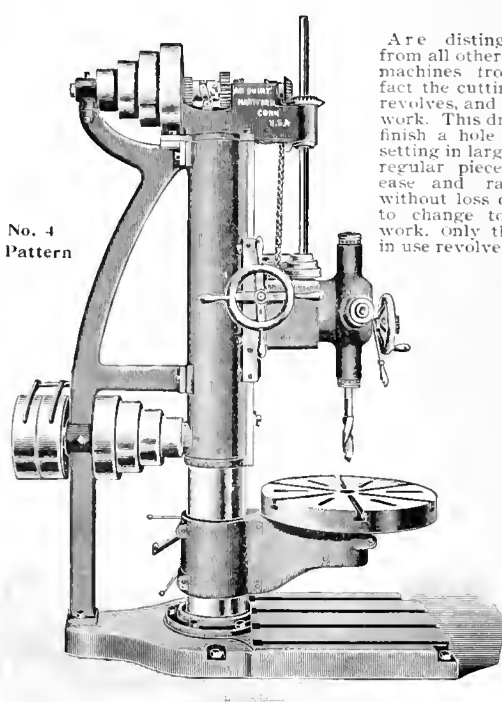
CONCORD, N. H.

Quint's Turret Drills

ARRANGED FOR TAPPING

Made with from Four to Twelve Spindles

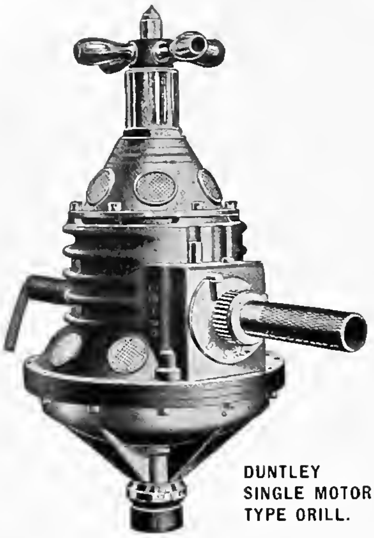
No. 4 Pattern



Are distinguished from all other turret machines from the fact the cutting tool revolves, and not the work. This drill will finish a hole at one setting in large or irregular pieces with ease and rapidity, without loss of time to change tools or work, only the tool in use revolves.

A. E. QUINT, Hartford, Conn., U. S. A.

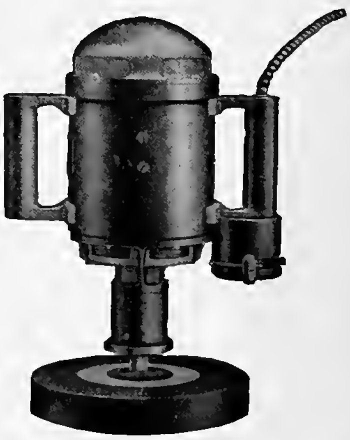
IN THESE DAYS OF KEEN COMPETITION



DUNTLEY SINGLE MOTOR TYPE DRILL.

and high cost of material and labor the shop owner must, of necessity, utilize every means at his command to procure a satisfactory margin of profit from his product.

He must be ever alert to conditions and methods throughout his entire establishment; must be a master of every detail, and above all things must have an equipment of modern, labor saving machinery—an equipment which will produce maximum results at minimum cost.



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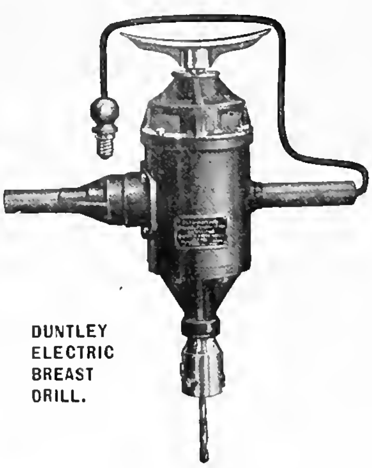
Built in Two Sizes.

DUNTLEY ELECTRIC

(AIR COOLED) TOOLS (PORTABLE)



DUNTLEY ELECTRIC BREAST DRILL.

Weight 13 lbs Cap ⅜-in. in iron or steel, ¾-in. in wood.

have demonstrated their time and money saving qualities in thousands of cases. They have a record of 100% earning power, and have saved their first cost for many purchasers in a few months.

They are wound for alternating or direct current, and each tool is guaranteed to perform the service for which it is designed.

We make them in all portable sizes and ship them on trial to responsible parties.

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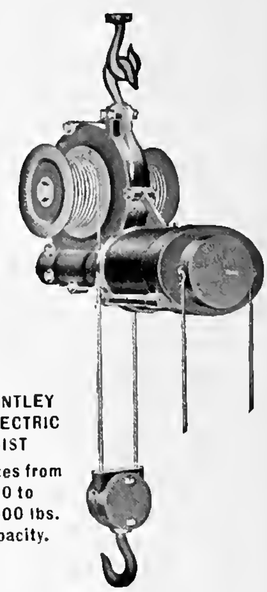

DUNTLEY ELECTRIC HOIST
Sizes from 250 to 2000 lbs. capacity.

We also manufacture FRANKLIN AIR COMPRESSORS in more than 100 styles and sizes, and a complete line of pneumatic tools and appliances.

CHICAGO PNEUMATIC TOOL COMPANY

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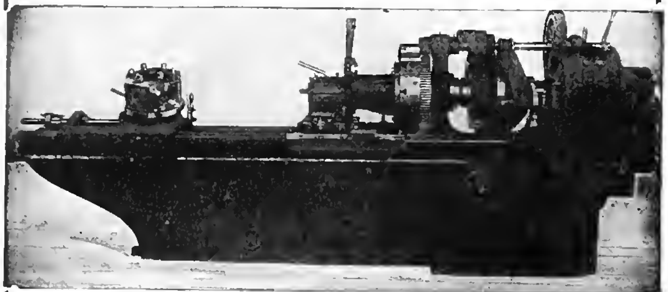
Westinghouse

Individual Motor-Drive



Westinghouse Type S Motor Driving Gisholt Lathe

It Pays to drive machine tools with individual Westinghouse Motors.

Because with individual drive machine tools can be operated more efficiently and placed where most advantageous, their position not being dictated by power wasting, unproductive shafting and belting.—With individual drive every horse-power is delivered direct to the tool.

Send for Motor-Drive Booklets

Westinghouse Electric & Mfg. Co.

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Canada: Canadian Westinghouse Co., Ltd., Hamilton, Ontario
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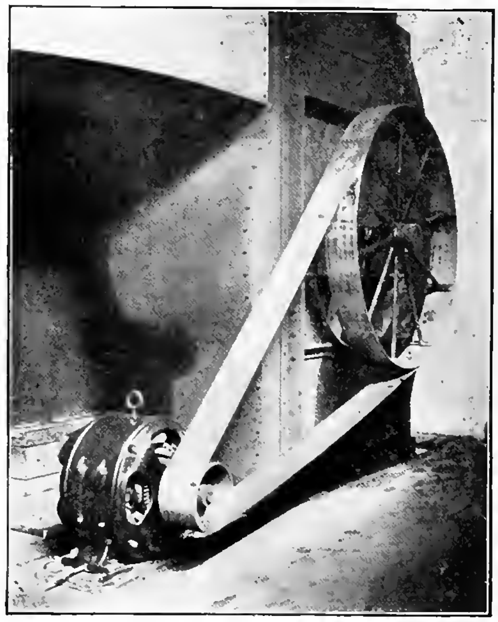
18 H.P. 500-volt Thompson-Ryan Variable Speed Motor Driving Ventilating Fan in the shops of the Philadelphia Rapid Transit Co.



The perfect speed control of the Thompson-Ryan Motors adapts them to a range of usefulness unequalled by other motors. The horse power and efficiency are constant at all speeds. No complicated controllers, no complex wiring required. *Write for bulletins.*

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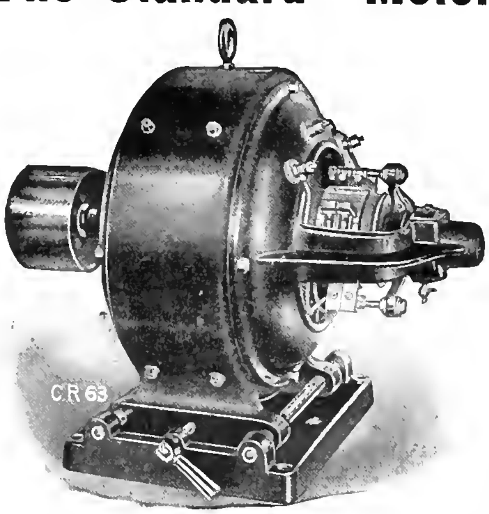
"The Standard" Motors



We are making 20 Standard Motor Frames for all kinds of work—open, gauze enclosed or solid enclosed, vertical shaft, back geared, variable speed, with sliding base, or with broad, flat, planed feet—in short, any kind of Motor you want of 15 H.P. to 1-30 H.P.

We have made over 16000 of these standard Motors, and we know the small Motor business as few ever can. "The Standard" Motors are made right. Our engineering advice is yours for the asking; state your case.

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An effective and economical method of heating.
A thorough system of ventilation.
The apparatus employed is described in catalogue No. 186-M. Shall we send you a copy?

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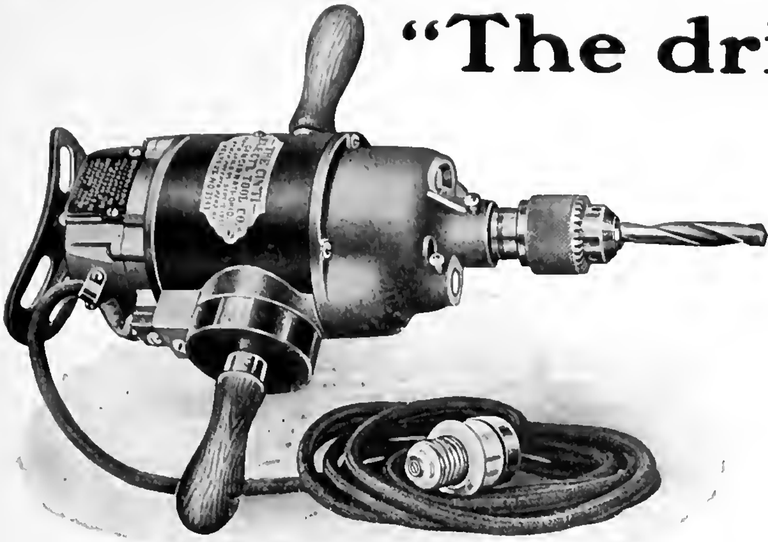

Don't wait until that other job on the drilling machine is finished; and even then the job has got to be jacked up, reversed, moved back again. Why don't you connect a

Cincinnati Portable Electrical Drill

to that lamp socket over there—*and drill.* It's much cheaper than waiting, cheaper than bringing the job to the drill. Take the drill to the job—

Cut out the waste—waste of time and money

No drill can be simpler, lighter in weight and last, or work in more inaccessible places. Ask for Bulletin P-4.

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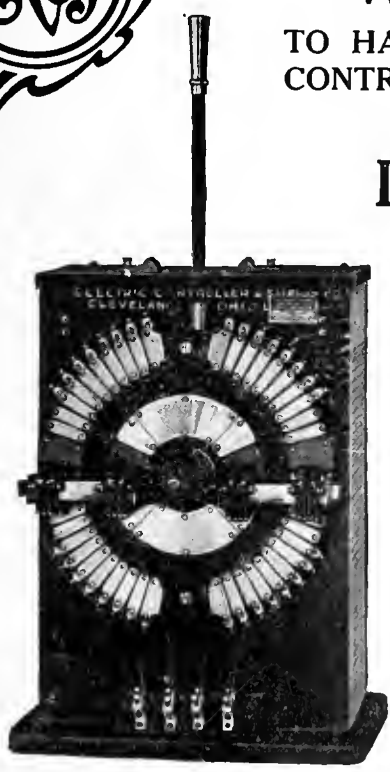
TO HAVE YOUR CRANES EQUIPPED WITH CONTROLLERS THAT YOU CAN FORGET?

IF YOU WOULD--SPECIFY

DINKEY VENTILATED CONTROLLERS



1 to 100 H.P.

Made of the best material throughout and will withstand severe service under the most exacting conditions. All parts are easy of access and interchangeable.

Send for Bulletin No. 99 giving details of construction.

The Electric Controller & Supply Co.

Cleveland, Ohio.

PAWLING & HARNISCHFEGER, - Milwaukee, Wis.

Designers and Builders of

CRANES
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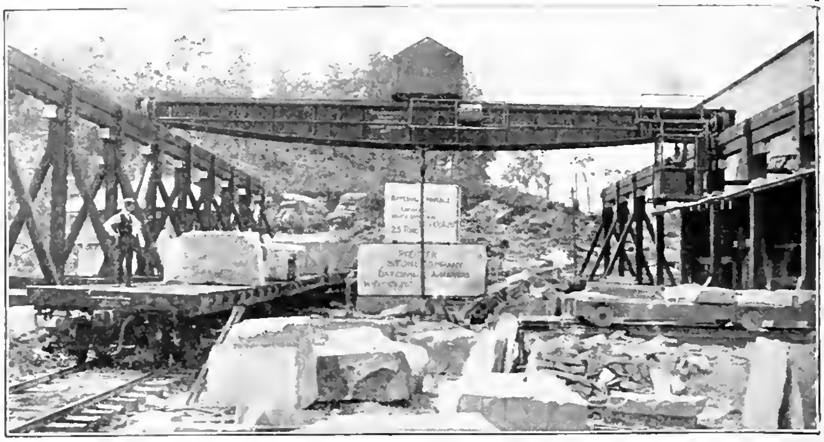
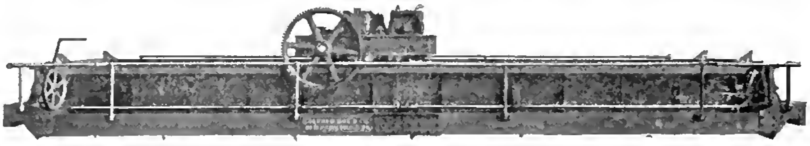
Over 1900 Machines in use

Capacities 1-2 to 200 tons





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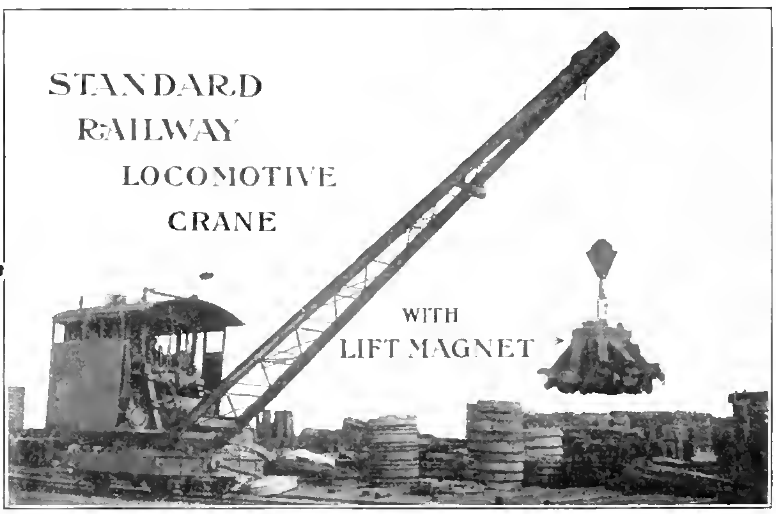
ELECTRIC AND HAND POWER.
Any capacity and for any service.

Write us your needs—25 years' experience in building cranes.

ALFRED BOX & COMPANY, Philadelphia, Pa.



Write for specification and price on

The Browning Standard Locomotive Crane with Clam Shell Bucket or Lift Magnet

THE BROWNING ENGINEERING COMPANY

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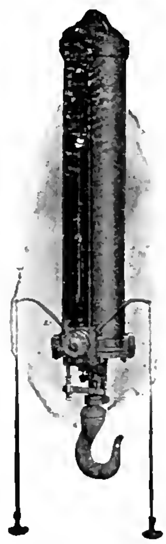

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STEEL CYLINDER

BALL AND SOCKET HOOK

CURTIS VALVES

PNEUMATIC ELEVATORS

CURTIS & CO. MFG. CO.
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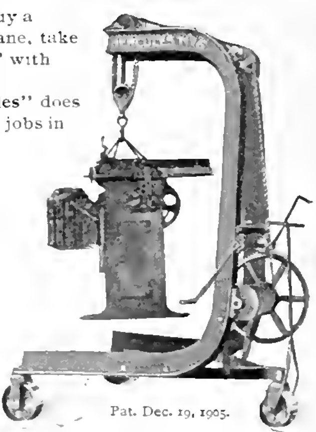
Hercules Portable Crane and Hoist

The Modern Model

When you buy a Portable Crane, take a "**Hercules**" with Steel frame. The "**Hercules**" does all the crane jobs in the quickest, easiest way, with least labor.



Standard Sizes.

Specials to Order.

Circular on request.

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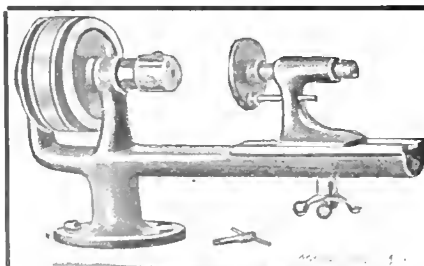
William S. Nicholls, 254 Broadway, New York



The Champion Tapping Machine

Beats them all for light high speed tapping. Taps holes either through or to depth. Capacity up to 1/4" holes; automatic and rapid in operation—saves the taps.

Sent on approval—write to-day

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Every Part of a

SHAW CRANE

is produced by The Shaw Electric Crane Co. This company shoulders ALL the Responsibility—never blames the motor builder or any "other fellow." Hence, the whole crane, every part of it, Must Make Good—and ALWAYS DOES.

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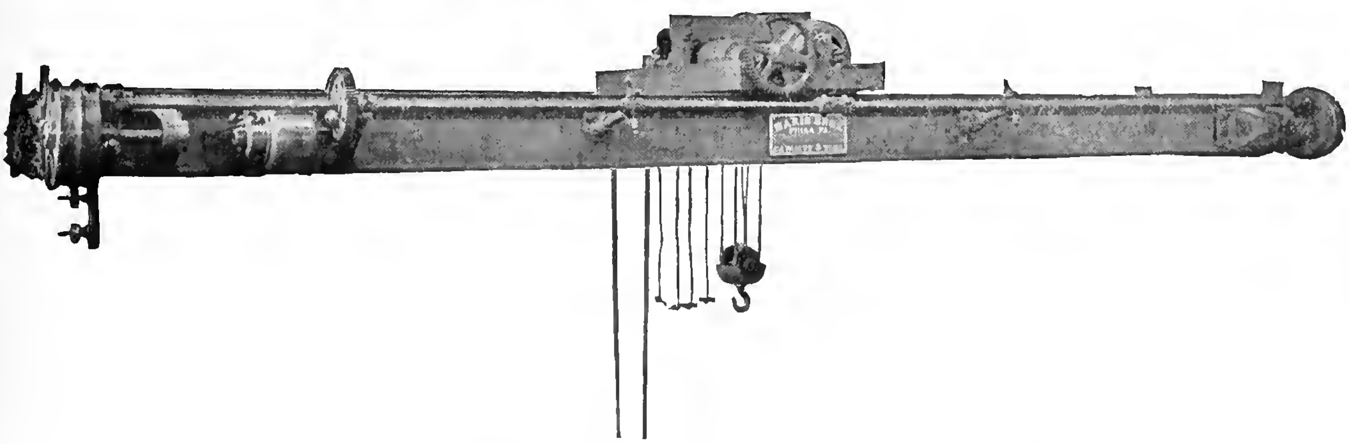

3 tons, 2 motors. Hoist and Bridge motion by power. Trolley motion by hand chain.

A handy crane for erecting floors in machine shops and for all service where loads are to be handled quickly and at low cost. Made with one, two or three motors, for power hoist, power hoist and bridge travel, or power hoist, bridge and trolley travel.

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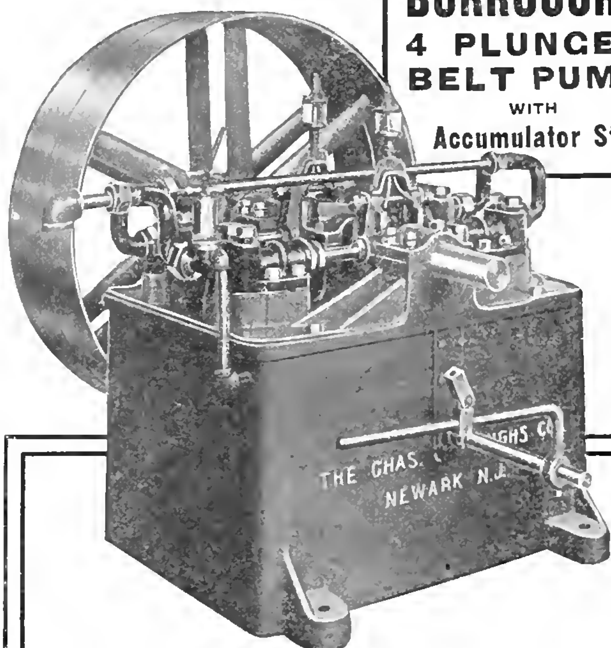
4 PLUNGER
BELT PUMP
WITH
Accumulator Stop



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HYDRAULIC MACHINERY OF EVERY CLASS

We have been 35 years in this line of work and can build machines for all purposes.

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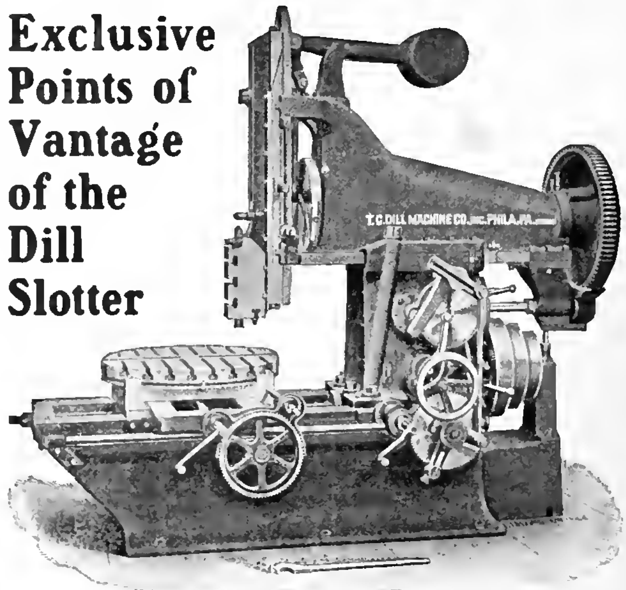
Exclusive Points of Vantage of the Dill Slotter



Traveling Head.	New Intermittent Feed.
Improved Quick Return.	Table Graduated in Degrees.
Quick Traverse Gear.	Hand Wheel Controller.
Wide Range of Speeds.	Tool Post in Relief Apron.

And other features of construction that make it a power for the machine shop.

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The Dill Slotter People
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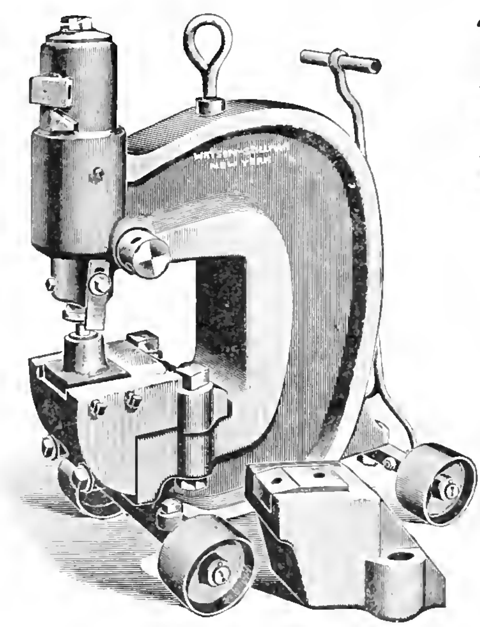

This Watson-Stillman Universal Hydraulic Beam Punch

is adapted for structural work of all kinds, but is particularly useful for punching beam flanges and special shapes, being so constructed that it will punch within three-quarters of an inch of the front of the machine. By the use of a specially designed removable jaw a beam as small as four inches can be punched on the flange.

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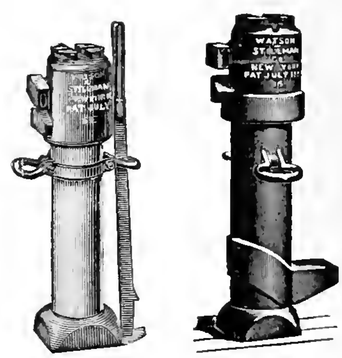
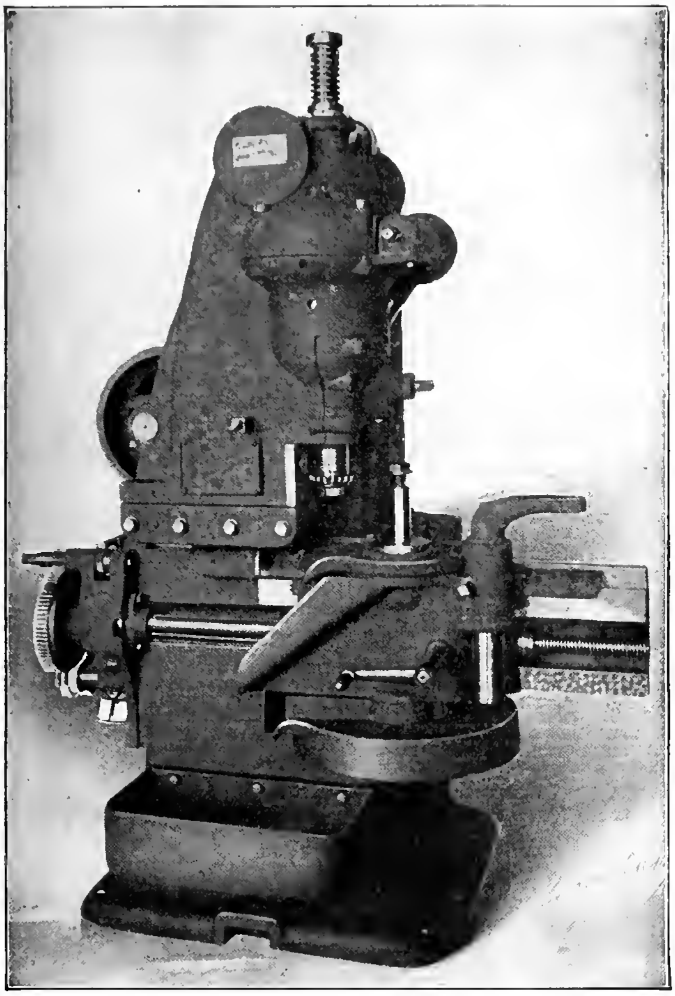


The Watson-Stillman Company
26 Cortlandt St., New York, U. S. A.
CHICAGO OFFICE, 453 ROOKERY

Better Gears at Less Cost.



Not better gearing at increased cost nor poorer gearing at less cost, but a combination of high quality and low cost is the result of using the Gear Shaper.

In no other part of a machine will inferior workmanship be detected so quickly as in the gears, because of the noise of inaccurate gearing. Therefore it is important that you use gearing that is the nearest approach to absolute accuracy of any obtainable, and that without extra cost. Such is the product of the Gear Shaper.

WHY?

1st. The cutter is theoretically correct; it is a generating tool.

2d. The cutter is correct in practice; after being hardened it is ground to the theoretical involute curve.

3d. The cutter has several teeth in operation at once; it travels practically the face of the blank only; the speed steel cutter is practicable even on the finest quality of work, because as stated above, it is ground after it is hardened; the machine is stiff enough in every detail to carry this cutter at speeds and feeds limited only by the endurance of the best speed steels. The above are some reasons why.

4th. Two Gear Shapers will do the work of three rotary type machines, which means a large saving in capital invested, floor space and operators.

In addition to the above, on account of the planing cutter the Gear Shaper will cut a large variety of work impracticable by any other method.

We would cut your gears until the Gear Shaper reached you.

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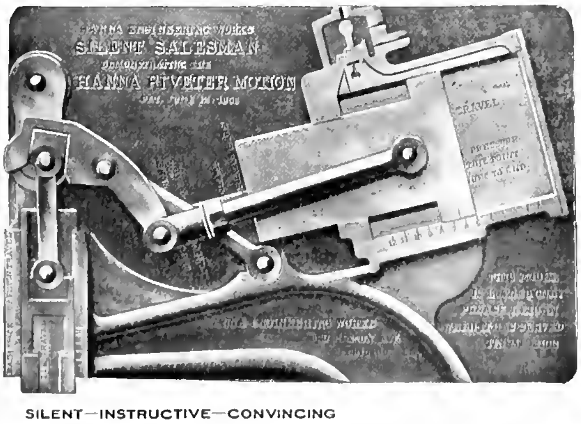

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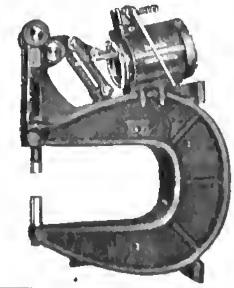
A MOST PLEASING ENTERTAINER
SEND FOR IT

IF IT WASN'T FOR THE

HANNA MOTION

THE HANNA RIVETER WOULD BE NO BETTER THAN ANY OTHER MACHINE

BUT IT IS **THE HANNA MOTION** (A COMBINATION TOGGLE AND LEVER ACTION) WHICH PUTS IT IN A CLASS BY ITSELF DRIVING **TIGHT** RIVETS WITH EVERY STROKE.



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Utmost accuracy of lead screw.
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Gears cut with special cutters.
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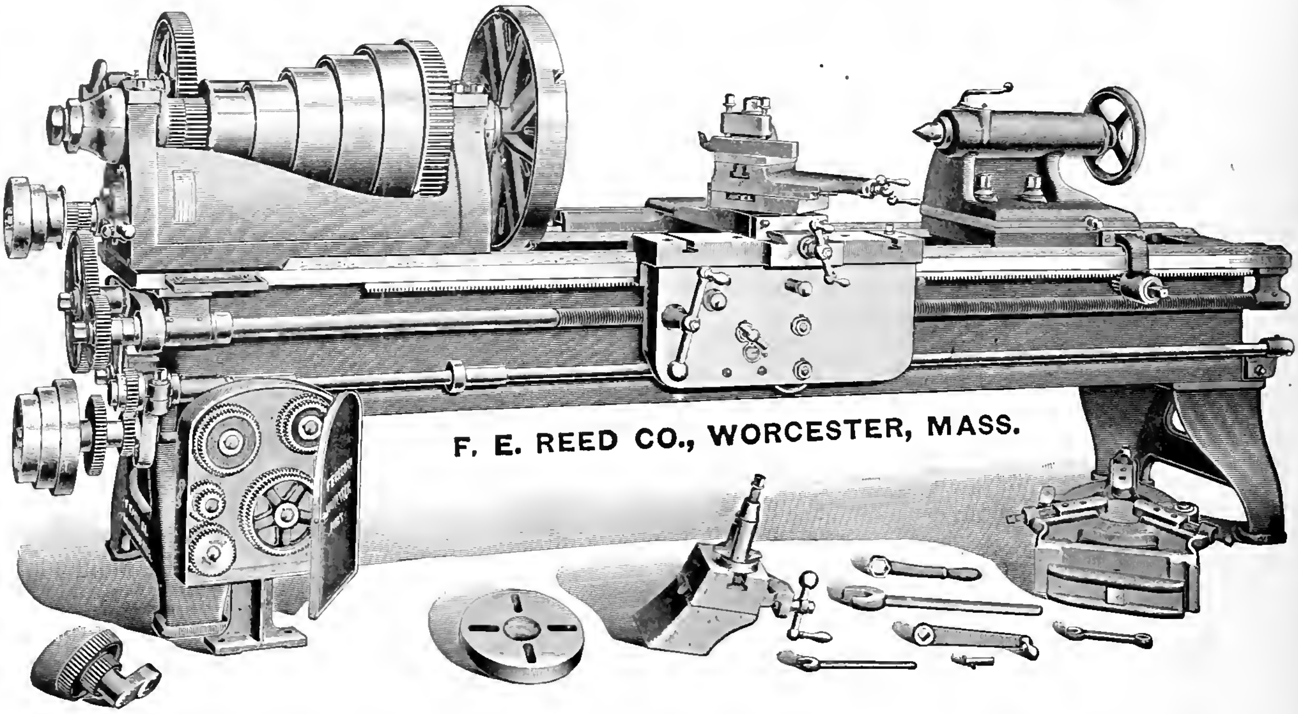
Best of all friction countershafts, etc., etc.



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Lathes 12" to 30".

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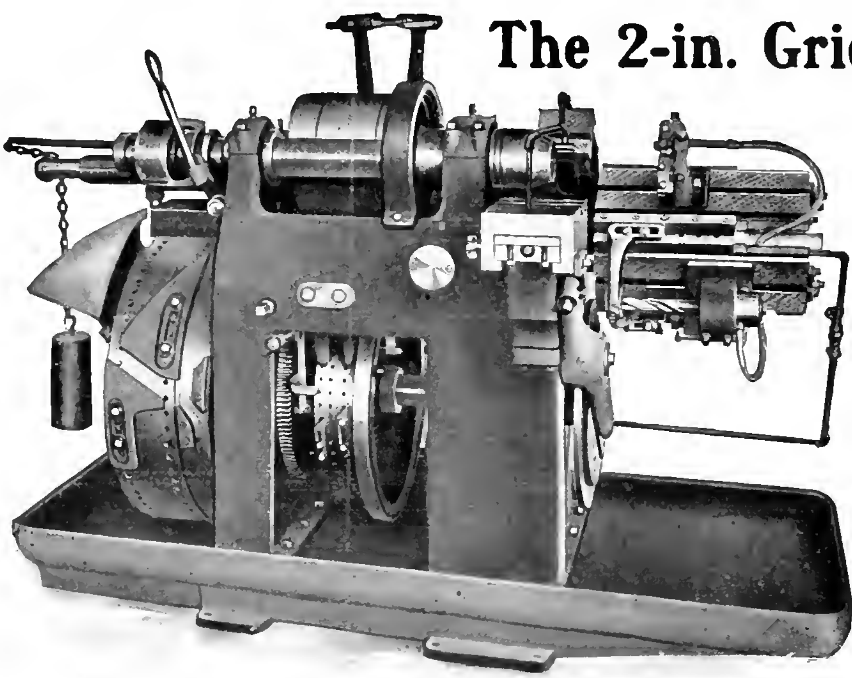
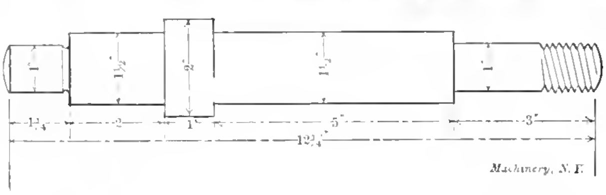
The 2-in. Gridley Automatic Turret Lathe





Does not require an expensive outfit of tools, and it does work twice the length of any other Automatics.

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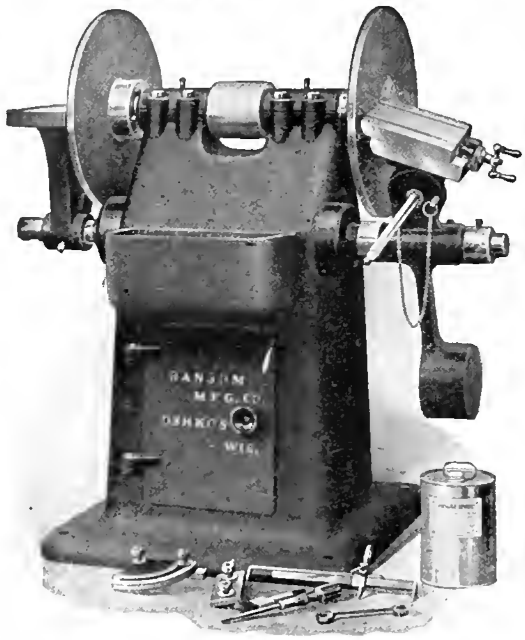

Most people believe that the most expensive machines are the best built. This is usually the case, but the

RANSOM DISC GRINDERS

are an exception, for they take first place with any disc grinder on the market yet sell for less money.

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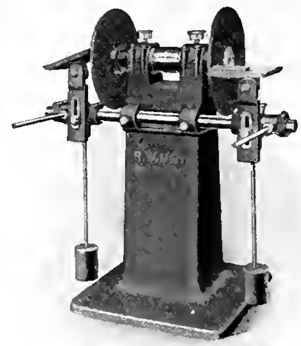


STOP, LOOK, LISTEN–

"OUR GUARANTEE"

The Ney Disk Grinder is the equal of any made, in Cutting Speed. We do not "guarantee" this only, but we *state* it and it's *a fact.*

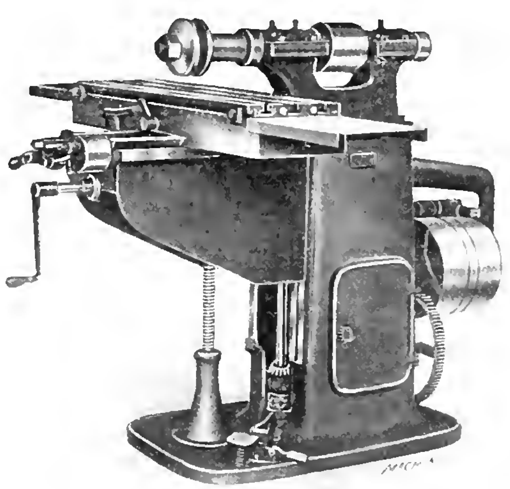
The *ordinary* loose guarantee simply means that if a machine doesn't fulfill the maker's claims you can return it — and try someone else. Now, where do you come in on that?

"OUR" guarantee means that if our machines are not as represented we will send you one that *is* right. Our first complaint is yet to arrive.

PRECISION DISK GRINDERS

ROSCOE W. NEY, Kingston, N.Y.

The Saxon Surface Grinder



When a machine, at a reasonable price and with more than the ordinary capacity, is wanted for finishing flat work accurately and rapidly, this one meets every requirement. It is making an enviable reputation in both manufacturing department and tool room. If it saves money for others isn't it worth your investigation? The price is not its least attractive feature. Why not get it?

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READING New Yankee Drill Grinder ADS

Won't Cut Your Drilling Costs One Cent.

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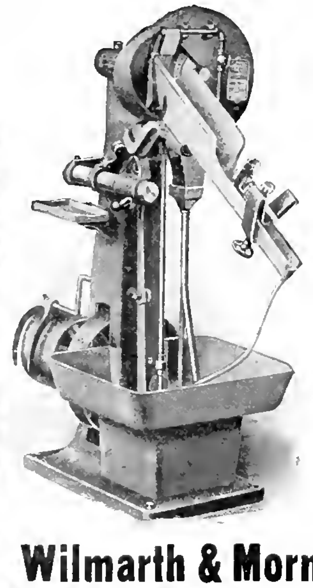
Thousands have done this and now don't have to read our ads to know why these machines save so much in time, work, drills and money.

HERE'S STYLE "F" WET GRINDER



(cap. $\frac{1}{4}$ to $3\frac{1}{2}''$ Drills) One of nearly

50 STYLES

In fact, there isn't a drill in your shop from No. 60 to 5 inches that we cannot furnish a machine to grind right.

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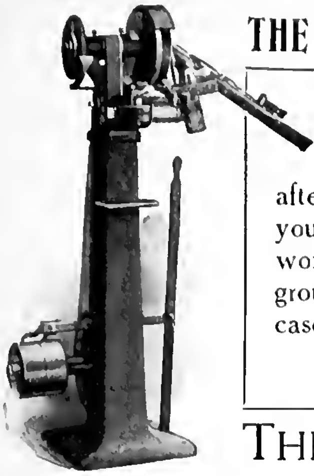
SUBMIT TO US YOUR DRILL GRINDING PROBLEMS

Wilmarth & Morman Co. 580 Canal St. Grand Rapids Michigan



THE ONLY WAY TO KNOW A THING IS RIGHT IS TO TRY IT

Have you tried grinding your Drills on the "American" Drill Grinder? The difference in quantity and quality of output in your drilling department after the hand grinding has been superseded by one of our machines will astonish you. Every drill will cut true and to size, cut faster and do twice as much work before it needs grinding; the shortest and smallest drills can be as easily ground as the larger ones, and a perfect form of drill point is assured in each case. There's economy and convenience in every grinder.

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These wheels are made from pure corundum by the vitrified process, are particularly uniform, durable and the most satisfactory abrasive wheels on the market.

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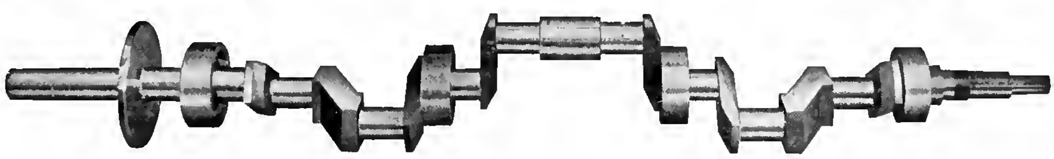

FINISHING MOTOR CRANK SHAFTS BY THE TINDEL SYSTEM OF LATHE AND GRINDING MACHINE

Beyond all comparison the cheapest way to finish motor crank shafts in quantity from the rough forgings, is by the use of the **Tindel-Albrecht Lathe** for rapid cutting down the rough forgings to grinding size and finishing in the **Tindel-Albrecht Special Crank Shaft Grinding Machine.** Cost of installation is less than any other. No accessory fixtures are required. The output is much the largest. The wear of grinding wheels is trifling. The accuracy of the work is unequaled. Write us for particulars.

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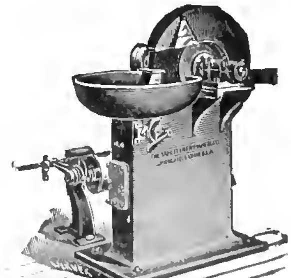

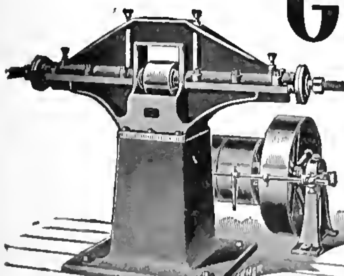

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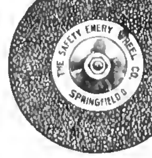

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Sterling Emery and Corundum Wheels

Are made in every grade from the finest to the coarsest.

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Compare an Abrasive Wheel with some other made from the same sizes of corundum. Our wheel is *sharper* than the other. That's because it has never been hammered down in a mould. It is open and porous in composition, no matter how fine the grains are. It's *made* that way by the vitrified process. *It cuts cool.*

Shall we send you one on trial?

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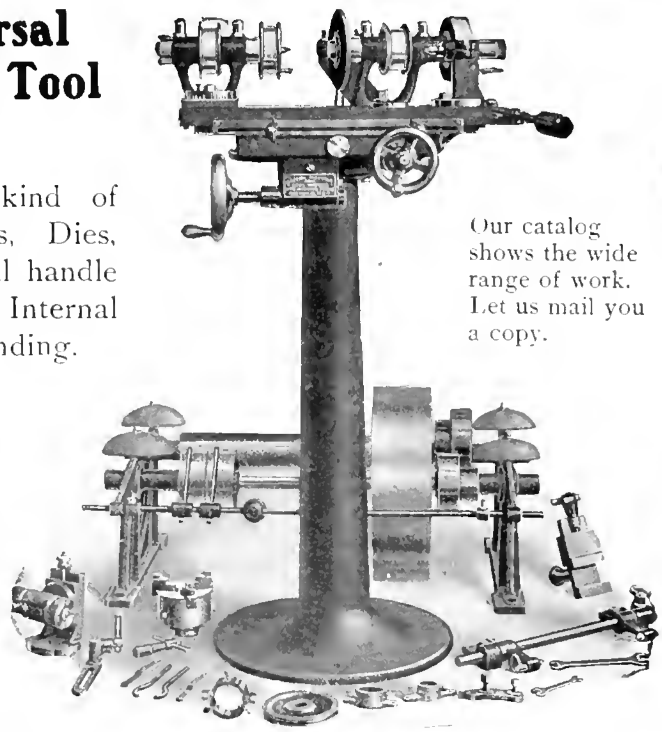
The Universal Cutter and Tool Grinder

Grinds every kind of Cutter, Reamers, Dies, Chasers, and will handle a wide range of Internal and Surface Grinding.



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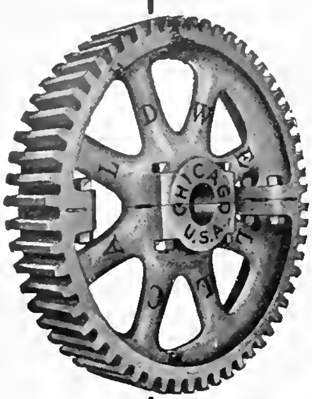

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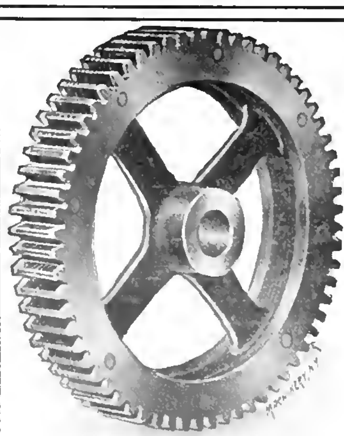

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Adapted for the Severest Service--Noiseless--Satisfactory on every score

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We are also equipped for Gear Cutting in all its branches —Cut Gears, Planed Bevel Gears. Estimates furnished.

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Take the place of weak headed bolts for this work and save enough time on the day's work to almost pay an extra man. It's a simple matter to keep a good supply of studs of various lengths on hand, and with them and the T heads you are always ready. No need to stop to clean out the slots when a job comes off either—put the new piece on and set the T Head Bolts where needed **after** the work is in place. Strong, will not break or injure the slots of the table. If you want to save time, increase your output and keep your men contented, you want to get posted on our T Bolt Heads.

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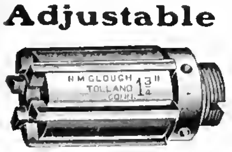

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The construction of this Reamer is such that it is necessary to grind only when dull. There is no uneven clamping with screws, nuts, or any other device. Adjustment made quickly and accurately.

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Steel Bins and Shelves for the Shop, Factory or Stock Room

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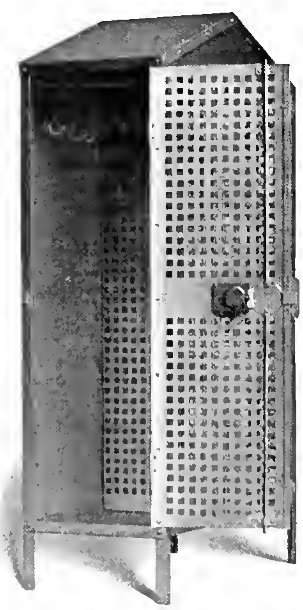

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Flat or pitched roof as preferred. New locking device. Special capacity hooks and round edged shelves.

We make a full line of styles and sizes suitable for shop, office, factory, public buildings—in fact we can fill your locker needs whatever they may be.

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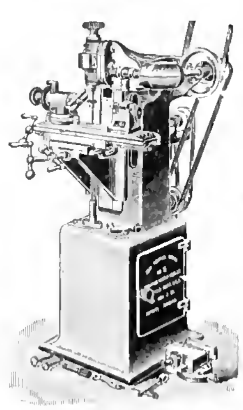

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ONE OF OUR
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make a very complete and valuable outfit for tool room use.

The split collets, arbors, etc., used with this size lathe interchange with those used with the milling machines, and one outfit serves for both.

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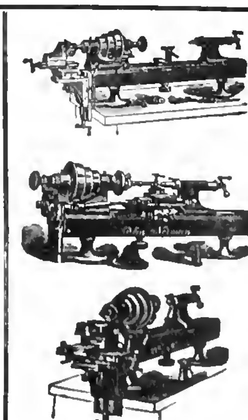

No. 5 Bench Lathe.

SEE OUR TOOL HOLDER AD. PAGE 95.

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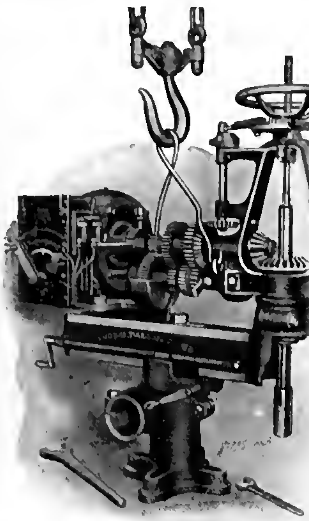

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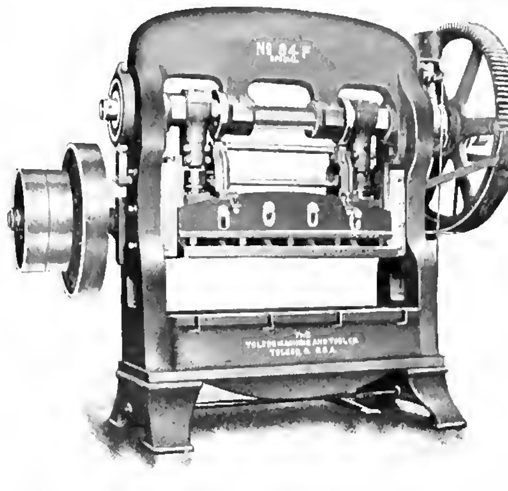

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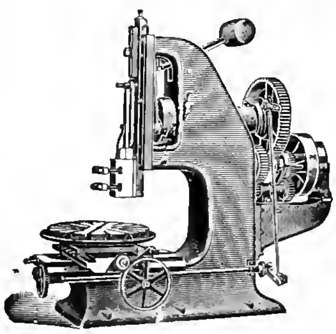
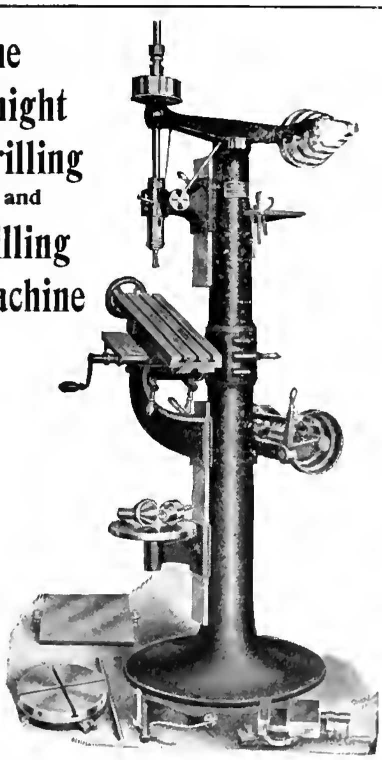


MANUFACTURERS OF

SLOTTERS, PLANERS, LATHES, DRILLS, ETC.

The Knight Drilling and Milling Machine



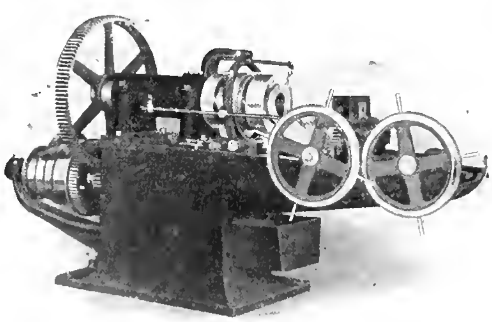
From 20 to 50 per cent. saved in making dies, jigs, cams, models, patterns, and in circular, experimental and tool room work.

Send for catalogue.

MANUFACTURED BY THE

W. B. Knight Machinery Co.
2019--2025 Lucas Ave., ST. LOUIS, MO.

You Can Double Your Capacity



For Threading and Cutting Bolts by Installing

STANDARD BOLT CUTTERS

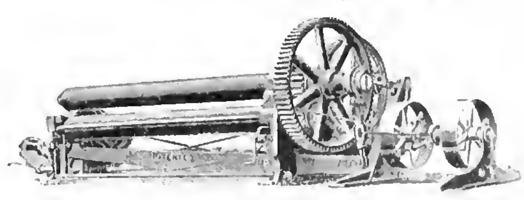
The Standard Head is unequalled for simplicity, durability and accurate product; the dies are adjustable and easily set to cut over or under size; threads cut are equal to lathe work, and once started a Standard Bolt Cutter looks after itself.

Catalogue?

Standard Machinery Co.
BOWLING GREEN, OHIO

Complete Index to
Machinery's Data Sheets
will be sent on request.
The Industrial Press, 49-55 Lafayette St., New York

10-ft. BENDING ROLL



This Bending Roll can be opened, the formed shell removed and the machine closed automatically by means of our Patented Opening Device, by one man, in less time than is required for opening alone on any other machine. It is built with Motor, Engine or Belt drive.

We build a complete line of **Shears, Punches and Bending Rolls** all sizes, hand or power drive.

BERTSCH & CO., Cambridge City, Ind.

Standard Engine Lathes

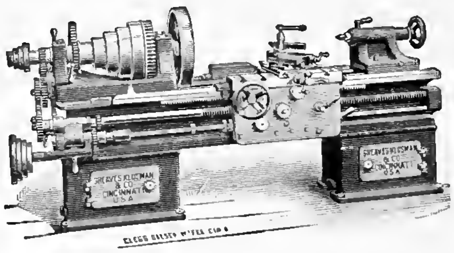
16 to 24 inch Swing

Built by

Greaves, Klusman & Co.

S. E. Cor. Cook & Alfred Sts.

CINCINNATI, OHIO, U. S. A.



Also Builders of Pattern Makers' Lathes and Machinery and Metal Spinners' Lathes

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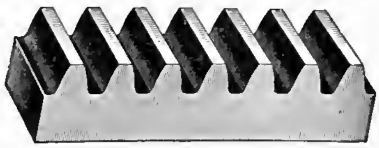
WE MANUFACTURE SHAPERS

EXCLUSIVELY.

12 TO 32 INCH STROKE.

SMITH & MILLS,

Cincinnati, Ohio, U. S. A.



DELAY IS SUCH A BUSY RASCAL

ACCURACY

FINISH

PRICE

Are our

CARDINAL POINTS

ELIMINATE CHANCE INTRODUCE SCIENCE

WRITE US TODAY ABOUT

YOUR RACK

It will cost you real money

To turn this down

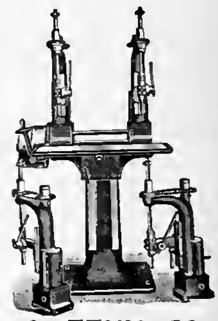
Standard Gauge Steel Co., Beaver Falls, Pa., U.S.A.

Pacific Tool & Supply Co., San Francisco, Cal. Seattle Hardware Co., Seattle, Wash.

Hall & Pickles, 64 Port St., Manchester, England.

Mighty handy for jig work

Our Manufacturers' Drill has adjustable top columns, three changes of speed for each spindle entirely independent of each other, lots of power, positive drive, quick changes of speed and plenty more good features which we can't tell about here. Get the catalog.



1 to 6 SPINDLES

THE TAYLOR & FENN CO.

Hartford, Conn., U. S. A.

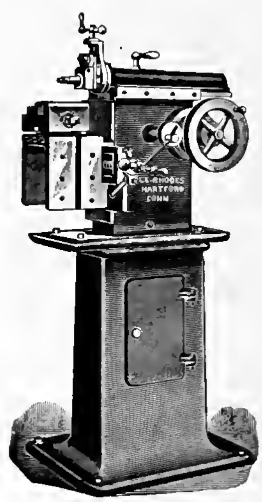
We Want to do Your Machine Work

Our Specialties include: Boiler, Tank and Sheet Iron Work, Patterns, Copper Work, Pipe Bending and Blacksmithing

Skinner Ship Building & Dry Dock Company, Baltimore, Md.

A LITTLE SHAPER

FOR YOUR LIGHTER WORK



All the essential features of the high priced machines are incorporated in the

RHODES

7 in. Crank Shaper,

and it will take care of small tool, die, model and light shaper work in general, quickly and accurately. Micrometer adjustment on both screws; quick adjusting vise.

Can be used as a bench machine when desired.

Circulars on request.

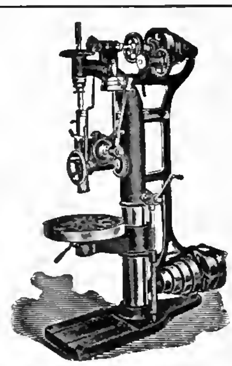
L. E. Rhodes

Hartford, Conn.

A Good Drill Press is a Tool of Many Uses.

A SIBLEY DRILL in your shop is rarely idle. With proper jigs these machines will accomplish a very large amount of work at a very low labor cost. They are rapid, accurate, have a wide range, are adapted for light or heavy work as occasion requires, and are fitted with all the latest improvements.

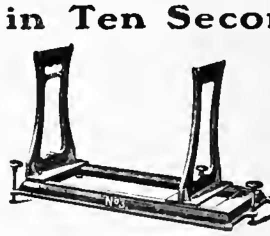
Write for Catalogue showing Styles and Sizes of Power Drills.



Sibley Machine Tool Co., South Bend, Ind.

Successors to Sibley & Ware.

An Absolute Level in Ten Seconds



Compare this with the old way—ten to twenty minutes saved, and results certain.

Bowsher's Patent Balancing Way

Is the New Way

Made in 3 sizes and styles, for bench and floor use. Ways chilled and ground, spirit levels attached.

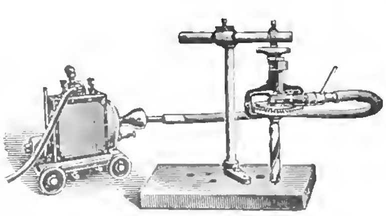
Circular "BW" for details.

The N. P. BOWSHER CO.

South Bend, Ind.

Fenwick Freres & Co., Agents, Paris.

The Stow Flexible Shaft



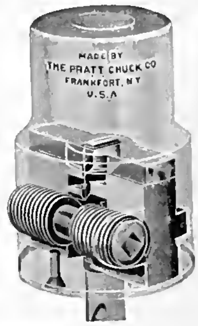
offers a way of substituting the quick, cheap and accurate work of special light machinery for the slow and costly hand labor that is still found in many shops. If your men are drilling, reaming, tapping, grinding, or polishing work by hand, you are losing money needlessly.

Send for our Catalog

Stow Flexible Shaft Co., Philadelphia, Pa.

HIGH SPEED DRILLING AND PRATT CHUCKS

Are bracketed together in the minds of most machinists, because the Pratt is so essentially the chuck for rapid work. Its construction makes slipping impossible and permits the operator to give his whole mind to the speed and accuracy of the work. It is at once simple, practical and durable, and not only holds the tool firmly but holds it without injuring the shank—adapted for every kind of drilling. All wearing parts of tool steel carefully tempered. *Catalogue on request.*



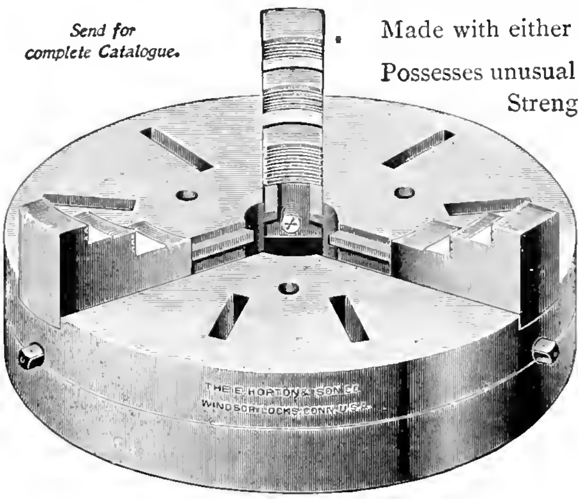
The Pratt Chuck Company, Frankfort, N. Y.

European Agents: Selig, Sonnenthal & Co., 85 Queen Victoria Street, London, England.

New Chuck. Heavy Universal, Three Jaws

18 INCH AND UPWARDS.

Send for complete Catalogue.



Made with either three or four Jaws.

Possesses unusual Power, Rigidity Weight and Strength.

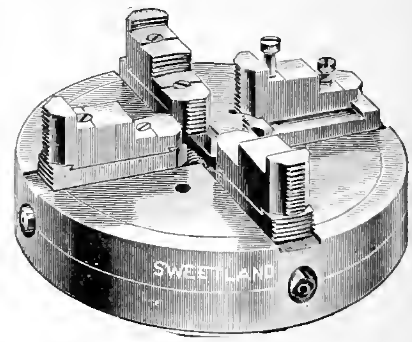
Built to withstand the severest strain.

Corresponds with Modern Machine Tools.

We are Specialists, and make nothing but Chucks.

The E. Horton & Son Company, Windsor Locks, Conn., U.S.A.

SWEETLAND CHUCKS



SWEETLAND CHUCK No. 4

WITH REVERSIBLE JAWS

Adapted for a wide range of work. Screws relieved of all strain, all the advantages of a solid jaw.

ACCURATE, SIMPLE, STRONG AND DURABLE

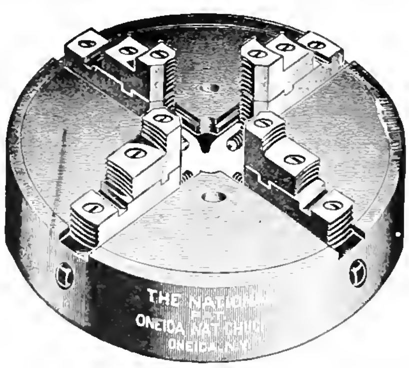
CATALOG ON REQUEST.

THE HOGGSON & PETTIS MFG. CO.

NEW HAVEN, CONN., U. S. A.

NEW YORK OFFICE: 107 LIBERTY ST.

National Improved Combination and Universal Lathe Chuck, 3 or 4 Jaws

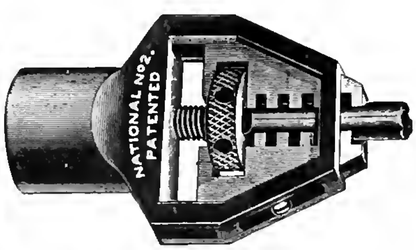


THE STRONGEST GEAR LATHE CHUCK MADE

Send for Catalogue.

National Drill Chuck

HAS NO EQUAL



Made Entirely of Steel

DOES NOT GET OUT OF ORDER

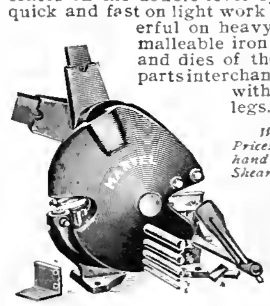
If you have a dirty job try it. Money refunded if not satisfied.

ONEIDA NATIONAL CHUCK COMPANY, ONEIDA, N. Y.

The MARVEL Combined Punch and Shear

Built Like a Machine Tool

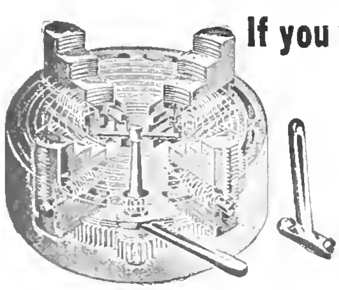
The handiest tool of its kind for the machine shop. Clips bolts and rods from 1/8 to 3/4 inch without crushing or marring. Cuts up to 1/2 x 2 inches flat; cuts angle iron up to 1/4 x 2 x 2 inches. It punches 3/8 hole in 3/8-inch iron and 1/2 hole in 1/4-inch iron. The **MARVEL** operates on the double lever system, making it quick and fast on light work and doubly powerful on heavy work. Made of malleable iron; blades, punches and dies of the best steel. All parts interchangeable. Equipped with or without iron legs.



Write for Circular and Prices of this and other hand operated Punches and Shears.

ARMSTRONG-BLUM MFG. CO.
113 N. Francisco Ave.
Chicago, U. S. A.

If you want the best Lathe and Drill Chucks—buy Westcott's



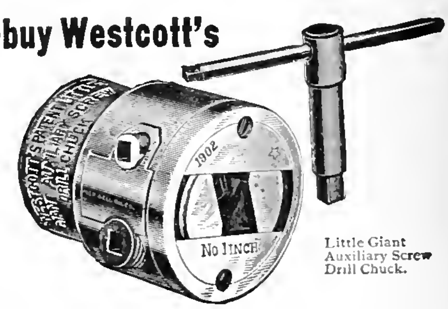
Spur Geared Scroll Combination Lathe Chuck.

Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Geared Combination Lathe Chucks, Geared Universal Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.

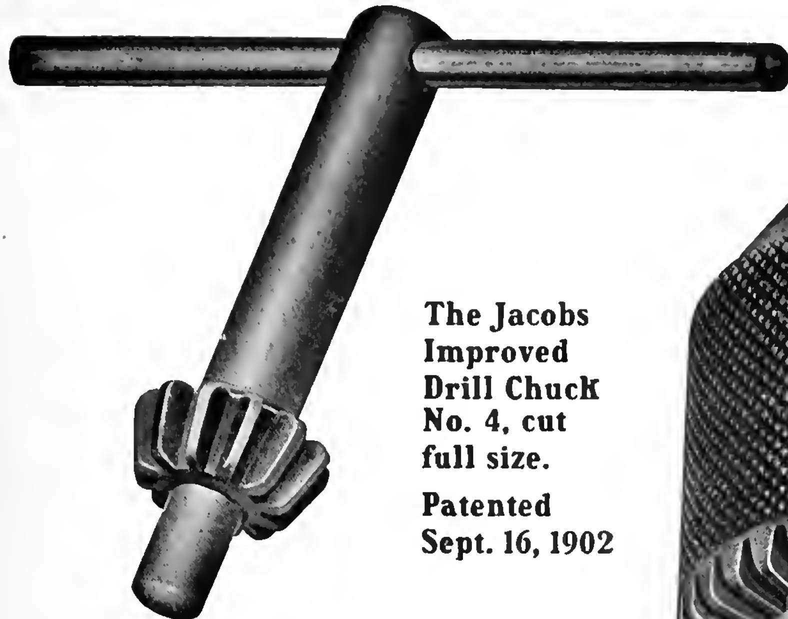
Strongest Grip, Greatest Capacity, Great Durability, Accurate.

WESTCOTT CHUCK CO., Oneida, N.Y., U.S.A.

Ask for catalogue in English, French, Spanish or German.



Little Giant Auxiliary Screw Drill Chuck.



The Jacobs
Improved
Drill Chuck
No. 4, cut
full size.

Patented
Sept. 16, 1902

The Five Sizes Jacobs Drill Chuck

Now on the market cover all requirements between very fine, small work, for which the No. 1 Chuck is designed, and work that requires a chuck with capacity up to one inch—

Get the One You Need

The "Jacobs" meets the demand for a chuck which is at once strong, accurate, effective and convenient to operate.

The toothed sleeve and key—its distinguishing feature—saves time, patience, tools. Any one can adjust it—there is no twisting of the spindle when tightening the tool, no slipping when the tool is in place—and no need for a man to have *three* hands to do the trick.

Write for our book—tells all about it.

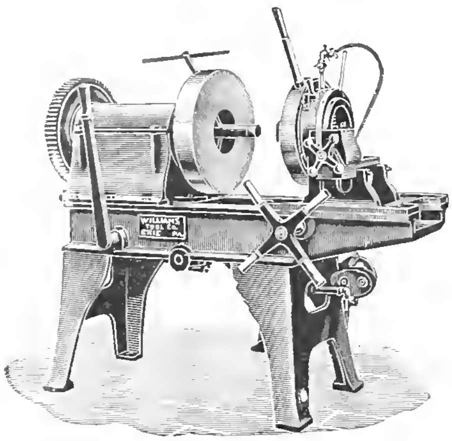
The Jacobs Manufacturing Co.

Hartford, Connecticut

U. S. A.

Williams Pipe Machine

Seven Sizes. Capacity from ¼" to 12"



Our line of Pipe Cutting Machines is complete, built from new designs, strong, durable, rapid and convenient. The No. 3 machine cuts from 1½" to 6" pipe, has quick opening adjustable dies and six speed changes without changing a gear.

Write for Prices.

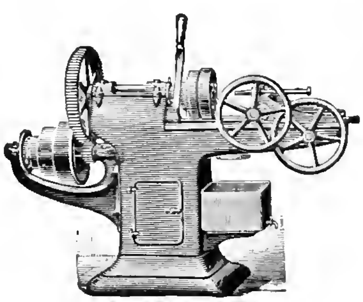
WILLIAMS TOOL CO., ERIE, PA.

UNIFORMITY OF PRODUCT

CAN BE DEPENDED ON WITH THE

Merriman Bolt Cutter

Bolts are all the same size and equally well finished.



This machine is distinguished by the very simple construction of the Head—which has but four parts—its durability and the few repairs needed. The square bearing of the dies in the ring gives them all the advantages of solid dies. The Merriman machine is very rapid and can be run by an unskilled operator.

Catalogue No. 11 gives full details

THE H. B BROWN COMPANY
Box B, East Hampton
Connecticut

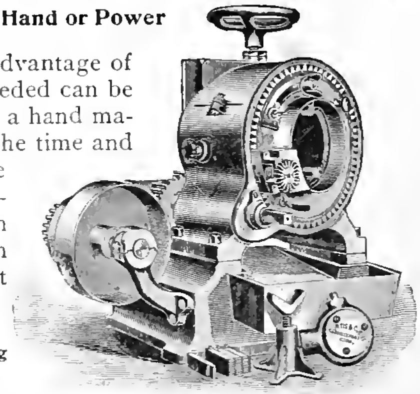
The Shop Operation Sheets

This series began with the May issue. Begin your subscription with that number.

MACHINERY, - ALL EDITIONS.

The Forbes Patent Die Stock

As Arranged for Hand or Power

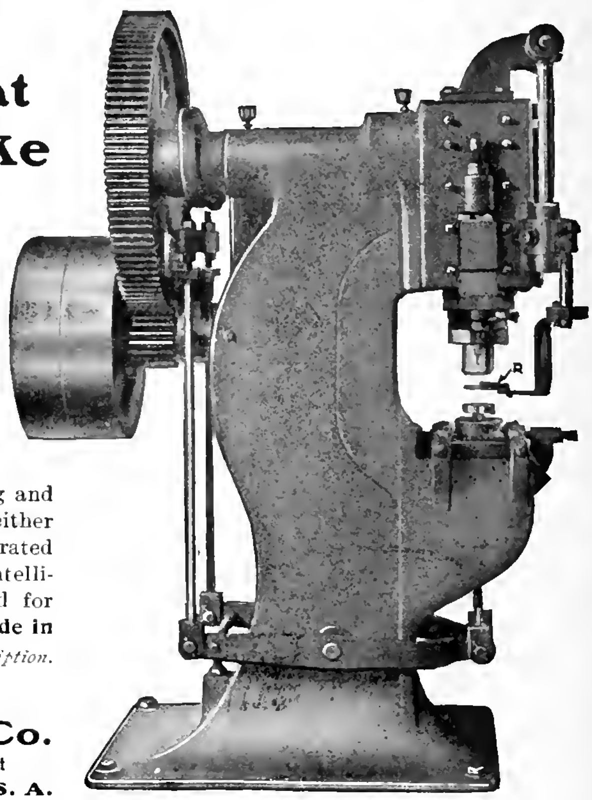


This machine has the double advantage of being a power machine, or when needed can be removed from the base and used as a hand machine on outside work. It has all the time and labor saving features for which the "Curtis" is noted, is complete in itself, especially valuable for work in cramped quarters, has a range from 2½" to 4", and a patent adjustment of shell by which wear is taken up.

Catalogue shows our full line of Pipe Cutting and Threading Machinery. Send for a copy.

The Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn.
New York Office, 60 Centre Street.

Cuts and Punches at One Stroke



This new Punching Machine is adapted for cutting and punching of almost every kind, but is especially valuable for making washers from scrap plate metals or fibre, and for cutting armature discs, hardware and electrical specialties from hard or soft metal.

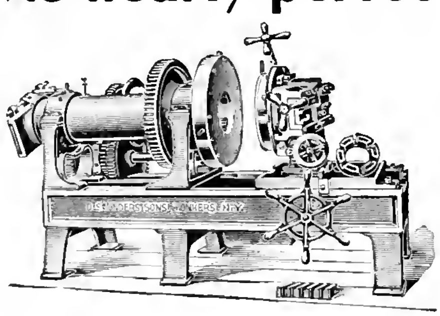
It is very rapid, cutting and punching at one stroke, either single or multiple; can be operated by any person of ordinary intelligence, and can be arranged for shearing when desired. **Made in four sizes.** *Write for full description.*

Krips-Mason Machine Co.
1636 North Hutchinson Street
Philadelphia, Pa., U. S. A.

As nearly perfect as can be made

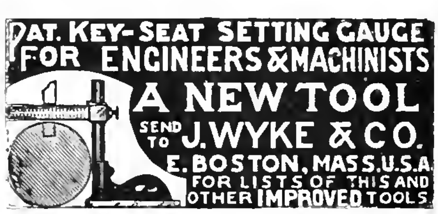
is what we claim for our

Pipe Threading and Cutting Machinery



These machines are the result of forty years' practical experience in this line of manufacture, and are unsurpassed for efficiency of operation and quality of workmanship. May we send you our catalogue?

D. Saunders' Sons, Yonkers, N. Y.



The Elgin Tool Works

BUILDERS OF

Light, High Grade Machinery and Tools
Watch Machinery a Specialty

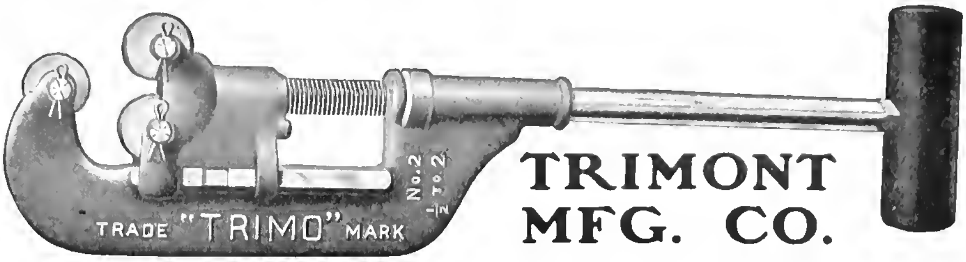
ELGIN, - ILLINOIS

"TRIMO" Pipe Cutter

Combination 1 and 3 Wheel

GOLD MEDAL
ST. LOUIS 1904

No thread in frame or roll block to wear out. Case hardened nut used instead.

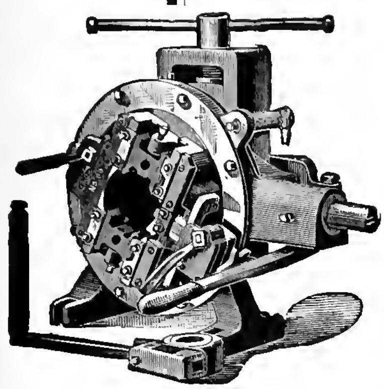


TRIMONT MFG. CO.

Interchangeable and guaranteed

New Catalogue No. 38 sent free

55 to 71 Amory St.
ROXBURY, MASS., U. S. A.



Take the Machine to the Work

If it isn't convenient to bring the work to the machine.

All sizes of Armstrong Pipe Cutting and Threading Machines up to 4 inches are portable and can be easily moved to the work outside or inside the shop.

All sizes, even the 6-inch machine can be turned by hand when power is not available.

Catalogues and prices on application.

The Armstrong Mfg. Co.,

297 Knowlton Street, Bridgeport, Conn.

Chicago Office, 23 South Canal Street.

Pipe Threaders and Cutters

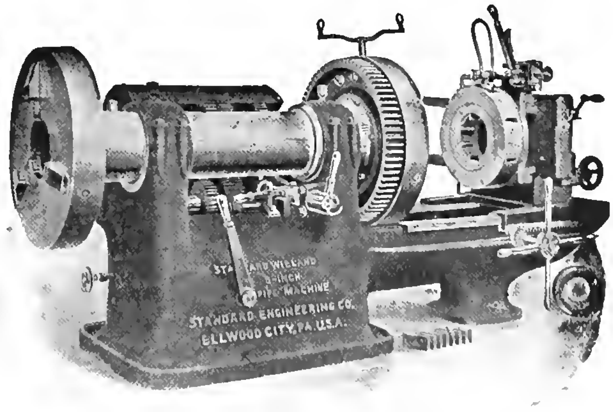
With efficiency as well as beauty.

Heavy—none more so; bed cast in one piece, no stands nor legs to work loose No oil soaked floors; fire risk reduced.

Single speed pulley; all-gear speed changes through semi-steel cut gears.

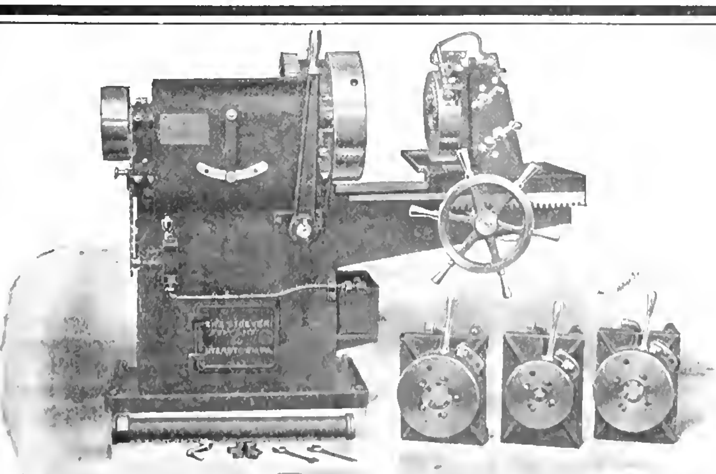
Deep chasers cutting long taper perfect threads in one cut as easily on steel as on iron pipe.

Let us prove to you that the higher cost for a modern tool is justified by the character and quantity of its product. Circulars for the asking.



Standard Engineering Co.,
Ellwood City, Penna.

St. Louis Office: 1012 Chemical Bldg.



HERE IS A

PIPE THREADING MACHINE

that has been designed to get work out quickly. One that can be changed rapidly from one size of pipe to another. One that is durable, stiff and heavy. For small pipe from 1/4 in. to 2 in.

Read the description of this machine in this issue and send for a circular.

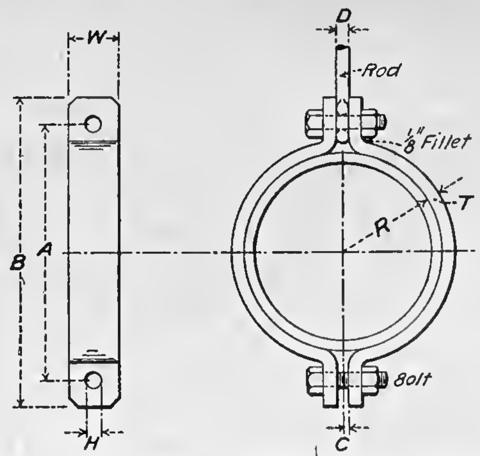
The Stoever Foundry & Mfg. Co.

MYERSTOWN, PA

CREASE HERE

PIPE CLAMPS AND HANGERS.—II.

Contributed by L. S. Richardson.



Pipe Clamps
Vertical Type.

All dimensions in inches

For all Clamps

Size of Pipe	C	D	H	T	W	Size of Bolt
4	1/2	3/4	1	3/8	1 3/4	7/8 x 3
4 1/2	1/2	3/4	1	3/8	1 3/4	7/8 x 3
5	1/2	3/4	1	3/8	2	7/8 x 3
6	1/2	3/4	1	3/8	2	7/8 x 3
7	1/2	3/4	1	3/8	2	7/8 x 3
8	9/16	7/8	1 1/8	7/16	2	1 x 3 1/2
9	9/16	7/8	1 1/8	7/16	2 1/4	1 x 3 1/2
10	9/16	7/8	1 1/8	7/16	2 1/4	1 x 3 1/2
12	5/8	1	1 1/4	1/2	2 1/2	1 1/8 x 4
14 15 O.D.	5/8	1	1 1/4	1/2	2 1/2	1 1/8 x 4
15 16 O.D.	5/8	1	1 1/4	1/2	2 1/2	1 1/8 x 4
16 17 O.D.	5/8	1	1 1/4	1/2	2 1/2	1 1/8 x 4

For Pipe Clamps

Size of Pipe	A	B	R
4	7 3/8	9 7/8	2 1/4
4 1/2	7 7/8	10 3/8	2 1/2
5	8 1/2	11	2 13/16
6	9 1/2	12	3 5/16
7	10 1/2	13	3 13/16
8	11 7/8	14 5/8	4 5/16
9	12 7/8	15 5/8	4 13/16
10	14	16 3/4	5 3/8
12	16 3/8	19 3/8	6 3/8
14 15 O.D.	18 5/8	21 5/8	7 1/2
15 16 O.D.	19 5/8	22 5/8	8
16 17 O.D.	20 5/8	23 5/8	8 1/2

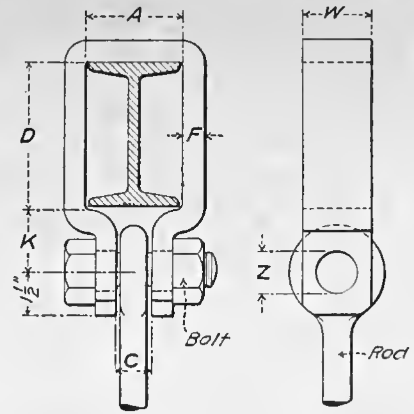
For Fitting Clamps

Size of Pipe	A	B	R
4	8 5/8	11 1/8	2 7/8
4 1/2	9 1/8	11 5/8	3 1/8
5	9 5/8	12 1/8	3 3/8
6	10 3/4	13 1/4	3 15/16
7	11 3/4	14 1/4	4 7/16
8	13 1/4	16	5
9	14 1/4	17	5 1/2
10	15 3/8	18 1/8	6 1/16
12	18 1/8	21 1/8	7 1/4
14 15 O.D.	20 3/8	23 3/8	8 3/8
15 16 O.D.	21 1/2	24 1/2	8 15/16
16 17 O.D.	22 5/8	25 5/8	9 1/2

CREASE HERE

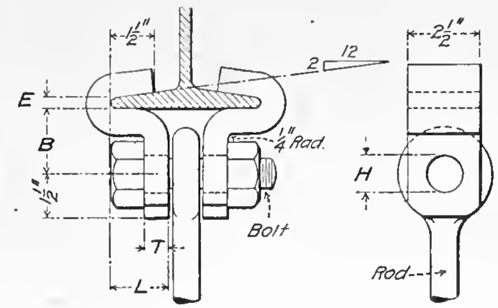
PIPE CLAMPS AND HANGERS.—I.

Contributed by L. S. Richardson.



Size of Rod	C	Z	F	W	K	Size of Bolt
3/4	7/8	1	1/2	2	1 5/8	7/8 x 3 1/4
7/8	1	1 1/8	5/8	2 1/4	1 7/8	1 x 3 3/4
1	1 1/8	1 1/4	3/4	2 1/2	2 1/8	1 1/8 x 4 1/4

Size of Beam	A	D
3	2 3/4	3 1/8
4	3 1/8	4 1/8
5	3 1/2	5 1/8
6	3 3/4	6 1/8
7	4	7 1/8



Loads Based on fibre stress of 12,000 pounds for wrought iron	
3/4 Rod	3500
7/8 Rod	5000
1 Rod	6500

All dimensions in inches
All loads in pounds

I Beam Clamps

Size of Rod	T	B	H	Size of Bolt
3/4	5/8	1 3/4	1	7/8 x 3 3/4
7/8	3/4	2	1 1/8	1 x 4 1/4
1	7/8	2 1/4	1 1/4	1 1/8 x 4 3/4

Size of Rod		Size of Beam							
		8	9	10	12	15	18	20	24
All Rods	E	5/16	5/16	5/16	3/8	7/8	1/2	9/16	5/8
3/4	L	1 9/16	1 3/4	1 7/8	2 1/16	2 5/16	2 9/16	2 11/16	3 1/16
7/8	L	1 1/2	1 11/16	1 13/16	2	2 1/4	2 1/2	2 5/8	3
1	L	1 7/16	1 5/8	1 3/4	1 15/16	2 3/16	2 7/16	2 9/16	2 15/16

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

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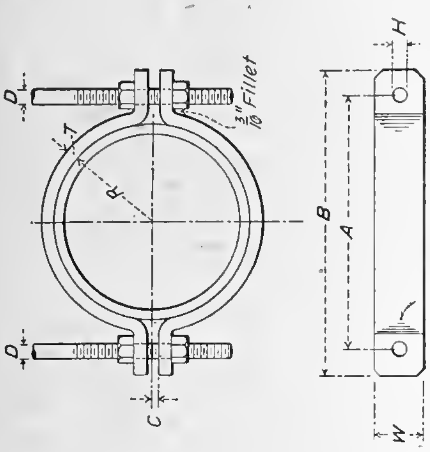
PIPE CLAMPS AND HANGERS.—III.



Pipe Clamps
Horizontal Type

All dimensions in inches

For all Clamps						For Pipe Clamps				For Fitting Clamps			
Size of Pipe	C	D	H	T	W	Size of Pipe	A	B	R	Size of Pipe	A	B	R
4	3/16	3/4	7/8	3/4	1 3/4	4	8	10 1/4	2 1/4	4	9 1/4	11 1/4	2 7/8
4 1/2	3/16	3/4	7/8	3/4	1 3/4	4 1/2	8 1/2	10 3/4	2 1/2	4 1/2	9 3/4	12 1/4	3 1/8
5	3/16	3/4	7/8	3/4	2	5	9 1/8	11 3/8	2 13/16	5	10 1/4	12 3/4	3 3/8
6	1/4	3/4	7/8	3/4	2	6	10 1/8	12 3/8	3 5/16	6	11 3/8	13 7/8	3 15/16
7	1/4	3/4	7/8	3/4	2	7	11 1/8	13 3/8	3 13/16	7	12 3/8	14 7/8	4 7/16
8	1/4	3/4	7/8	3/4	2	8	12 1/8	14 3/8	4 5/16	8	13 1/2	16	5
9	1/4	3/4	7/8	3/4	2 1/4	9	13 1/8	15 3/8	4 13/16	9	14 1/2	17	5 1/2
10	1/4	3/4	7/8	3/4	2 1/4	10	14 1/4	16 1/2	5 3/8	10	15 5/8	18 1/8	6 1/16
12	5/16	7/8	1	1	2 1/2	12	17	19 1/2	6 3/8	12	18 3/4	21 1/2	7 1/4
14 15 O.D.	5/16	7/8	1	1	2 1/2	14 15 O.D.	19 1/4	21 3/4	7 1/2	14 15 O.D.	21	23 3/4	8 3/8
15 16 O.D.	5/16	7/8	1	1	2 1/2	15 16 O.D.	20 1/4	22 3/4	8	15 16 O.D.	22 1/8	24 7/8	8 15/16
16 17 O.D.	5/16	7/8	1	1	2 1/2	16 17 O.D.	21 1/4	23 3/4	8 1/2	16 17 O.D.	23 1/4	26	9 1/2

Contributed by L. S. Richardson.

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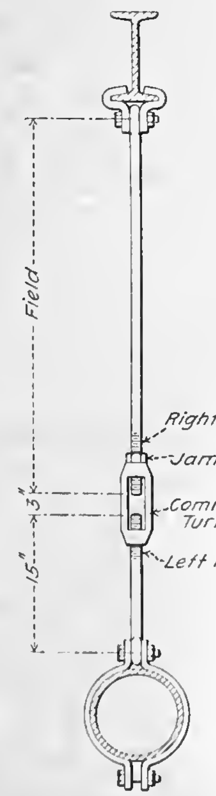
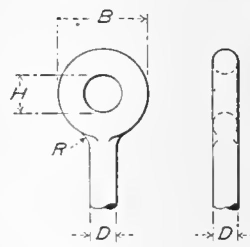
PIPE CLAMPS AND HANGERS.—IV.

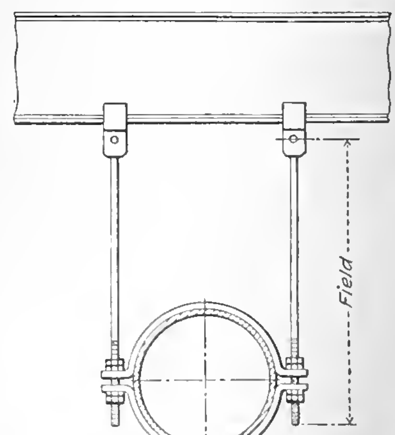


Vertical Type



Detail of Eye Bolt End

Size of Rod (D)	B	H	R
3/4	2 1/2	1	1
7/8	2 7/8	1 1/8	1 1/8
1	3 1/4	1 1/4	1 1/4



Horizontal Type

All dimensions in inches

The size of the rod is determined by the size of the pipe. See tables II and III.
The size of the beam clamp is determined by the size of the beam and the size of the rod. See table I.
For the vertical type make the lower rod 15 inches long with left hand thread. These can be made up in lots and be carried in stock.
Upper rod to have right hand thread and one jam nut. Determine length of rod in field.
Use commercial turnbuckles.
Figure clearance between upper and lower rods as about 3 inches.
Rods are not upset at ends. Make threads 6 inches long. Horizontal type rods to have 4 nuts each, right hand thread. Determine length of rod in field.

Contributed by L. S. Richardson.

MACHINERY.

October, 1907.

VANADIUM STEEL.*

THE CHARACTERISTICS OF A NEW STEEL FOR MACHINE CONSTRUCTION.

E. F. LAKE.†

Among the many new alloy steels which have been brought out in the last few years, the vanadium steels are probably the latest addition which steel makers have adopted, and this has been done after many experiments had been made. This steel, in many different percentages of alloy, has been given numerous tests of many different characters in order to determine the qualities of the steel and its action when submitted to the various strains and stresses it is liable to meet when put into actual use. These tests would seem to place it in the front rank of high-grade alloy steels, although it will be, after all, the actual use of it for the moving parts of machinery and other purposes that will demonstrate to a certainty its wearing qualities, as well as its ability to withstand strains and stresses.

strains applied in a totally different manner to that under which it was tested by simply pulling a bar until it broke.

In machine construction, those parts which are liable to failure while in use require high dynamic qualities, that is, resistance to repeated stresses, alternating stresses, simple repeated, or alternating impacts, and fatigue, the latter being the outward and visible sign of the inter-molecular vibratory deterioration.

Thus a new field is being opened out, and while vanadium affects steel in a manner that tends to increase the static strengths of other alloys, it also raises the dynamic properties to an extent that is not thought of in other alloys. It is here that vanadium gives an added value to the high grade alloy steels.

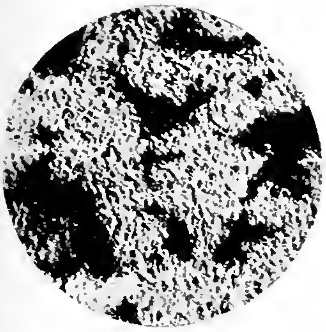


Fig. 1. Carbon Axle Steel, magnified 350 Diameters. Heat Treatment, Normal.

Fig. 2. Nickel Axle Steel, magnified 350 Diameters. Heat Treatment, Normal.

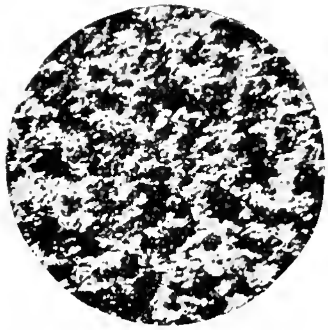


Fig. 3. Vanadium Axle Steel, magnified 350 Diameters. Heat Treatment, Normal.

Fig. 4. Vanadium Axle Steel, magnified 350 Diameters. Heat Treatment, Normal.

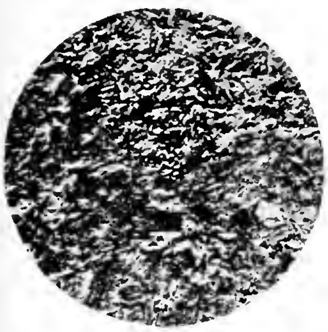


Fig. 5. Vanadium Crank-shaft Steel, magnified 350 Diameters. Heat Treatment: Quenched from 1650 deg. F. and Annealed at 1000 deg. F. for one hour.

Fig. 6. Vanadium Crank-shaft Steel, magnified and Treated same as Sample in Fig. 5.

Fig. 7. Vanadium Mesh-gear Steel, magnified 350 Diameters. Heat Treatment: Quenched from 1750 deg. F. in Lard Oil; Annealed at 675 deg. F. for one-half hour in Lead Bath; Cooled in Air.

Fig. 8. Vanadium Mesh-gear Steel, magnified and Treated the same as Sample in Fig. 7. In both samples Undecomposed Martensite is noticeable.

As manufacturers are beginning to use this steel for different purposes, the positive proof will be forthcoming in the very near future, if it has not already been obtained by those who are using it.

The mechanical engineers of the present day have been forced to become better metallurgists than they ever were in the past, in order to intelligently design high-grade machinery, as the, so-called, mysterious failures of steels are becoming more numerous and more pronounced every day.

These, so-called, mysterious failures of steel, which occur in high-grade alloys the same as in the Bessemer steel rails, although not as frequently, have proven to the engineers of to-day that the old custom of judging a steel by its resistance to static load, and the amount it would stretch under that load, is not always to be depended on.

The uses to which steel is put call upon it to resist

Some recent tests of armor plate, made by the United States Government, give an illustration of this. In the past it has been the custom to make armor plate as hard as possible, and at the same time retain a high degree of strength. For this reason chromium was used as the principal alloy, and in many cases the only alloy, as it gave steel a hardness that is not obtainable with any other. In the recent test spoken of, a vanadium-chrome steel was used with a hard outer shell and a very soft core, similar to the condition obtained by carbonizing. The result was that it withstood a much higher test of the impact blows delivered by the shots from a gun than the formerly used hard steels.

Vanadium acts as a physic on the other elements and is a very powerful medicine, as very small percentages give the desired results; but if used in too large a percentage it will dynamically poison the metal. Sometimes the vanadium will perform its mission properly and physic through the metal, leaving but a trace to show on analyzing the steel, but in the majority of instances it stays in the metal. Vanadium

* For additional information regarding the manufacture and characteristics of this and kindred steels, see the article in the September, 1907, issue of MACHINERY: Nickel Steel, and previous articles referred to in the same issue.

† Address: 111 Crane St., Detroit, Mich.

steel is the most difficult of all the alloy steels for the chemist to get a correct analysis of.

Vanadium has the property of elusiveness to a very marked degree, and must be handled by the steel maker very carefully in order to get the necessary results. It is, therefore, marketed in the form of ferro-vanadium in the proportions of about two parts of iron to one part vanadium. For machinery purposes it is generally alloyed with steel in percentages of from 0.10 to 0.30 per cent, but it has been tried as a tool steel with as high as 3 per cent, and when this was compared with a 3 per cent tungsten tool steel by cutting

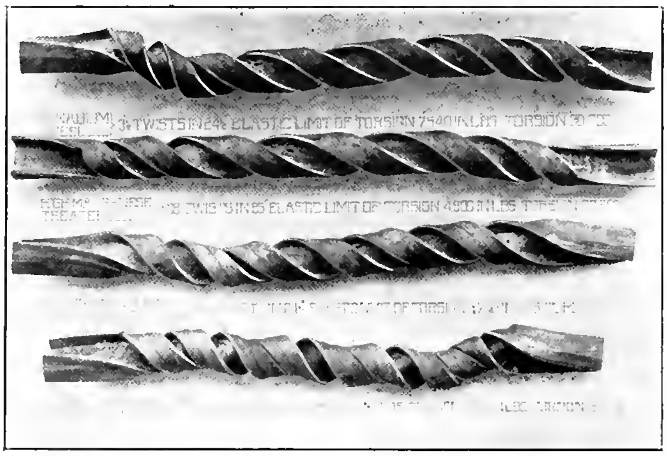


Fig. 9. Axle Steel Samples showing Difference in Physical Qualities Length, 52 inches; Depth, 2 inches; Width, 1 1-2 inch; Thickness of Flanges, 3-16 inch at Edge, 3-8 inch at Web; Thickness of Web, 3-16 inch.

a chilled white iron plate, and then collecting and weighing the cuttings, the vanadium tool steel was found to excel the tungsten tool steel by 25 per cent. It is used in manufacturing a tool steel by one steel maker, in this country, who uses vanadium in a small percentage, tungsten in a large percentage, chromium in a small percentage, and a few other ingredients in small percentages, and the tests given this steel show that it excels other tool steels by from 10 to 20 per cent in their cutting qualities.

Vanadium is not like nickel, chromium, manganese and other mineral elements used in high-grade steel making, as it contains within itself no virtues but in its action as a physic

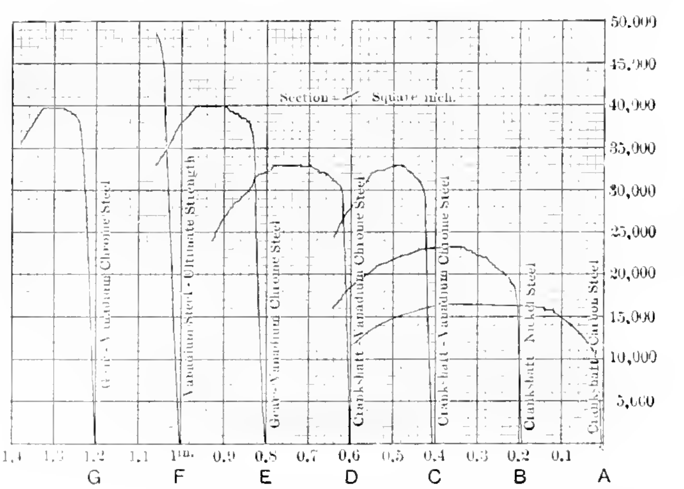


Fig 10. Chart taken on Olsen Testing Machine. Test Bar, 1-5 square inch Section. Figures should be multiplied by 5.

on the other elements. It imparts some very desirable properties, hence its most successful application lies in the direction of the quaternary steels such as chrome-vanadium or nickel-vanadium. In a technical sense it retards the segregation of the carbides, thereby producing in steel a high degree of homogeneity and a grain of great uniformity and fine texture. This is best shown by the series of microphotographs Figs. 1 to 8, which are magnified 350 diameters. One of these shows the ordinary carbon steel, another nickel steel axle stock, and the others vanadium-chrome steel under different degrees of heat treatment.

These photographs were furnished the writer by the Ford Motor Co., Detroit, Mich., from a special heat of 50 tons which it had rolled for its own use. This steel is being used on all the automobiles built by the company.

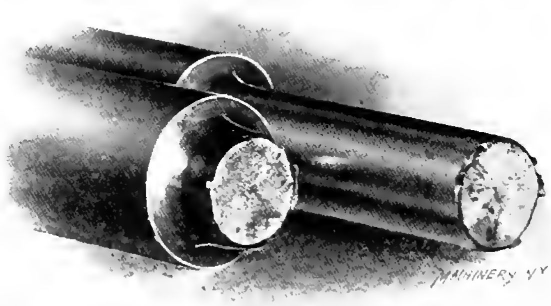


Fig. 11. Test Bar, 1-2 inch Diameter. Heat Treated for Mesh-gears. Star Fracture.

In retarding the segregation of the carbides, vanadium renders steel susceptible to great improvements by heat treatment or tempering, and in this manner the steel can be prepared to resist wear and erosion. It also renders possible the natural formation of the "sorbitic" structure which is necessary in metals which have to withstand wear and erosion.

Vanadium steel also has self-lubricating properties to a greater extent than other high-grade steels, hence it is more

Fig. 12. Test Bar, 1-2 inch Diameter Vanadium Axle Steel. Star Fracture.

valuable for shafts running in parallel bearings and for gears. It also produces soundness mechanically as well as chemically and toughens the steel, thus conferring great powers of resistance to torsional rupture.

Chromium gives to steel a brittle hardness which makes it very difficult to forge, machine or work, but vanadium, when added to chrome-steel, reduces this brittle hardness to such an extent that it can be machined as readily as a 0.40 per cent carbon steel, and it forges so much more easily that the Ford front axle—shown twisted in Fig. 9—which is 52

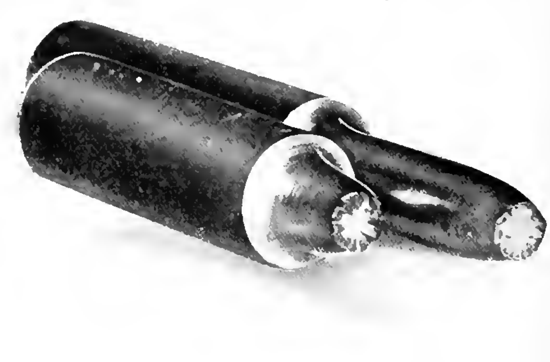


Fig. 13. Test Bar, 1-2 inch Diameter, Vanadium Crank-shaft Steel. Star Fracture.

inches long, 2 inches deep, of I-beam section, with the web only 3/16 inch thick, is being forged in three heats. The first heat is used to forge the straight I-beam part; the second heat is used to forge the arm for the steering-rod connection and the projections for the steering pivot, on one

end, while the third heat is required to forge the same on the other end of the axle. Automobile axles of similar design, when forged out of chrome-nickel steel, require from 15 to 20 heats to give them the proper shape, and even then the dies give a great deal of trouble.

For these reasons the nickel or chrome-nickel axles are usually forged in two halves, and welded together in the center by the electric welding process.

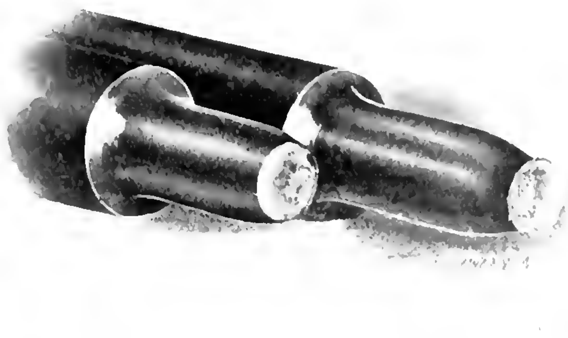


Fig. 14. Test Bar, 1-2 inch Diameter, Vanadium Crank-shaft Steel. Cup Fracture.

Vanadium, by reducing the brittle hardness of chromium and rendering steel very homogeneous, makes it capable of being machined as easily as ordinary carbon steel, that is, running at the same speed and using high-speed tools. The Ford Motor Co. says: "Thus we find in actual practice that vanadium steel costs no more than ordinary carbon steel and vastly less than nickel, because of the saving in machining, forging and tempering, and the greater accuracy we are able to obtain, owing to uniformity of metal and the lighter weight of metal we are capable of using, owing to its great strength."

TABLE I.

Specimen.	Tensile Strength in pounds per square inch.	Elastic Limit in pounds per square inch.	Elongation in 2 inches, per cent.	Reduction of Area, per cent.
A	82,500	50,000	30	66
B	116,000	90,000	21	71
C	165,000	147,000	11	61
D	165,000	147,000	16	59
E	200,000	185,000	11	56
F	228,375	228,375	..	..
G	198,750	190,000	9	34

TABLE II.

Specimen.	Tensile Strength in pounds per square inch.	Elastic Limit in pounds per square inch.	Elongation in 2 inches, per cent.	Reduction of Area, per cent.
1	88,000	64,500	29	59
2	98,750	67,500	25	77
3	127,500	110,000	14	59
4	147,000	140,750	17	57
5	165,000	155,000	16	55
6	176,500	175,000	7	27

Fig. 9 shows the comparative amounts of torsion which vanadium and some other steels will stand by twisting. Fig. 10 shows the comparative strengths of carbon, nickel and vanadium-chrome steels. The figures for this chart read as in Table I.

A is a 0.06 per cent carbon steel, heat treated. *B* is a 0.07 per cent nickel steel, heat treated. The others are all taken from the same bar of vanadium steel and subjected to different degrees of heat treatment. *F* merely shows the ultimate strength.

Vanadium steel can also be given a wide range of strengths together with hardness or softness by properly heat treating. This is best shown by the accompanying Table II, of test bars which were pulled on an Olsen testing machine by the Ford Motor Co. especially for the writer. The test bars were all made out of one bar of steel.

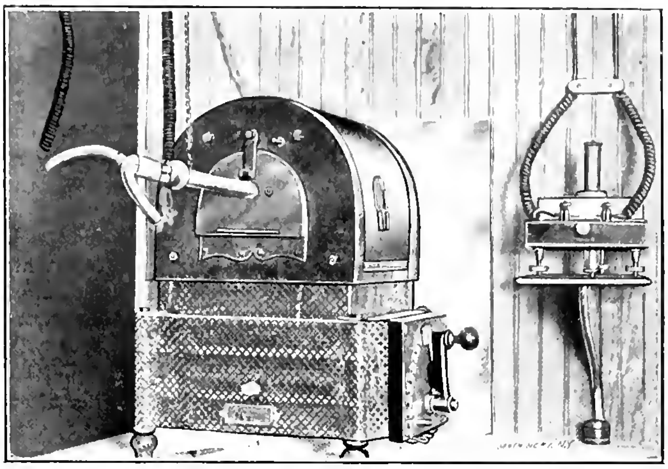
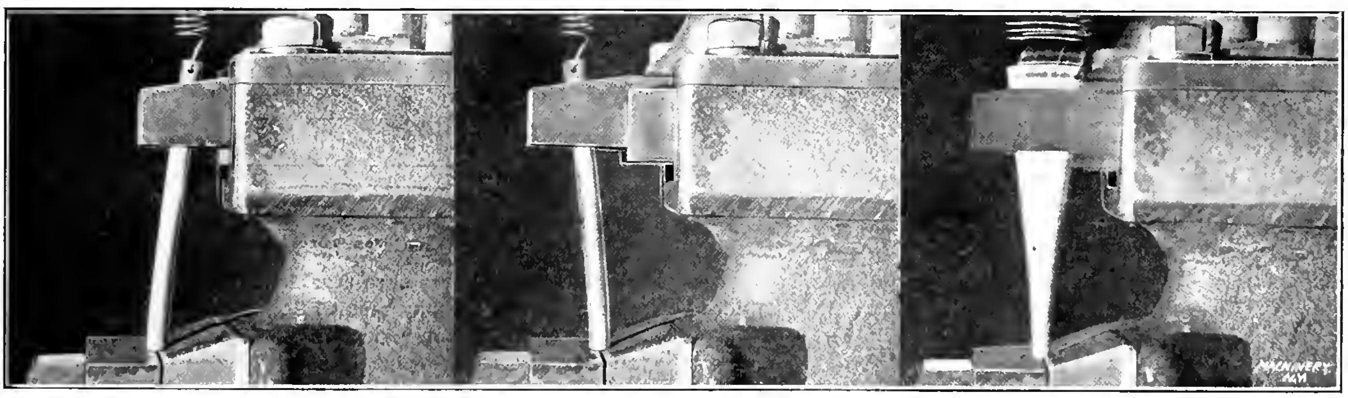


Fig. 15. Heat Treatment Furnace, electrically heated.

Specimens 1 and 2 are in their softest condition; specimen 3 is in the condition of an axle; specimens 4 and 5 are in the crank-shaft condition; and specimen 6 is in a mesh gear condition.

Other tests have shown much higher strengths, but the remarkable features of these tests are the way the elastic limit has been brought up nearly to the tensile strength, and the high reduction of area.



Figs. 16, 17 and 18. Alternating Impact Machine.

Figs. 11, 12, 13, and 14, which are photographs of four of these bars, will more clearly show the reduction as well as the almost perfect breaks.

TABLE III.

Kind of Steel.	Pendulum Impact, Foot-pounds.	Alternating Impact, Number of Stresses.	Falling Weight on Notched Bar, Number of Blows.	Rotary Vibrations, Number of Revolutions.
Carbon axle stock ..	12.3	960	25	6,200
Nickel axle stock..	11.0	800	35	10,000
Vanadium axle stock..........	16.5	2700	69	67,500
Vanadium crank shaft stock.....	12.0	1850	76	......
Vanadium mesh gear stock........	6.0	800	..	......

Fig. 15 shows the furnace which was used in treating the steels in Table II. To it was attached a pyrometer, which was

fastened to the wall above, and therefore does not show in the cut, but the wire at the back leads to it. With this it was possible to regulate the heat to the exact degree required for obtaining the heat treatment wanted for each specimen.

While the static strengths before stated are and can be made the equal of almost any alloy steel, it is in the dynamics that vanadium steel excels all others, and these are becoming more and more the real tests of steel for use in moving machinery or where strains other than a direct pull are put upon it.

The dynamics of vanadium steel as compared with carbon and nickel steel are shown by the tests given in the accompanying Table III. These tests were made with a bar ½ inch in diameter.

These tests have given the present day engineer something tangible on which to base the size, shape and strength in designing parts for machinery which has to withstand great strains. In the past the engineer was contented if he knew the static strengths were high, but these, in reality, were but about 15 per cent of his requirements, and having made sure of these, he hoped that in some way he had acquired the other 85 per cent.

At the present time, however, by submitting his steels to the dynamic tests, he no longer hopes, but knows, what his steel will stand under all kinds of conditions and strains, and is therefore enabled to do his designing with much more assurance and knowledge of what the different parts will require.

Figs. 16, 17 and 18 show the machine on which the alternating impact tests were made, the first two showing it in its extreme position at each end, and the third showing it while in motion.

* * *

EFFECT OF MOISTURE ON WOOD.

The Forest Service of the U. S. Department of Agriculture has just issued a publication entitled "The Strength of Wood as Influenced by Moisture," in which is shown the strength of representative woods in all the degrees of moisture, from the green state to absolute dryness, and the effects of resoaking. By different methods of seasoning, two pieces of the same stick may be given very different degrees of strength.

Wood, in its green state, contains moisture in the pores of the cells, like honey in a comb, and also in the substance of the cell walls. As seasoning begins, the moisture in the pores is first evaporated. This lessens the weight of the wood, but does not affect its strength. It is not until the moisture in the substance of the cell walls is drawn upon, that the strength of the wood begins to increase. Scientifically, this point is known as the "fiber-saturation point." From this condition to that of absolute dryness the gain in the strength of wood is somewhat remarkable. In the case of spruce, the strength is multiplied four times; indeed, spruce, in small sizes, thoroughly dried in an oven, is as strong, weight for weight, as steel. Even after the reabsorption of moisture, when the wood is again exposed to the air, the strength of the sticks is still from 50 to 150 per cent greater than when it was green. When, in drying, the fiber-saturation point is passed, the strength of wood increases as drying progresses, in accordance with a definite law, and this law can be used to calculate, from the strength of a stick at one degree of moisture, what its strength will be at any other degree.

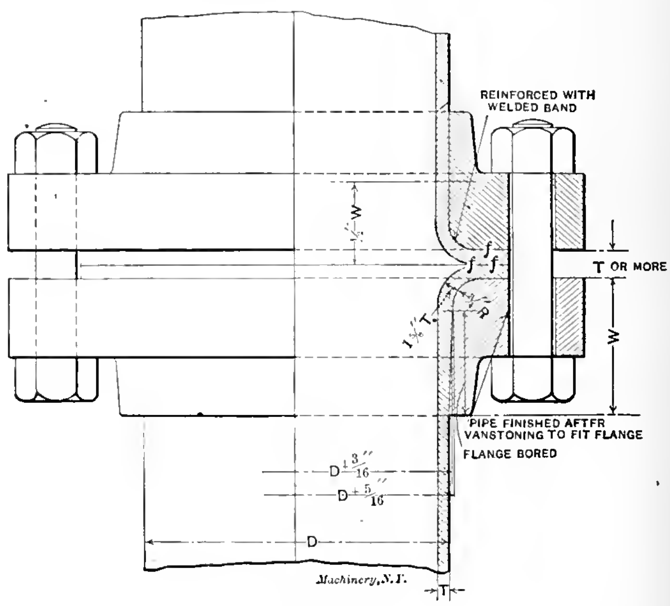
Manufacturers, engineers, and builders need to know not only the strength, but the weakness, of the materials they use, and for this reason they are quite as much interested in knowing how timbers are weakened by knots, checks, cross-grain, and other defects, as they are in knowing how they are affected by moisture. It is obvious that where timbers are certain to be weakened by excessive moisture they will have to be used in larger sizes, for safety. So far, engineers of timber tests, while showing that small pieces gain greatly in strength, do not advise counting on the same results in the seasoning of large timbers, owing to the fact that the large timbers usually found in the market have defects which are sure to counterbalance the gain from seasoning.

MATERIALS FOR CONTROL OF SUPERHEATED STEAM.*

Since the introduction of superheated steam as a large factor in economy in stationary power plant use, the question of what type of material is best for the proper controlling of the resulting high temperatures has caused a great deal of investigation and interest. This article treats particularly of what might be called in a general way piping systems, which systems are made up of pipe, fittings, valves, and the necessary details connected therewith, such as joints, gaskets, etc., and are taken up separately.

Pipe.

There can be little question as to the matter of pipe except quality. Of course, welded wrought iron or steel pipe is successful, but the difference in the quality of pipe is very material. As in nearly all instances in a superheated steam station the old fashioned screwed joint is not satisfactory, it is necessary to do what is termed "work" the pipe—that is, weld, van Stone, etc.—to make either a welded, van Stone, or other joint of the same general description. In the cut is shown what is known as a van Stone joint. For this work the pipe made from open hearth steel is by far the best for manufacturing reasons, because it can be properly "worked," there being less carbon, and the quality is much more uniform. Bessemer steel pipe will very often act in a satisfactory manner, but one is never sure that Bessemer will run even, and, therefore, troubles may result. It is practically impossible to "work" wrought iron pipe. In making what is known as a van Stone joint, the pipe is nearly sure to split very badly, not only at the weld, but all around its outer circumference.



Van Stone Joint.

Nearly opposite qualities from those used for getting good results from "working" pipe are required for threading. A good quality of wrought iron will cut and thread more easily with standard pipe machines and standard dies than a steel pipe, and a Bessemer steel pipe will thread much more easily with standard dies than open hearth. A great many manufacturers have difficulties in threading open hearth steel pipe, for the reason that they set the dies exactly the same as if they were cutting other qualities. This causes ripping of threads, etc. The die in a pipe machine should be set at a greater angle with the radius of the pipe, passing through the point of contact of the die, for soft steel than it would be for other kinds, and this in itself will very often eliminate great troubles in this line.

The ordinary commercial pipe will stand more pressure than the average person believes. A standard 1-inch piece of welded pipe will usually not break under 1,600 pounds per square inch hydraulic pressure. Full weight pipe is suitable for any temperature and any working pressure up to 225 or 250

* Paper by M. W. Kellogg, read before the American Society of Mechanical Engineers, May Meeting, 1907.

pounds, as long as it is not thinned at any point by cutting and threading.

Fittings.

The designs of fittings as generally manufactured for different purposes are, in a general way, satisfactory, with the one exception that very few manufacturers on their standard articles include what is known as the "long fillet" between the body of the fitting and the flange. This is a very desirable point, due to the fact that at this place there is the greatest strain from shrinkage in the molds, which also tends to develop porous spots. Most large users of this type of material have learned this thoroughly, and design their fittings accordingly. The quality of the material in fittings, however, is a very important thing in connection with superheated steam.

The latest practice is to do away with fittings entirely on high pressure steam lines, and put what are known as "nozzles" on the piping itself. This is accomplished by welding wrought steel pipe on the side of another section, so as to accomplish the same result as a fitting. In this way rolled or cast steel flanges and a van Stone or welded joint can be used. This method has three distinct advantages, to wit:

a. The quality of the metal used, for reasons explained hereafter, when the subject of the effect of heat on metals is taken up.
b. The lightening of the entire work.
c. The doing away with a great many joints.

As a general average, at least 50 per cent of the joints can be left out, and sometimes this proportion runs up as high as 60 or 70 per cent, according to the layout of the system. If this method is employed, substantial welds must be made, not only to stand the pressure required, but also the strain.

Valves.

It is important to have a good design of valve. In general, nearly any of the designs made by the best manufacturers are entirely suitable; such as a broken or solid wedge valve of the ordinary type, under the condition that all machine work is done thoroughly and the quality of metal used is of high grade, is satisfactory for the purpose intended.

Metals.

As a rule, different authorities vary slightly in their statements as to what temperatures different metals will stand with good results. German authorities state that cast iron should not be used above 480 degrees F. Other authorities allow us to go as high as 575 degrees F. Above these temperatures, in cast iron, the limit of elasticity is reached with a pressure varying from 140 to 175 pounds. Under such conditions the material is strained and does not resume its former shape, and eventually shows surface cracks, which continue to grow. These temperatures and pressures also lead in time to a shrinkage of all parts, and to a structural alteration of the metal, which results in leakages in valves at the seatings. Therefore, it would seem that iron castings are not suitable for either fittings or valves to be used in any superheated steam work.

The only adaptable metal is cast steel. Results of tests on this metal for the effect of temperature are such that at 572 degrees F., the reduction in breaking strength only amounts to about 1.1 per cent, and at 752 degrees F. to about 7.8 per cent. Therefore, it seems that this metal is practically capable of withstanding all pressures and temperatures up to at least 800 degrees F., without showing any appreciable weakness.

The influence of high temperatures on bronze, etc., is very material. At ordinary temperatures this metal has a breaking strength of about 34,100 pounds per square inch and an elongation of 36 per cent. At 572 degrees F. the breaking strength falls to about 19,500 pounds per square inch and the elongation to 11.5 per cent. At 662 degrees F., which is quite a common temperature, as the steam leaves the superheaters, the breaking strength of bronze only amounts to 12,200 pounds per square inch and the elongation at the breaking point is only approximately 1¾ per cent. This seems to eliminate entirely brass or bronze of ordinary composition for use with highly superheated steam.

The effect of temperature on nickel is very similar to that on cast steel, and in consequence this material is very suitable for use in connection with highly superheated steam. Even neglecting the special quality of nickel seatings, on account of the great toughness of this metal and the methods which can be used for securing rings of this substance to the valves and conical surfaces, it has the special advantage of having the coefficient of contraction and expansion with temperature almost exactly the same as that of cast steel, so that no slackness of the rings occurs and the valves remain absolutely steam tight. There are instances in which valves constructed with nickel seating have been satisfactorily used with steam temperatures up as high as 932 degrees F. Seats, disks, and bushings made of brass or plain bronze do not retain their shape.

For spindles on superheated steam works nickel steel is recommended. Seatings in valves should not only be screwed in, but also pinned in addition, using a fine thread which is very long, to give a tight joint. Seats should also have a flange on the top that makes a joint with the body when screwed down, which prevents the tendency to leak through.

Joints.

It is generally acknowledged that the old-fashioned screwed joint, no matter how well made, would not be suitable for superheated steam work. This leaves for discussion two general types, *viz.*, welded joints and what are generally known as van Stone or climax joints, that is, any joint where the pipe is turned over the face of the flanges. In welding a flange on a piece of pipe, great care must be taken to see that the weld is perfect, because of the unequal thicknesses of the metals to be so welded. If the weld is thoroughly made, this type of joint is very good, although for erection purposes, due to the fact that the flanges cannot swivel, it does not equal the turned-over joint as mentioned above. The manufacturing expenses in making a welded joint are also much more for the same type of work accomplished, on account of the necessity of doing all finishing work after all rough work, such as welding and bending, has been completed.

In regard to the turned over or van Stone joint, the quality of its manufacture seems to be the most important feature. This joint can be made in a careless way where the pipe is in no way thickened up and only faced on the front. A joint of this latter kind does not give good results, principally for two reasons:

a. The thinness of the metal on the turned-over portion; and
b. On account of the recesses left between the back of the pipe on the turned over portion and the flange, due to the pipe not being finished at this point.

The writer believes, however, if this joint is properly made, it is equal to the welded joint as a manufactured article, and superior to the welded joint as an article for erection.

To have this type well made, the pipe on the end should be thickened up an amount sufficient so that after the joint is turned over there will be enough metal left to face the turned over portion on the front, on the outer edge, and on the back. We, of course, take for granted that the flanges are finished on the front. After the work above mentioned is done, the pipe should be as thick on the turned over portion as the original thickness, or very close to it. The point made of facing the turned over portion of the pipe on the back is an exceedingly important one, much more so than most people seem to realize. In reference to making up a joint, it is certain that the face of all flanges or pipe where a joint should be made ought to be given a fine tool finish and have the face level, and then a gasket of some description used.

Gaskets.

There are large numbers of gaskets manufactured of all types and descriptions. It is very hard to take up this subject and be fair to each of the manufacturers, for the reason that practically no one has ever had experience with every type made, to judge for himself, and hearsay would lead us to suppose that all of them are at one time perfect and at other times useless. The writer has used many different types of gaskets, however, and has obtained the best results with a corrugated soft Swedish steel gasket with "Smooth-on" applied, and with the McKim gasket, which is of copper or bronze surrounding asbestos. The ordinary corrugated copper gasket is a very popular make and has been used a great deal. On superheated steam, usually sad results follow. There seems to be some peculiar action that causes this, as on super-

heated steam lines a corrugated copper gasket will in time pit out in some part of the flange nearly through the entire gasket.

The wear of a gasket depends largely on the method of pulling up bolts on flanges. If joints are pulled up entirely on one side and left loose on the other, and then taken up on that side, trouble with the gasket is almost certain. The bolts should be taken up gradually all around the flange. The experience of the erecting crews on high class superheated steam lines is an exceedingly important thing. The average steam fitter is not suited to this type of work. Most troubles can be eliminated by using only steam fitters experienced in the type of work under consideration.

* * *

PHOTOGRAPHING DRAWINGS.

Photographing drawings to a greatly reduced scale, for the purpose of record, or even for use in the shop, is coming to be quite common practice in the larger manufacturing plants. The Schenectady works of the American Locomotive Company follows this practice extensively for card records, and has a room in the engineering building specially fitted for the purpose. The standard size tracings of locomotive erecting "cards" are about 25 x 66 inches, and these are reduced to 8¼ inches length, a 6½ x 8½-inch plate camera being used. One plate is large enough for the reductions of two tracings, so, for example, the side elevation and cross-sections, or any other combination of two tracings desired, may be photographed on the same plate.

The tracings are photographed by transmitted light, as experience has demonstrated that the results are more uniform and generally satisfactory than when photographed by reflected light. North light is used, a large "window" facing the north having been provided. The window is double, there being two frames, each carrying a pane about 4 x 11 feet. The frame carrying the inner pane is swung on hinges at one end, and a circular track and trolley supports the opposite end, this being necessary because of the great weight and length of the frame and pane. Both panes are mounted flush in their frames, facing each other, so that when the swinging frame is closed upon the stationary frame, the panes are closely pressed together.

The tracings are mounted on the outer pane by stickers at the corners, and then the inner frame is closed upon it, thereby pressing the tracing down flat, holding it firmly and without wrinkles. The large size of the "window" permits four standard tracings to be mounted at once. These may be the locomotive side elevation, and cross-sections, and the boiler side elevation, and cross-sections, thus compressing on two comparatively small plates all the general data of a locomotive not carried on the specification card.

* * *

A good illustration of the cost of selling goods and the apparently extravagant prices that must be charged for small articles that can be cheaply made, is the safety razor. One of these useful tools of a certain make is sold for, say $5, including one dozen blades. Extra blades are sold for 50 cents a dozen. Now, of course, the principal part of any razor is the blade, but here we have a dozen blades sold for one-ninth the price charged for the handle and its case. Now, while the handle is nicely made, no doubt it and its case could be produced with some profit for 50 cents. This leaves $4 for profit and selling costs, which seems like a most exorbitant figure. No doubt it does represent a handsome profit, but not as much as is derived from the sale of the blades, notwithstanding their low price. The reason is simply that when a razor has been sold, there is no further selling cost of consequence. Every user is a customer for blades without solicitation.

GENERATING A LARGE WORM-WHEEL.

In the December, 1904, issue of MACHINERY was described a machine built by the Eberhardt Bros. Machine Co. of Newark, N. J., for cutting the teeth of worm-wheels to the proper form without the use of a hob. This machine is in daily use in this plant, having been built for custom work. While the principle on which it works was described in the article referred to, it may be worth while to explain it again in a few words.

Fig. 1 is a partial view showing a worm, A, meshing with a worm-wheel, B. The shape of the tooth of the worm-wheel should be the same as would be given to it by the worm if the wheel were made of some plastic material, like clay or wax,

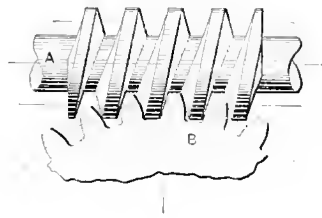
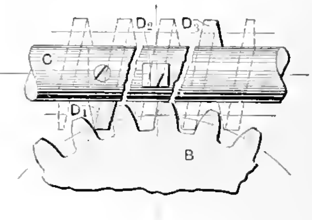


Fig. 1. Section of Worm-wheel Meshing with Worm.



Machinery N. Y.

Fig. 2. Helical Path of Fly-tool for Cutting Worm-wheel shown in Fig 1.

and it were revolved with the worm at the proper rate. In usual practice this form is obtained by replacing the worm with a hob, having cutting teeth of the same shape as the worm threads, the hob being fed into the work with work and hob revolving at the proper speed. This hob has to have a multiplicity of teeth to give the same effect as that produced by the theoretical solid worm on the clay or wax wheel. The way in which this same correct shape can be formed with a single tool will be evident from Fig. 2. Here the worm of Fig. 1 shows in the dotted lines. D_1 is a tool held in boring bar C, with an outline exactly coinciding with the thread of the imaginary worm at the point where it is located. If the wheel B and boring bar C are revolved together continuously

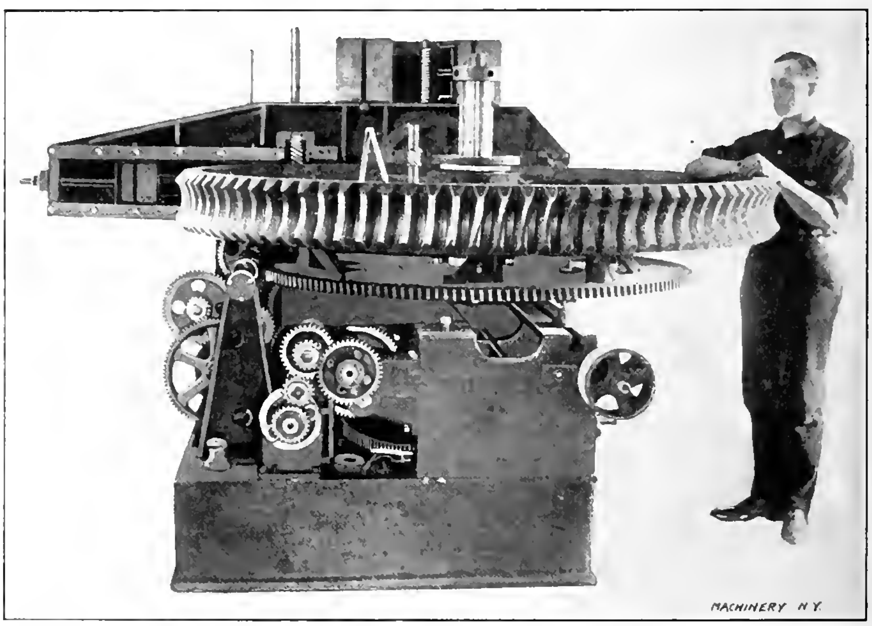


Fig. 3. Eberhardt Bros. Worm-gear Generating Machine, Involving the Principle shown in Fig. 2.

at the proper rate, with the tool in position D_1, it is evident that it will cut out in the wheel a suitable form for that portion of the worm with which it coincides. If the tool blade be shifted to D_2, and be rotated with the wheel as before, it will evidently at this point further shape the wheel to agree with the portion of the work with which it now coincides. The same may be said when the tool is shifted to D_3 or any other location in which it coincides with the thread of the worm. Evidently, in order to make the teeth which this tool cuts absolutely match the worm, it is only necessary to have it revolve with the work at the proper rate and be advanced meanwhile helically on the thread of the imaginary worm from one end of it to the other, so that it successively

coincides with every portion of the thread surface of the worm.

This is what is done in the machine shown in Fig. 3. The cross rail in the rear of the machine carries a boring bar with a single-bladed tool in it, shaped to match the outline of the worm which is to be used with the wheel. This spindle and the blank are revolved together. The tool meanwhile, starting to the left-hand end, is fed helically along in the direction of the thread of the worm which it represents. This movement is accomplished by a train of differential gears which shift the spindle endwise and give it at the same time a forward rotary motion, independently of the train of gearing connecting the spindle with the work arbor. For details as to this the reader should refer to the article previously mentioned.

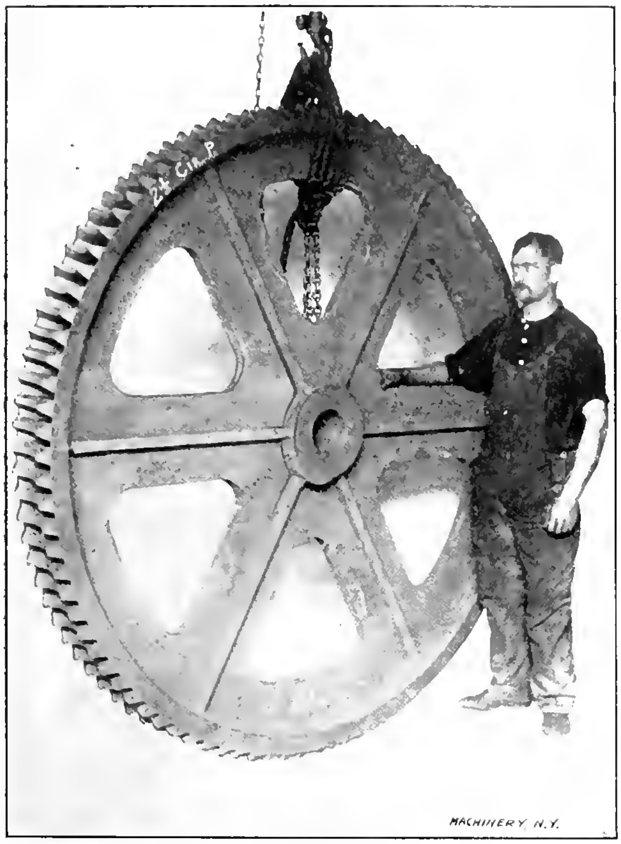


Fig. 4. The Completed Worm-gear.

The wheel shown in place in the machine in Fig. 3 and completed in Fig. 4 is believed to be the largest one ever made by this process, in this country at least. It has a pitch diameter of about 78 inches, with 98 teeth of 2½-inch circular pitch. It has a face 7½ inches wide, for a worm 10¾ inches outside diameter. The wheel blank weighs 3,150 pounds. It was made for a Western contracting firm, and is intended for some form of machinery used in the beet sugar industry.

For this large wheel, the work spindle is not rotated by the usual means provided for smaller ones; instead a face-plate drive is used. As shown, this face-plate has worm teeth formed on its periphery, and through these the rotary motion is transmitted to the work. Although this job is a large one, it does not tax the machine to the utmost, either in dimensional capacity or in driving power. As the other extreme of its range, a small worm-wheel shown standing upright on the rim of the work in Fig. 3, is interesting. This "wheel" is of the kind sometimes used for spindle drives in gear-cutting machines, in which the worm is considerably larger than its mate. This accounts for its peculiar appearance. These two parts together indicate the great range of usefulness which this process of cutting possesses, owing to the fact that the question of hobs is not the determining factor.

* * *

The parting sand used by the molder to prevent the sand in the cope and nowel sticking together is simply the burned sand scraped from the surface of castings.

FAULTS OF IRON CASTINGS.—1.

POINTS FOR THE MACHINE DESIGNER.

FORREST E. CARDULLO *

Forrest E. Cardullo.†

The most useful and indispensable of all the materials with which the designer has to do, is cast iron. Of all the metals used in the construction of machinery, it is the cheapest. It is the one to which we can the most readily give the form and proportions which we desire. It is, of all the common materials, the most easy to machine. While it is lacking in strength and ductility, its cheapness makes it possible to use it in such ample quantity as to overcome these disadvantages, and in many constructions it may be so shaped and proportioned, or so reinforced by other materials, as to make this lack but a slight detriment. It is therefore a matter of interest to the designer to learn of the various faults to which this valuable material is subject, and the best ways in which they can be avoided or minimized.

Causes of Blow-holes.

Probably the one fault which spoils more castings than any other, is the result of an outrush of gas from the materials of the cores or the mold, into the molten iron, at the instant of solidification. If the solidification of the iron has proceeded so far that the outrushing gas or steam cannot bubble through it, and escape through the vents which should be provided for the purpose, it will be imprisoned in the substance of the casting, forming one or more holes, according to the special shape of the casting, and the quantity of the escaping gas. These holes, which are known as blow-holes, may not be apparent on the outside, and quite often occur in such a location that they do no particular harm, but it is more often the case that they occur at some point where they become apparent when the metal is being cleaned, or where their presence weakens the casting greatly.

Steam from Moisture in Sand.

The gases which cause blow-holes may come from three sources. They may be, and generally are, caused by the generation of quantities of steam from the moisture contained in the molding sand, by the heat of the iron. In the case of dry sand and loam castings, the quantity of steam so generated is so insignificant, if the molds have been properly heated, that it gives no trouble whatever. In the case of green sand castings, however, the moisture present, and therefore the steam generated, is quite large in amount, and special precautions have to be taken to prevent blow-holes.

When the molten iron pours into a green sand mold, all the moisture in the layer of sand immediately in contact with the iron will at once be transformed into steam. The depth of the sand layer so affected depends on the thickness and extent of the fiery mass to which it is adjacent. The steam so formed must either force its way through the molten iron in the form of a mass of bubbles, or else it must escape through the sand. To facilitate its escape, the mold is vented. That is, after the damp sand has been packed around the wooden pattern by ramming it closely into place, a wire is thrust repeatedly into the mold, making numerous passages for the escape of the steam and gas.

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It is obviously impossible that one of these vent-holes should extend to every point in the layer of sand adjacent to the casting, so it is necessary that the most of the steam and gas should force its way for some small distance through the sand, before it can reach a vent-hole. This it can only do when the sand is somewhat porous. If the sand is too tightly rammed, it will lack the necessary porosity, and even though it be unusually dry, and the venting carefully done, the casting will be full of blow-holes. I have known of cases where molds have been rammed so hard that the castings were nothing better than shells, the whole interior being a mass of blow-holes.

Decomposition of Binder in Cores and Entrapping of Air.

The second cause of blow-holes in iron castings is the decomposition of the material, generally flour or molasses, used as a binder in preparing the cores, and its escape in the form of gas, into the iron, at the instant of pouring. It is impossible to prepare and bake a core in such a way that it will not give off large quantities of gas when the iron is poured, and so means must be provided for the escape of this gas. In order to do this, the cores are prepared with wax strips running through them. When the core is baked, the wax melts, leaving passages for the escape of these gases, known as core vents. If the core is of such form, and so set in the mold, that the gases can escape from these vents in an upward or sidewise direction, and leave the mold without forcing their way through the molten iron, no blow-holes will result.

A third source of blow-holes is the entrapping of air in certain parts of the mold, and its mixing, on expansion, with the iron. This trouble is due to insufficient venting of the mold, and is not a fault to which the designer need pay any particular attention.

Dry Sand or Loam Advisable for Large Complicated Castings.

In the case of large and complicated castings, it is generally advisable to make dry sand or loam castings, in order to avoid, as far as possible, the chance of blow-holes. When the mold is very large, it is difficult to vent it thoroughly, and when the work on it extends over a period of three or four weeks, it is impossible to keep the vents from filling up; hence the general use of dry sand work for large castings. Often, however, for the sake of economy, fairly large and complicated pieces must be undertaken in green sand, and it becomes a matter of importance that they be so designed that the molder will not be compelled to invite disaster by keeping his sand too wet, or ramming it too hard, and that there is no part of the mold which may not be thoroughly vented.

Elements of Green Sand Molding.

In order that we may understand thoroughly the effect of the design of a casting on the probability of blow-holes, it is necessary that we review in a brief way, the elements of green sand molding. The sand is sprinkled with water, and thoroughly mixed and sifted, preparatory to packing, or "ramming" it around the pattern. The object of wetting the sand is of course to cause it to stick together when it is packed. Up to a certain point, the wetter it is, the better it will stick, but the molder should not wet it any more than is necessary. In the same way, the more tightly the sand is rammed, the better its particles will cohere, and the more easily will the mold be handled, and the pattern drawn. However, tight ramming and wet sand, while they make a solid and easily handled mold, invariably produce blow-holes, and are therefore to be avoided.

It will be apparent then, that if a pattern be of complicated form, or hard to draw, or if when it is drawn it leaves the sand in such a form that the mold will easily fall together at a little jarring, the molder will be compelled to wet the sand more, and to ram it harder than usual. Small deep openings, sharp fillets, and thin walls and partitions of sand, are especially troublesome. Not only do they make it difficult to draw the pattern, and handle the mold, and so make excessive wetting, and hard ramming imperative, but they make spots in the mold which the venting wire is unlikely to reach. For these reasons, they are to be avoided when possible, in any class of molding, whether it be green sand, dry sand, or loam work, and on no account should such work be permitted in the case of large green sand castings.

When designing a casting to be made in green sand, the designer ought to know the position which it will occupy in the mold, when it is poured. In general, the parts of a casting which lie in the bottom of the mold will be the soundest, and those parts which must be machined, or which require the greatest strength, should therefore occupy the bottom of the mold, if possible, when the casting is poured. Having decided which side will be down, the designer needs generally to pay no particular attention to the configuration of the lower part of the mold, provided only that all of the pattern can be drawn, and that there are no sand partitions which overhang, or whose extent is large in proportion to their thickness. To insure a sound casting, the sand in the lower parts of the mold must be comparatively dry, and loosely rammed. This condition of affairs is not generally hard to attain, since all the work on the sand is done with the pattern in place, and that part of the mold is not generally moved or handled after the support of the pattern has been withdrawn. In the lower part of the mold, the sand is generally supported at all points in a very thorough manner by the sand lying under it, and so hard ramming or wet sand is unnecessary. If, however, the pattern must be made with loose pieces, or with sharp fillets, or must leave thin walls or tongues of sand when it is withdrawn, the case is changed. Then hard ramming and wet sand are almost compulsory, and the molder is not to be blamed if he does not produce sound green sand castings. The fault is with the designer.

The upper part of the mold must of necessity be rammed harder than the lower part, since the sand is not supported from beneath, but hangs from above. This is not as great a disadvantage as it might seem to be at first sight, since the escaping gases do not have to make their way through the iron, as they would if they were given off by the sand in the lower part of the mold. The venting, however, must be just as thorough, and it is desirable that the sand should be as dry as possible. The whole arrangement of the upper part of the casting should be such that the sand may be well supported from above. Generously rounded fillets and corners, simple surfaces, plenty of "draft," and an absence of depending walls and masses of sand, make the mold easy to handle, and therefore promote freedom from blow-holes.

When Green Sand and Dry Sand Both may be Used.

It often occurs that the larger part of a casting is of simple form, and easy to mold. A certain part of it, however, may be of a form exceedingly difficult to mold, and therefore likely to give a good deal of trouble. It is not necessary that the whole casting should be made in a dry sand mold, but a core-box may be made to take care of the difficult part of the work, even though the work would ordinarily be done without a core. It is just as easy, and often just as desirable to cast the external face of a casting against a core, as the internal face. While it may not pay to do this if only one casting is wanted, if a great many are wanted, it is often the cheapest possible way of making them, and reduces to a minimum both the work of the molder and the chance of a spoiled casting. Often forms may be cast in this way which could not be attempted in any other. If it is desirable to use this method of working, the designer has it in his power to make the construction of the core-box much simpler and cheaper than it might otherwise be, by giving the matter a little thought.

Support of Cores.

In arranging the coring of a mold, it is always better, if possible, to support the cores at the top. The gases formed in the core, being light, tend to rise, and if the core is supported at the bottom only, they tend to escape into the iron, and to bubble through it. If they can escape at the top, they will pass off without coming in contact with the iron. When it is impossible to support the cores at the top, they should be so arranged that the gases can pass off at the sides, and escape from the mold without coming in contact with the iron.

CUTTING BEVEL GEARS WITH A ROTARY CUTTER.*

H. P. FAIRFIELD.†

Pictures are a great help in understanding a machine shop operation. It is often possible, with a few half tones, to convey ideas that would require many pages of written matter to express them. In the following article advantage has been taken of this facility of the photograph to express ideas, so that a long story has been told in comparatively few words.

While the process of forming the teeth of a bevel gear by milling them with a rotary cutter, is not easy to describe without telling how to make a drawing of the blank, it seems best to leave the designing and drawing for another article. The average apprentice approaches the problems of the machine shop with hardly enough knowledge of the art of making drawings to enable him to read them, to say nothing of making them. It is to be hoped that the day will come when a boy may be given an opportunity to master some things of both sides of his life work.

The Drawing.

Fig. 5 represents the drawing of a bevel gear and its pinion, as it is given to the workman. It is to be noted that draftsmen are not all bound by the same conventions, but this drawing is as it would be made by at least one large firm who cuts many bevel gears. All dimensions other than those necessary to our description have been omitted to avoid confusion. The description will, therefore, be confined to those operations bearing upon the subject at hand, and will show what, in the writer's estimation, should be the best order of operation to insure accuracy, convenience, and speed. In machining the blank to the required angles and dimensions, use is made of an engine lathe fitted with a compound toolslide, and the tooth cutting operations are made in a milling machine fitted with a universal index head, with graduated dials on its feed screws.

In the drawing Fig. 5 are figured the angles needed to shape up the blank, and those needed when cutting the teeth. Those angles which are to be worked out in the lathe, using the compound slide, are figured from the line normal to, or at right angles to, the center line of the blank. Figured in this way, they conform to the graduations on the compound slide of the lathe, and all calculations by the workman in the shop are avoided. The cutting angle is figured from the center line to conform with the graduations upon the milling machine. The diameter of the gear, as drawn, is 6.18 inches, and operation No. 1 is to size the blank to this diameter. While some draftsmen in bevel gear work give the outside diameter to thousandths of an inch, the nearest hundredth is sufficiently accurate.

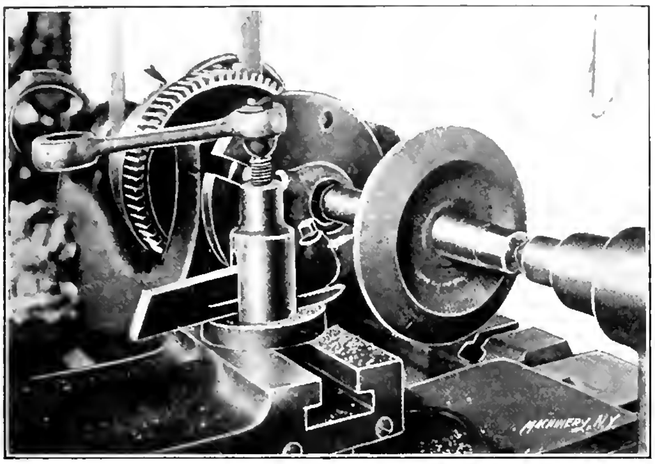

Fig. 1. Sizing the Outside Diameter of the Blank.

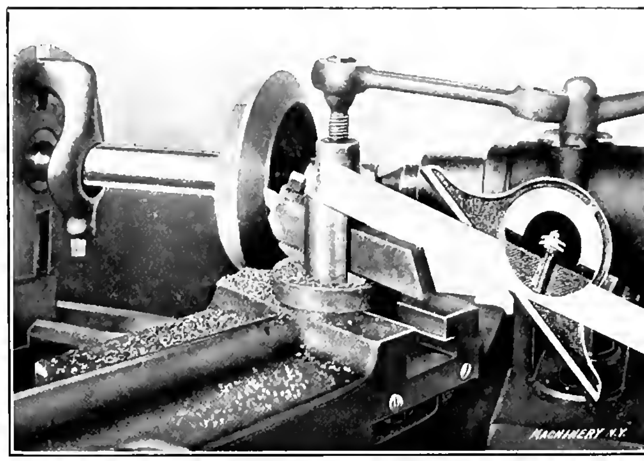

Fig. 2. Turning the Face.

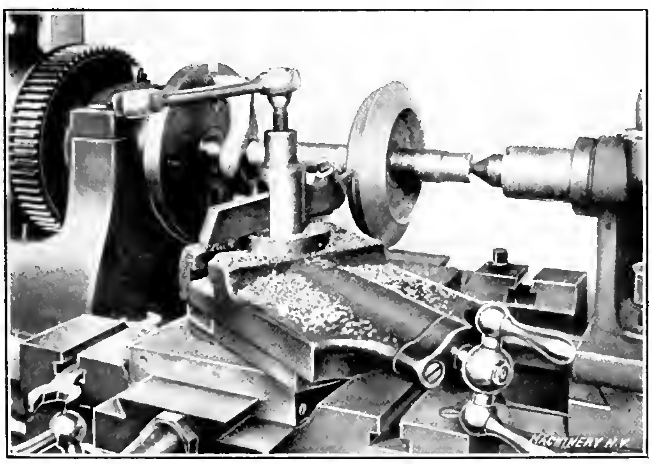

Fig. 3. Turning the Outer Edge.

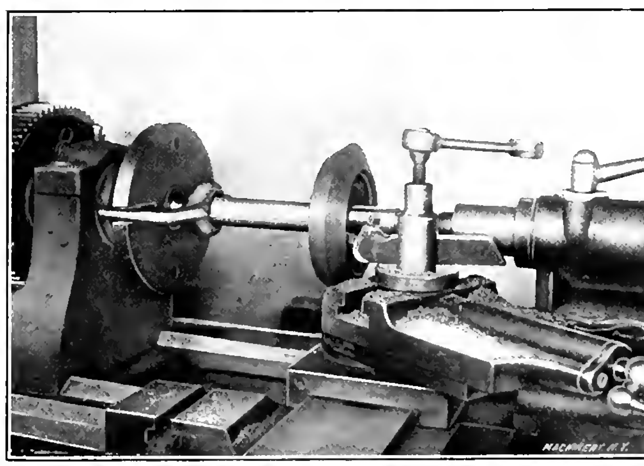

Fig. 4. Turning the Inner Edge of the Teeth.

Turning the Blank.

Fig. 1 shows operation No. 1, sizing the outside diameter, which leaves a flat surface easy to caliper.

Operation No. 2, shown in Fig. 2, is the turning of the face angle. As figured on the drawing, this angle is 31 degrees, and the compound slide, as shown in the cut, is set to conform to this. In setting the slide, the nearest quarter degree is all that is needed. A sufficient amount of stock is removed by this operation to leave a well finished surface for the tops of the teeth.

Fig. 3 shows operation No. 3, which is the forming of the back angle, or angle of edge. As figured, this is 56 degrees 20 minutes, and the compound rest is reset to read to the required angle. In this operation, sufficient stock is removed to bring this surface up to an edge with the one previously formed. Note that in all the operations the tool is adjusted normal to the surface operated on, to obtain the maximum cutting efficiency.

* The following articles relating to the calculation and cutting of bevel gears have been previously published in MACHINERY: Cutting Bevel Gears with Correct Teeth, and Cutting Bevel Gears, June, 1898; Gearing, March, 1902; Proportion of Gears, May, 1903, engineering edition; Use of Diagrams and Tables for the Solution of Problems in Gearing, March, 1904, engineering edition; An Automatic Gear Cutting Machine, July, 1905; Bevel Gear Chart, September, 1905; To Calculate the Center Angles of a Pair of Bevel Gears, having their axes at other than Right Angles, June, 1906; Bevel Gear Formulas, May, 1907, engineering edition.

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Fig. 4 shows operation No. 4, the finishing of the inner ends of the teeth. As these are parallel to the outer ends, the compound slide remains as set for operation No. 3. Sufficient stock is removed to make the teeth of the required length as figured (that is, 1¼ inch), and an ordinary steel rule obtains this measurement with sufficient accuracy. Filing or scraping the surfaces puts the blank in readiness, so far as the teeth are concerned, for the milling operations. If the performed operations have been done on a reliable lathe, and care has been taken in reading the figures on the drawing and the graduations on the compound slide, the blank must agree with the drawing. It is well, however, to check the angles with a protractor, and Fig. 6 shows this. While the blank and the tool would ordinarily be held in the hands when making this test, for convenience in photographing they are placed as shown.

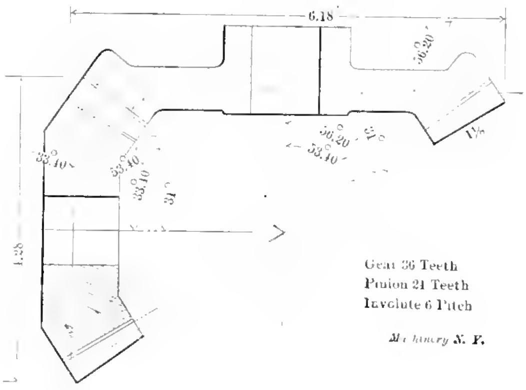

Fig. 5. Essential Dimensions of the Gear to be Cut.

With the drawing figured as shown, and the operations followed as numbered, it will be noted that so far the greatest simplicity has resulted in the setting of the machine and in the measurements made.

Selecting the Cuttter.

The tooth cutting operations are made in the milling machine, but the points to be brought out will apply to gear-cutting machines as well, with slight modifications due to the different mechanism. There are in use at least four different methods by which the machines may be used to form the teeth, and as all bevel gears cut with a rotary cutter must be in error, some latitude as to means can be allowed the workman. For the pair of gears shown, the diametral pitch at the large end of the tooth is 6, since the gear has 36 teeth or 6 teeth for each inch of the largest pitch diameter. At the inner end of the gear the pitch diameter is much less. The number of teeth is the same, however, and thus the pitch is finer; or, in other words, there are a greater number of teeth per inch of pitch diameter. Suppose, for example, that the pitch diameter at the inner end of the teeth is four inches, the number of teeth per inch would be nine, and the pitch is therefore nine, or, as it is commonly written, 9 P.

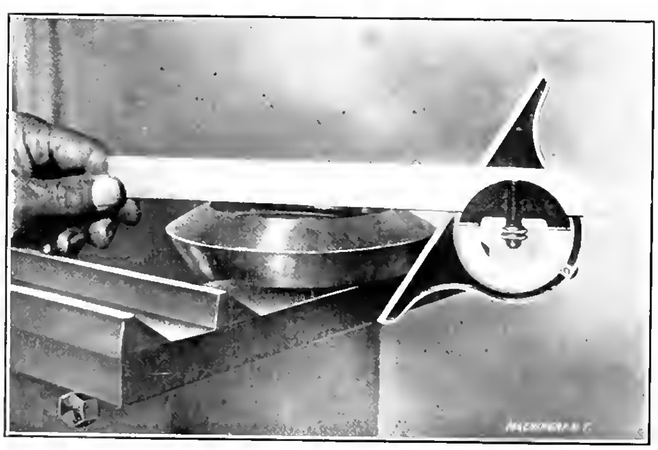

Fig. 6. Testing the Accuracy of the Angles.

In choosing a cutter with which to form the teeth, it will thus be seen that if it is the right pitch for one end of the teeth, it must be in error for the other, and it is for this reason that all bevel gear teeth cut by milling are at the best a compromise for the true shape. As noted above, there are four methods of compromising, but the one chosen for illustration is that usually termed the "rolling method," meaning that the gear is rolled to and fro for adjustment with the cutter.

To choose a cutter for spur gear cutting, the pitch and number of teeth being given, is a simple matter if Table I,

TABLE I. RANGE OF CUTTERS IN STANDARD INVOLUTE SERIES.

No. 1	will cut wheels from	135 teeth	to a rack.	
" 2	" "	55 "	134 teeth.	
" 3	" "	35 "	54 "	
" 4	" "	26 "	34 "	
" 5	" "	21 "	25 "	
" 6	" "	17 "	20 "	
" 7	" "	14 "	16 "	
" 8	" "	12 "	13 "	

taken from the catalogue of the Brown & Sharpe Mfg. Co., is used. To choose a cutter for milling bevel gears, however, the method given below, and illustrated in the diagram, Fig. 7, is used. Instead, then, of taking a cutter for the number of teeth which you wish to cut, it may have to be for a much larger number. While this rule is not universally followed and has its limitations, it covers most cases better than any other with which the writer is familiar, and a cutter chosen by this method is the correct curvature for the teeth at the extreme large end, though it cannot have the right curve, for the rest of the tooth. It must, also, be so

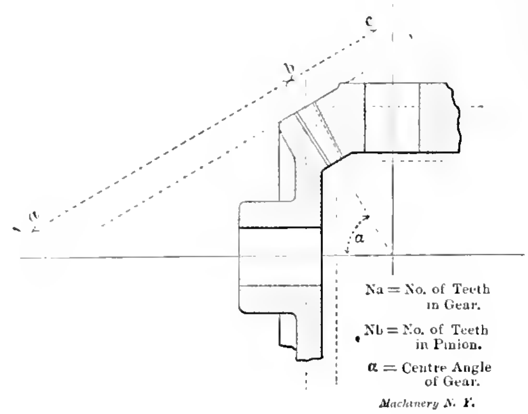

Fig. 7. Diagram showing Method of Selecting Cutters for Bevel Gears.

chosen as to be at least as thin as the width of space at the inner end of the teeth. This makes it necessary to use special cutters, somewhat thinner at the pitch line than those used for spur gears.

Measuring the dimension in the drawing, Fig. 5, which corresponds to the line *a b*, Fig. 7, and doubling it, gives a length of 10¾ inches, nearly. This dimension is not indicated in Fig. 5. Multiplying this by the pitch, makes the number of teeth for which the cutter must be chosen, sixty-four plus. In Table I, a No. 2 cutter is listed to cut from 55 to 134 teeth, and is the one selected. When it is inconvenient to measure the back cone radius, use is made of the following formulas, taken from Brown & Sharpe Mfg. Co.'s catalogue.

$$\text{Tan } a = \frac{N_a}{N_b} \qquad (1)$$

$$\text{No. of teeth to select cutter for gear} = \frac{N_a}{\cos a} \qquad (2)$$

$$\text{No. of teeth to select cutter for pinion} = \frac{N_b}{\sin a} \qquad (3)$$

If the gears are miters, or alike, only one cutter is needed. If one is larger than the other two cutters may be needed.

Setting Up the Work for Trial Cuts.

The cutting angle of the gear is 53 degrees 40 minutes, figured from the center line of the gear, which corresponds to the center line of the index centers. The center head is therefore swiveled in the vertical plane to the position shown in Fig. 8, or through an arc of 53 degrees 40 minutes by the graduations. The cutter is placed in cutting position upon

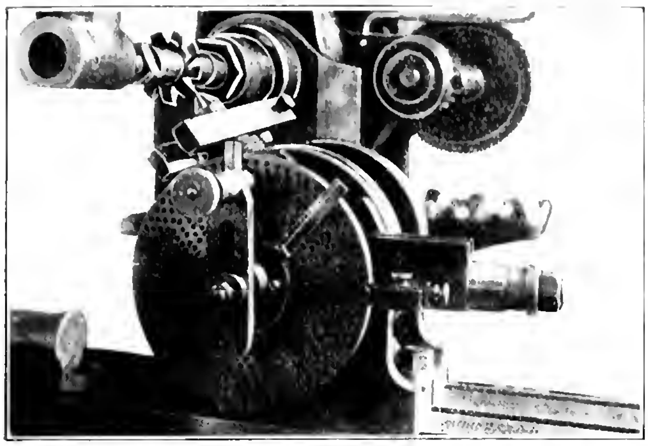

Fig. 8. Spiral Head Set for Proper Center Angle and Indexing.

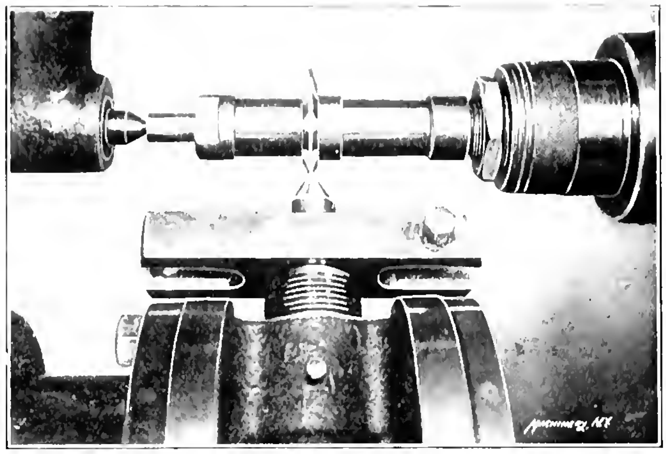

Fig. 9. Setting the Cutter Central with the Work Spindle

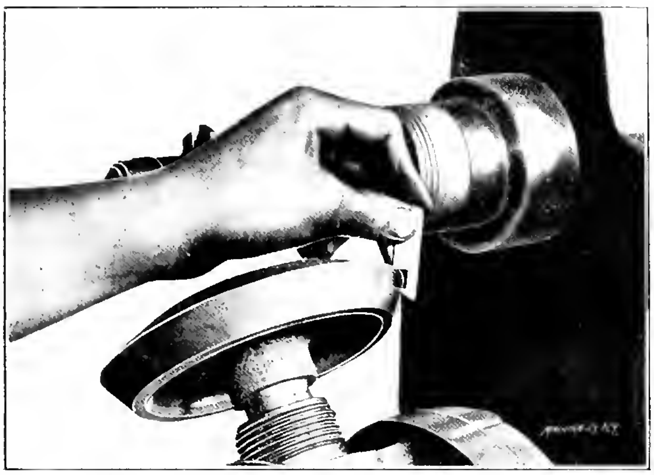

Fig. 10. Marking the Depth of Tooth with Depth Gage.

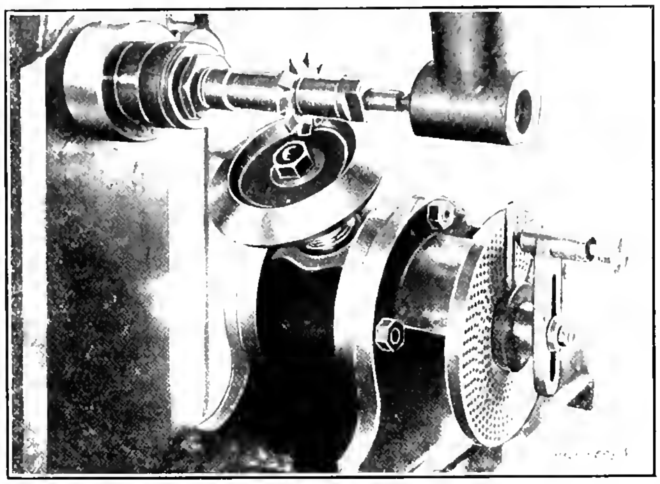

Fig. 11. Work in Place on Machine, Ready for Trial Cut.

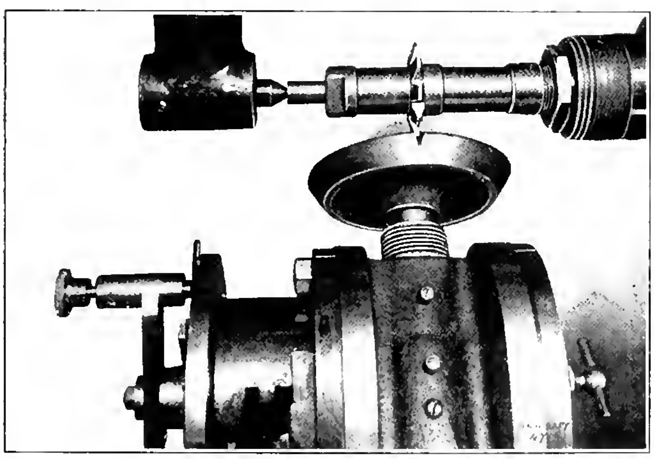

Fig. 12. Trial Cut Completed.

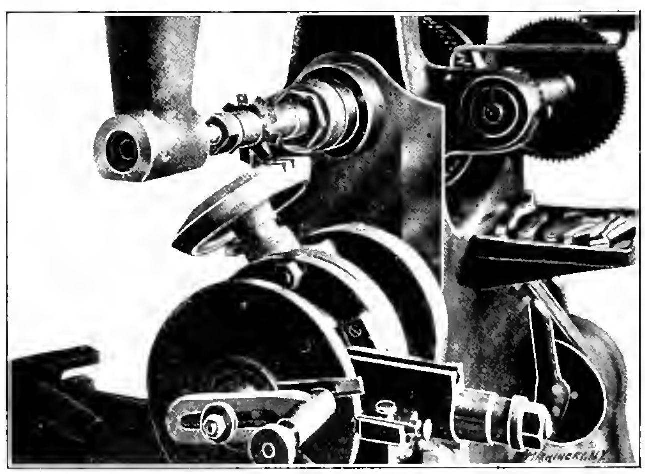

Fig 13. Trial Tooth Formed by Two Trial Cuts.

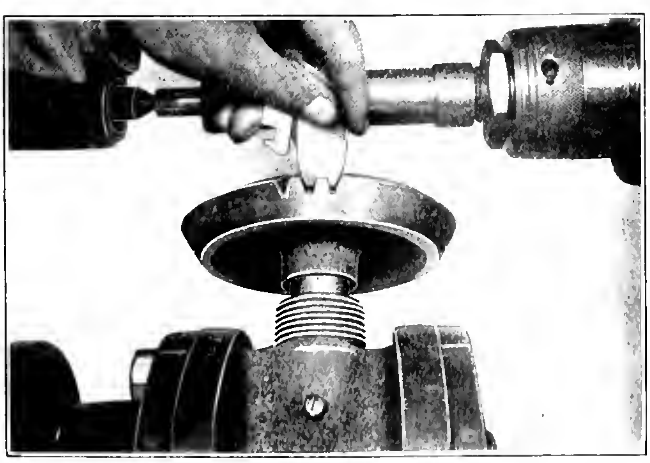

Fig 14 Testing Accuracy of Settings for Approximating the Tooth.

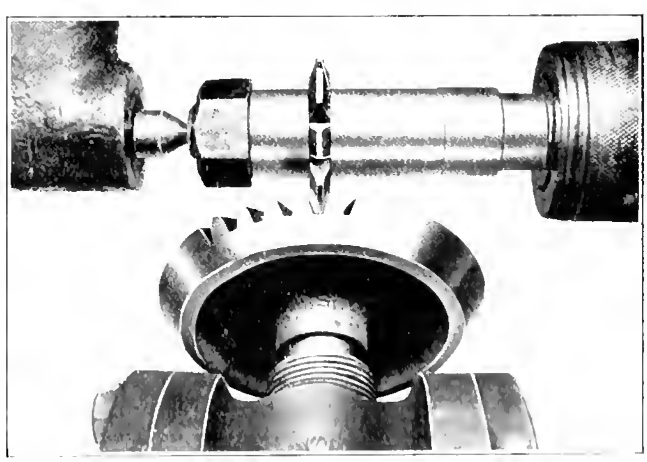

Fig 15. Cutter Completing the Tooth, showing Widened Tooth Space

the milling machine arbor, which must run true. Fig. 9 shows how the cutter and the index center are brought into alignment by adjusting the cross slide. Most makes of cutters have a center line scribed on the tops of the teeth, or on the back face, to set the center to in making this adjustment. Be sure that the center runs true. It is best to try it with a test indicator. The gear blank, as shown in Fig. 10, is mounted firmly on a special true-running arbor, with a taper shank to fit the index head.

Fig. 8 also shows the index pin and adjustable sector set for spacing thirty-six teeth on the blank. Although use can be made of the printed table which comes with the milling machine to learn the turns and parts of turns to make when

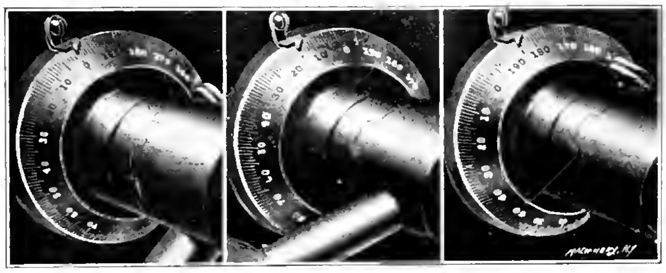

Fig. 16. Cross-feed Dial when Work Spindle is Set Central. Fig. 17. Cross-feed Dial Set for Cutting Outer Side of Tooth. Fig. 18. Cross-feed Dial Set for Cutting Inner Side of Tooth.

indexing, a very simple calculation gives it, when the number of revolutions which must be made with the index pin to give the work a complete turn is known. In most milling machine index heads, this number is 40, as they have a 40-toothed worm gear and a single-thread worm; 40, then, is the numerator of a fraction, the denominator of which is the required spacing; or, in other words, dividing forty by the number of spaces required gives the number of turns and parts of a turn of the index pin. In this case, $40/36 = 1\,4/36 = 1\,1/9$ revolutions, or one turn and one-ninth of a turn. Six holes in the 54-hole circle is taken to give the one-ninth of a turn required. Any circle of holes evenly divisible by nine, can, of course, be used.

With the blank set to the required cutting angle, the next step is to make a line on its back edge showing, as in Fig. 10, the depth of the teeth at this point. This is done with a "depth of gear tooth" gage of the proper pitch. Such gages may be bought in different sizes for different pitches. Be careful to hold it parallel to the back edge of the blank when scribing the line.

Fig. 11 shows the machine and work completely set up, and adjusted for the trial cut. This cut must not be so carelessly made as to be deeper than the tooth depth line marked out in Fig. 10, and several trial cuts, each deeper than the other, may well be made in getting the required depth for the first space.

Approximating the Correct Tooth-form by Rolling.

Fig. 12 shows the first space cut to depth. The work is then indexed for another cut. Fig. 13 shows the trial tooth left by the two trial or central cuts. It is noticeable that the tooth is much wider on the pitch line than it should be, at the outer end. This may also be true of the inner ends at the pitch lines, and is certain to be true of the inner ends above the pitch line when the gear is finished, unless this part of the tooth is afterward filed somewhat. The coarser the pitch and the longer the tooth face, the more this latter shows. The rolling method of approximating the true tooth shape starts by making several central cuts, such as shown in Fig. 14, giving teeth which may be used to test adjustments by as they are made. With the cross feed index set at zero, the table is moved off center *toward* the column of the machine a trial distance, and then clamped immovably. By means of the index pin, the work blank is rotated or "rolled" back toward the cutter again to just admit it to the space at the inner end of the teeth. Do not disturb the adjustable sector when doing this, but leave it to mark the hole which is correct for the central position.

Rolling the gear is equivalent to swivelling the tooth about the apex of the cone, and allows the cutter to take a heavier shaving or chip at the outer end of the tooth than it does at the inner end. The greater the adjustment off center and the more the blank is rolled, the greater this difference.

If, for example, the cutter leaves the trial teeth accurate in thickness at their inner ends, the blank would be rolled, when making adjustments, to allow the cutter to just enter the trial cut at that end without thinning the teeth. Exceptions to this will be noted further along.

After the trial cut has been taken upon one side of the tooth, the index pin and the cross slide should be returned to their original central position, and the blank indexed one tooth, to bring the cutter upon the side opposite to that already thinned off. Afterward set the cross slide off center *away* from the column and roll the blank toward the cutter again, the same amount as before, until the cutter just enters the space at the inner end. Thin off this side. If the larger end of the tooth is still too thick, it shows that the cross slide was not set off from its central position a great enough distance, and another trial cut must be made on each side of the tooth, carefully duplicating the operations just noted, but giving additional movement to the cross slide and the rolling of the blank, repeating this until the gage shows the right thickness at the outer end of the teeth as in Fig. 14. The gage shown is one of a form common in gear cutting practice. The notch in the end of it has a depth equal to the addendum, and a width equal to the tooth thickness, of the pitch for which it is intended—6 in this case.

As previously stated, all this has been done on the supposition that the thickness of the cut left the space and teeth at

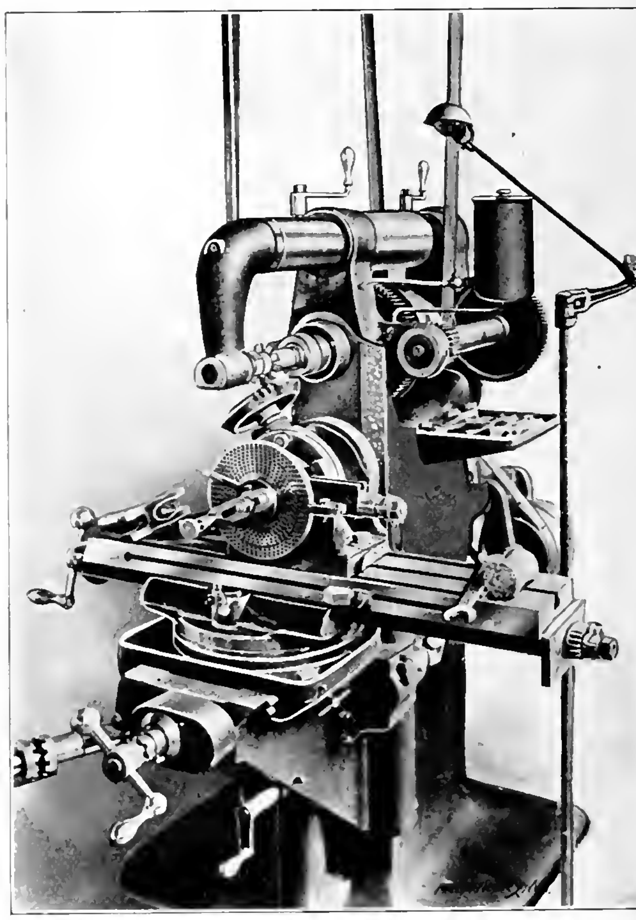

Fig. 19. General View of Machine as Arranged for Cutting Bevel Gear.

their inner ends the right width. If the cutter is too thin to do this, the teeth must be shaved on their sides at the smaller as well as at the larger ends. It is then necessary to observe that neither end is cut too narrow, and the cross-slide adjustments, as well as the rolling of the blank, must allow for shaving the tooth its entire length.

In the gear shown, the cutter was considerably thinner, and the tooth was shaved its entire length. In making the trial cut, the cross slide was offset 0.010 inch, and the blank rolled four holes in the 54-hole circle, and the trial tooth shaved upon both its sides. These amounts were afterward increased to an offset of the cross slide to 0.015 inch each side of the zero line and seven holes in the 54-hole circle. This gave a

tooth that gaged up as desired at its inner and outer ends on the pitch line.

If the teeth of the pinion are not to be filed at their inner end above the pitch line to bring that portion of the tooth more nearly to shape than the cutter will leave it, it may be necessary to widen the space at the inner ends of the gear to give additional room. On the finer pitches, the cutter leaves the teeth so nearly correct that they need not be filed; but in the coarser pitches, filing is quite necessary.

Cutting the Teeth.

Having established the amount off center, and the angle to roll the blank, proceed to cut the rest of the teeth. If the pitch is rather coarse, three cuts may be necessary all the way around each blank. In the finer pitches, however, two cuts around are sufficient. In the case of three cuts, the first is a central cut made as already shown, with the standard cutter, all the way around, and then the two thinning cuts follow. Some gear-makers use a so-called "stocking cutter" in making the central cuts, afterward thinning the teeth with a standard cutter as noted. This undoubtedly leads to less sharpening of the standard, and therefore, less wear.

If the pitch allows two cuts around the blank to be sufficient, the first is, of course, made with the table offset and the work rolled to shape one side of the teeth, and the second, with the machine and work set to shape the opposite side, each cut going all around the blank.

Figs. 16, 17 and 18 show the cross-feed screw index dial, as adjusted for the central cuts, and afterward the thinning cuts.

Fig. 15 shows the amount that the space is wider than the cutting edge of the cutter; and Fig. 19 is a general view of the entire machine as set up.

General Directions.

In closing, it may be well to note some precautions: Mounting the work as shown, with all "overhangs" as short as possible, still leaves the outer end unsupported. Care must therefore be taken to have the taper arbor in the index head well fitted and driven firmly in place; the work must also be mounted upon the outer end of the arbor so that it will not slip under the action of the cutter.

The cutter must be carefully ground sharp, with each cutting edge radial and exact, relative to the center hole. The cutter must also be in coincidence with the center line of the index centers or the teeth will "hook," relative to the apex of the cone as well as to the radius.

In making adjustments of the cross-slide or with the index pin, see that the final motions are always in the same directions. This prevents errors of adjustment due to lost motion or backlash. For example, in Fig. 17 the zero setting was made by moving the cross-feed handle to the right until the dial read to the zero mark. That shown in Fig. 18 was a continuation of this motion, and in Fig. 19 the handle was reversed at least a half revolution, and then turned in a right-hand direction to the required graduation. All milling machines and index heads are provided with means of clamping the several slides and swivels, and these should always be tightened while the cut is being made, and, of course, loosened when adjusting. After the indexing for a cut, place the counting sector in readiness, as shown in the cuts, for the next adjustment.

In turning up the blanks, machine an extra one to use as a "dummy" for setting the machine. This dummy may be used until cut up. Finally, settle upon a regular order of operations, follow it until a habit is formed, and fewer errors will result.

* * *

Prof. Battle, of London, stated in the course of a recent lecture that it is believed that American roller press flour is a prime cause of the great increase of appendicitis noted since its introduction throughout the world. He claims that particles of iron are found in the appendix concretions, etc. Unfortunately for Prof. Battle's theory, machinists show no greater susceptibility to appendicitis than people engaged in other occupations, and surely the machinist swallows a much larger quantity of iron dust every day, while in the machine shop, than he ever gets in the bread he eats.

EXAMINING AND TESTING FILES.*

OSCAR E. PERRIGO.†

In discussing the question of files and their qualities, it may not be out of place, and it should certainly be of interest, to consider briefly the properties of files in general, and more particularly, the characteristics of good files.

While a file is one of the oldest and most ordinary tools of the mechanic, and one with which every machinist is supposed to be perfectly familiar, it is yet the one tool about which the average machinist knows the least, when the fundamental principles of its construction and operation are considered, and with which he is usually less efficient than with almost any tool he uses. In former years this last condition did not exist in nearly as great a degree as at present, for the reason that hand tools were used to a far greater extent. Apprentices were early taught their proper use, and in time became very expert and efficient, particularly with the cold chisel and hammer and the file. It has been well said that "the range of usefulness of a good file is only limited by the skill and efficiency of the operator."

Although the file is one of the oldest tools, it is one whose simple design and primitive construction has seemed to defy all attempts to improve it, except in the form of its teeth

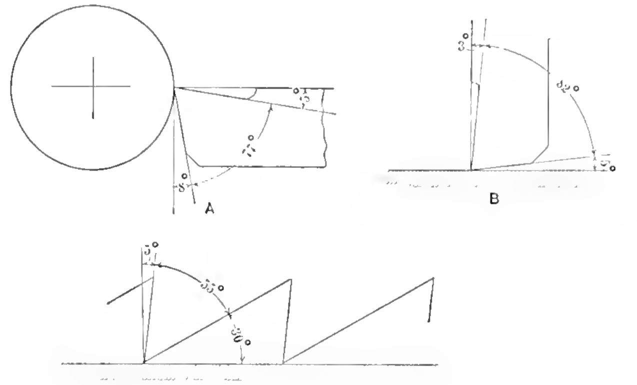

Fig. 1. Cutting Angles of Planer Tool, Lathe Tool and File.

and the methods of its manufacture. Machines have been invented to do much of the work of file-making, which was formerly performed by hand, but still many thousands of files are annually made by the same primitive hand methods that were used hundreds of years ago—the cold chisel and hand hammer. In fact the file that is mentioned in the Bible (1st. Sam. 13 : 21) was probably made in substantially the same manner.

Characteristics of the File.

The file, like many other tools, has three distinct and important characteristics, which demand attention of the manufacturer, the buyer and the user, if quality is to be taken into account, namely: first, the quality of the steel of which it is made; second, the form of its teeth, no matter whether cut by machine or by hand; and third, the temper, no matter by what process it has been hardened.

The first of these questions, the quality, and hence the price, of the steel used, should cut as little figure in producing a really good file as in producing any other good tool. Yet there is more than a suspicion, from the most casual and superficial test, that there is a great deal of poor steel used in the manufacture of files.

The form of the teeth, as will presently be shown, may vary considerably in different specimens, or they may appear in an ordinary examination to be very nearly alike, but when it is considered how little variation there may be between the teeth of a good file and those of a comparatively worthless one, this point assumes much importance.

The tempering of files is another process in which much ingenuity and study may be profitably employed. A good process, properly applied, may almost save a poorly made file and produce a fairly efficient one, while a poor or defective process, or one inefficiently handled, will ruin a file

* For further information regarding testing of files, see MACHINERY, February, 1898, The File and Filing; March, 1898, The Bite of a File.

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of excellent material and, so far, of good workmanship. The tempering should be so performed as to produce *hard*, and at the same time *tough*, teeth, and as nearly as possible *uniformity* of temper over the entire surface of the file, from heel to point.

The essential features and characteristics of files, to which it is advisable to give attention, in a systematic examination and practical test of files of different lengths, forms and cuts, will now be taken up in regular order.

Correctness of Form of File Blanks.

With the exception of the edges of such files as are called "hand, or pottance," "equalling," "pillar," and a few special forms, having the same width through their entire length, there should be no absolutely straight lines lengthwise of a file. All these lines should be convex. The amount of this convexity on the sides of well-made flat, square, round and taper (triangular) files, is substantially 0.08 inch per foot, that is, a six-inch straight-edge placed on the file and touching it at the center will show a space of 0.02 inch open at each end. On the edges of such shapes as half round, crossing, knife, etc., this convexity will be about twice this amount. Special curved files are, of course, excepted. Distortion from these limits should be observed, and files having concave lines, short bends, etc., should be rejected, except when they are to be used on very ordinary or rough work.

Transverse surfaces, nominally flat, should be very slightly convex, more nearly straight on fine cut files than the ordinary kinds. Those having concave surfaces should be rejected.

Surfaces which should be the arc of a circle, such as half round, crossing, round, etc., may be tested for correct form by laying them into drilled holes of various diameters in a thin plate of iron or steel. It will be found that a cheaply made file will hardly ever conform to a true arc, but is liable to have flat places on its surface, which, when in use will not come into proper contact with the work.

Triangular files may be tested for form with a 60-degree thread or center gage, and the corners of square and flat files with a thin steel square.

It will be surprising to note the many inaccuracies that will be brought out by these tests.

Not only the *form*, but the *finish* of blanks should be examined. It will usually be found that American-made files have a finish much superior to that of imported files, in which will be found deep scratches and furrows that detract not only from the appearance, but the efficiency of the file, particularly of the finer qualities.

The blank must not only be *thoroughly* annealed, but it must be *evenly* annealed. If there are hard and soft spots, it is evident that, in the cutting, the chisel will sink deeper in the soft than in the harder portions, thus making an uneven cut and a file comparatively worthless, for good work.

Correctness and Uniformity of Teeth.

The variation in the number of teeth on the different sizes, shapes and cuts, as well as on files of different manufacturers, is very considerable, ranging in files of 14 inches long and shorter, from 20 to over 200 per inch. On ordinary machinist's files, made in this country, the following is a fair average, *viz.*:—bastard cut from 20 to 25 per inch; second cut, 30 to 40; smooth, 50 to 60; dead smooth, 70 to 80.

Of the finer files, whose grade of cutting is indicated by numbers, the Grobet Swiss Files are as follows: No. 0, 40 to 70 teeth per inch; No. 1, 75 to 88; No. 2, 58 to 104; No. 3, 100 to 130; No. 4, 120 to 160; No. 6, 200 to 220.

Of the American made files of similar shapes and sizes as the Grobet files: No. 0, 35 to 60; No. 1, 55 to 75; No. 2, 80 to 95; No. 3, 90 to 120; No. 4, 125 to 135; No. 6, 160 to 200. It will be noticed that there is more regularity in the American system of numbers than the foreign. There is yet room for an improvement, similar to that made in this country in the old time wire gages.

The form of the teeth is a matter of much importance. If we analyze the form and action of a file tooth, we find it to be a straight knife or cutter as, for instance, a broad lathe or planer tool, whose face angle (or top rake) and whose cutting angle (or relief) will determine the amount of pressure necessary to cause it to cut, and which frequently (in the planer tool) has its line of cut set at an angle to the line of motion (as a file tooth), to cause it to cut easier and smoother. If this cutting edge is very thin and sharp, it is evident that the necessary pressure is very much reduced, while it may be so thick and with so little relief as to slide over the work, even under greatly increased pressure.

In the case of the file we have a large number of similar cutting edges, and consequently a proportionately large increase of pressure necessary to produce the desired effect. For this reason, and from the fact that the available pressure is greatly limited, the cutting edges must be comparatively thin and sharp, and the cutting angle (or relief) must be very acute. For instance, in Fig. 1, at *A*, is shown the proper angles for a lathe tool, and at *B*, those for a planer tool.

At *C* are given the ideal angles for file teeth. While these file teeth angles are desirable and would make an excellent file, they are not practically attainable mechanically. If the teeth of files were formed by a tool traveling parallel to their cutting edges we might produce any angle desired. But this is not practical. The teeth are formed with a rather obtuse angled chisel, which raises a portion of the metal above the surface being cut, as well as makes a depression

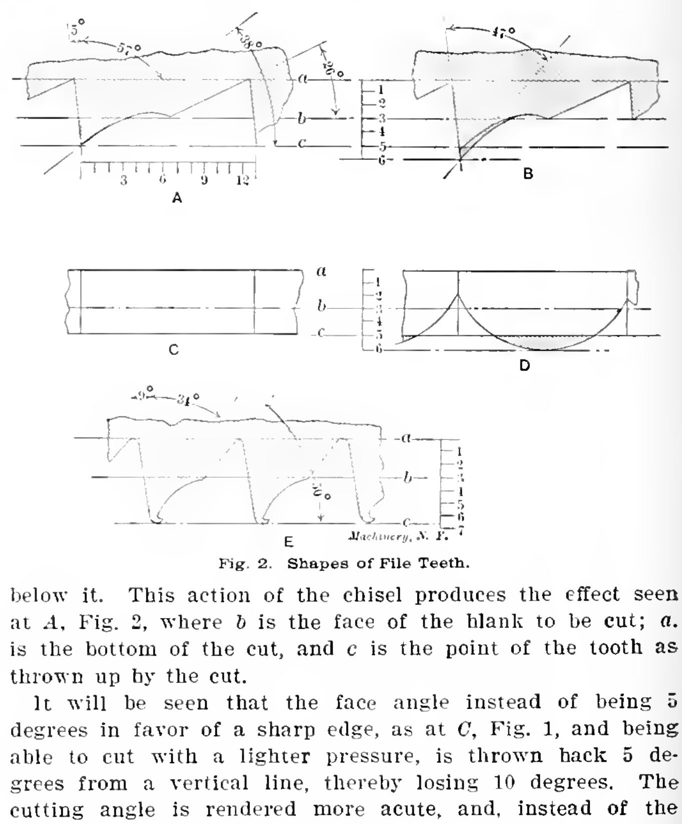


Fig. 2. Shapes of File Teeth.

below it. This action of the chisel produces the effect seen at *A*, Fig. 2, where *b* is the face of the blank to be cut; *a*. is the bottom of the cut, and *c* is the point of the tooth as thrown up by the cut.

It will be seen that the face angle instead of being 5 degrees in favor of a sharp edge, as at *C*, Fig. 1, and being able to cut with a lighter pressure, is thrown back 5 degrees from a vertical line, thereby losing 10 degrees. The cutting angle is rendered more acute, and, instead of the 30 degrees shown at *C*, Fig. 1, a tangent to the curve at the cutting edge shows 38 degrees, thus compensating to a considerable extent for the change of the face angle. At the same time, the angle of 55 degrees for the cutting edges, Fig. 1, becomes 62 degrees ($57 + 5 = 62$).

There is one other element that enters into this condition and modifies it considerably. This is the cross cutting of the file. It may here be remarked that many mechanics fall into the error of supposing that the cross cutting *follows* the regular cut, while in fact it preceeds it, as a strong magnifying glass will readily show.

The influence of this cross-cutting is shown at *B* and *D*, Fig. 2. At *B* the darker shaded portion of the section of the tooth is due to the cross-cutting and when seen from the front causes the tooth to assume the rounded form shown in section at *D*, while in a single cut file the edge of the tooth would appear as a straight line, as at *C*. The cutting edge of a cross-cut file is quite thin, the angle being changed from 62 to 47 degrees, and it is this delicate but very useful, keen, edge that is soon lost by rough usage and too

much pressure on a new file, or by careless handling, allowing files to come into direct contact with each other. It is the custom with many manufacturers to reduce these sharp edges or points somewhat, either by a fine file or emery stick, or similar means before tempering, or by a sand blast in the cleaning process after tempering. One reason for doing this is that these fine points are not all of the same height and therefore give the file a tendency to "scratch" when first used. This is avoided by levelling them down. The better process is to use pulverized clay instead of sand in the cleaning blast.

At *E*, Fig. 2, is shown a cross-section of the teeth of a poorly cut file. In this case the angle of the edge of the cutting chisel is too acute, the pitch of the teeth is too short, the blow too heavy, and the consequent result is that the extreme points of the teeth are turned over in a "burr" which, by the tempering process, will necessarily be much harder than the thicker parts of the tooth, and will soon break off, as may be seen by standing with ones back to the source of light, holding the file on a level with the eye and looking lengthwise of it from the point to the tang, the broken points of the teeth being seen as small glistening spots or fractures.

In examining and testing files the pitch and form of the teeth will call for much careful attention, as much may be learned from their characteristics when viewed through a magnifying glass, which should not be over a half inch focus.

Uniformity of Temper.

There are various simple methods of testing a file for uniformity of temper that will readily suggest themselves to a mechanic, the most common being with the end or corner of a smooth piece of steel hardened very hard and not drawn to temper. This may be rubbed or drawn for a short distance over the file teeth at various points on the surface of the file, and the results examined with the aid of the magnifying glass. To one accustomed to such work the results will be very conclusive, the points of the file teeth being distinctly bent over where the temper is too soft.

Durability on Metals of Different Degrees of Hardness.

If we were to establish a file testing plant it would probably include, as an important factor, a filing machine particularly designed for testing the durability of files on different metals. In this machine provision would be made for a reciprocating motion of the file to be tested; a device for feeding the end of the metal to be filed up to the file; and a recording apparatus which would indicate, by a curved line traced upon a ruled sheet of paper, the number of strokes of the file, the amount of metal cut away, etc.

A machine of this character was constructed and used in Manchester, England, and described by Mr. Edward G. Herbert, who records some valuable data as the result. He claims to have found that with English files there was a great difference in the efficiency of the two sides of these files, amounting in some cases to 30 to 1. Judging from the many cases of distortion of foreign, made files, their methods of tempering do not compare favorably with those in use in the United States, and this may account, to some extent at least, for such results. A difference in the efficiency of the two sides of a file has been often observed, but there is no record in this country of such results as Mr. Herbert has observed. Possibly it is for the reason that we can claim in file making as in many other mechanical processes, great improvements in the details of the work, and demonstrate in many respects the superiority of American products, including files.

In testing the durability of files by hand, comparative tests will, of course, have to be made by the same man, as no two men will handle a file exactly alike. Each file may be used for 500 strokes; then examined under the magnifying glass and the results noted. Then 500 strokes more, and again examined, noted, and so on until the file refuses to cut. The amount of metal filed away should be weighed carefully. These tests should be made on cast iron, wrought iron, soft steel, and steel hardened and drawn so that it will require a fairly good file to cut it at all.

By using pieces of half an inch square, containing one-quarter of a square inch area, and carefully measuring the length before and after each 500 strokes, the careful saving and weighing of the filings may be avoided. Either method may be rendered very instructive, exact and valuable.

Strength and Elasticity.

These two qualities may be tested at the same time. A convenient arrangement for holding files during these tests will be any kind of a vise with jaws in a horizontal instead of a vertical position.

These tests will consist essentially of clamping the tang in the vise and suspending known weights upon the point, noting the degree of flexibility for *elasticity*, and the weight necessary to finally break the file to ascertain the relative *strength*. A good file should bend to the extent of 5 degrees without breaking, and some will bend several degrees more. Those breaking at 2 degrees are too brittle for practical use. If long, slim files break at 3 degrees they should be rejected, as the workmen are likely to break them before they are half worn out.

This article has been prepared with a view to proposing only such methods as are easy of practical application, without any special or expensive apparatus being necessary.

* * *

RIFLED PIPE LINES FOR CONVEYING OIL.

A contract has been let by the Southern Pacific Company for the building of a rifled oil pipe line 256 miles long from oil properties in Kern County, in the southern part of California, to tide water on San Francisco Bay. An interesting feature of the line is the character of the pipe used, its "rifled" construction being a radical departure from that of lines now generally in use for conveying oil. Spiral indentations accomplished in the rolling of the pipe constitute the rifling. (See MACHINERY, February and July, 1906, engineering edition.) An exhaustive series of experiments has demonstrated that after a small per cent of water has been added to the oil, and the necessary pressure applied, that the whole will develop a whirling motion, and that the water being the heavier will seek the outside of the pipe, thereby enveloping the oil in a thin film or shell of water, this shell or film of water acting as a lubricant between the oil and the pipe, and thereby greatly reducing the friction and allowing the core of oil to glide through the pipe readily. Throughout the length of 256 miles of pipe there will be twenty-three pumping stations, the equipment of each station being in duplicate so that in the event of a breakage of any part of the machinery of one pump, the other may immediately be put into service. With the size of the pipe, which is 8 inches, and the high pressure carried, and improved facilities in every way, a rapid transmission of the oil has been shown to be possible, and it is estimated that at least 23,000 barrels of fuel oil can be delivered every twenty-four hours.

* * *

A POOR REASON WHY.

"The Creator made the ocean salt to save the land from putrefaction," etc.—*Marine Journal.*

This might be defined as an excellent example of reasoning that runs like a crab—backwards. The flora and fauna of the earth to-day are what they are because the conditions of environment, past and present, have been favorable to their development. If the ocean had been fresh there would have been, no doubt, an entirely different existing order of life, and then some would-be philosopher would have gravely remarked how fortunate it was that the ocean was fresh, etc. The author of the paragraph should take a half-hour course in the elements of world-making and evolution. He might as well assert that it is fortunate that the sun gives light or that rivers always flow through the valleys.

While the above is not precisely germane to the general character of MACHINERY, it was written for the purpose of emphasizing the need for clear thinking, which shall not confuse cause and effect. Perhaps in no business is it required more than in machine design and construction. The qualities that are required in the mental make-up of the designer enable him to quickly understand the absurdity of such reasoning as the above quotation, notwithstanding that many writers indulging in it have acquired some fame.

MAKING SWISS FILES IN AMERICA.—2.

In the September issue was published a description of the methods followed in the manufacture of files by the American Swiss File and Tool Co. of Elizabethport, N. J. Various operations were illustrated and described, leading from the cutting, forging and annealing of the stock, through the grinding and stripping operations, to the store-room, where the blanks await their turn to have the teeth formed on them.

The File-cutting Machines.

Those files which are to be machine cut are taken to the cutting room, located as shown in the plan Fig. 2. (See previous issue.) There was a noticeable absence of noise in this department, compared with what the writer has met with elsewhere; conversation was easily possible with everything going at full blast. Mr. Reichhelm attributes this freedom from noise to the care with which the foundations of the file-cutting machines were laid. They go down 2 feet below those of the building foundations. There is a row of these desired depth, and means for feeding a file blank past the chisel at such a rate of speed as to give the desired spacing of the tooth.

The machine shown is driven by the belt and pulley at *A*. A cam is keyed to the driving shaft which, through a lever, raises the ram in head *C* against the resistance of the India rubber spring *D*, and allows it to fall again freely. The chisel *E*, held in the end of the ram, is thus able to deal a series of very rapid blows on the blank beneath it, the shaft revolving at a high rate of speed, and the cam having several lobes or teeth. The work *F* is laid on a holder *G*, resting on the inclined bed of the machine. It is fed along under the chisel, being drawn by a plate *B*, which is clamped between friction rolls at *H*. These rolls are driven at a uniform rate of speed, through gears and belting, from the main shaft of the machine. No provision is made for varying the spacing in a file, the makers believing that there is no virtue in the "increment" cut, but that there is a decided advantage in having the file uniform from end to end.

Fig. 7. General View of the Cutting Department of the American Swies File and Tool Co.

monolithic bases extending the full length of each side of the cutting room. Only about one-third of the space reserved for these machines is as yet filled. Fig. 7 is a partial view of that side of the room in which the equipment of machines has been completed. The curtains shown hanging from brackets on the wall are used to prevent cross lights, at times when the sun is shining in such a way as to offer difficulties on this score. In order to see just what he is doing, it is necessary for the workman to have the light shining on his work from the front.

Three designs of file-cutting machines are in use in this room. There are the original machines with which the business was begun, made by an American firm, the Hess Machine Co. of Philadelphia; then there is a German machine of quite different construction; and in Fig. 8 is a picture of one of the latest machines which have been installed. This embodies the results of the firm's experience with the two previous types. A file-cutting machine provides, essentially, means for striking a series of rapid blows with a suitably formed chisel to any

The presser foot *J*, under the influence of a weight, follows the work just in front of the chisel and holds it firmly down to the holder *G*. The latter has a cylindrical bearing on a seat in the bed, so that on flat files the blank is free to adjust itself under the presser foot until the surface is parallel to the cutting edge of the chisel. In the case of half-round files, the holder is rocked by handle *K* to bring under the influence of the chisel any part of the surface desired. The distance between the work and the chisel may be altered by crank *M*, so the depth of cut may be varied at will. This is important, and much of the skill of the cutter lies in his adjustment for depth of cut. It is a vital requirement that the teeth be uniform from end to end. On a tapering file, such for instance as the flat side of a half round, a blow on the point of the file of the same force as that delivered in the middle section, where the blank is widest, would make so deep a cut as to almost sever the blank. The workman, then, in running from the point to the heel, starts in lightly, increasing the force of the blow by adjusting the crank *M* as

the width of the blank changes. The setting of the bed on an angle as shown, and the continuous feeding of the blank while the blows are being struck, has the effect of opening up the teeth as the chisel leaves each cut.

Etching of Teeth in Files.

Most mechanics are familiar with the idea of file-cutting with a chisel by hand or machine, but how many of them are aware of the fact that great quantities of the files they use are not made with the chisel at all, but by a grooving process somewhat akin to knurling, and known as "etching"? The workmen shown in Fig. 9 are employed in this work. The file

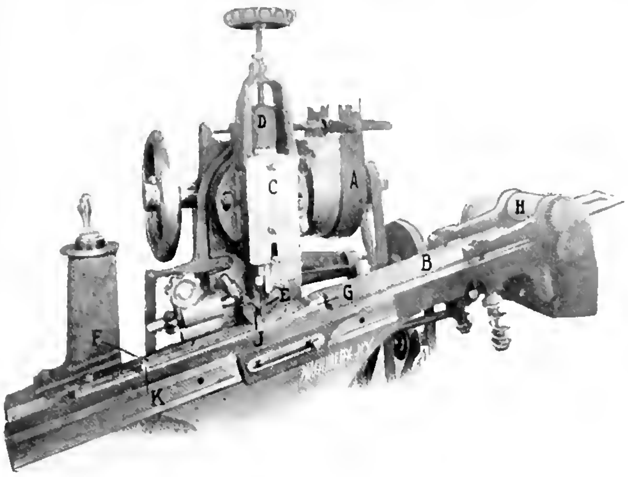


Fig. 8. File-cutting Machine.

being treated is laid in the holder as shown, where it is steadied and guided by the workman's left hand. With his right hand, by the handle which it grasps, he operates the etching tool attached to the swinging framework. This tool is a triangular bar with file teeth cut in each of its three edges. Any one of these edges may be presented to the work. The cutting of these teeth is an art in itself. They have to be made with uniform depth and regularity, since it is necessary for the teeth to "track" in the grooves previously cut in the work. The etching tool is simply swept back and forth across the work at the proper angle and with the proper degree of pressure, as determined by the foot of the operator

Fig. 9. Process of "Etching" Teeth on Files.

bearing down on the stirrup shown hanging from the handle. The teeth on the edge of the tool cut and trace out the grooves which are to form the teeth of the file. Simple as the process sounds, it requires a high degree of skill. No little training is necessary to give the steadiness of movement, evenness of pressure, and sureness of positioning needed. The process, as practiced here, is an improvement over that employed in Switzerland, where two operators are required, one to hold the blank and the other to guide the tool, using both hands for the purpose. In the case of round and half round surfaces, the tool is swept across the blank in a series of strokes from one end to the other on one portion of the surface. The blank is then rotated a trifle and the operation repeated, and so on until the whole surface is covered. So well must the etching tool be made, however, and so careful is the work, that the teeth are continuous throughout the whole surface.

A machine is being tried out in this shop for performing this operation. It is shown in Fig. 10. It duplicates the motions of the workman in the hand operation. The work is held at *A* and the etching tool at *B*. The tool is swept back and forth across the work on the angle desired for the tooth, the pressure being relieved on the back stroke. The blank is turned from time to time, if the surface is curved, so as to bring the whole area of the file under the influence of the etching tool. The process bids fair to be successful.

The shape of the file is the consideration which determines whether a blank shall be etched or cut with the chisel. A flat surface cannot be etched, nor is there any need for it. On round surfaces, however, particularly where it is necessary to preserve accurately the outline of the blank, etching is preferable to cutting. In a round file, the action of the chisel throws up the stock in such a way that the shape is polygonal, rather than round, when the file is completed. In etching, on the contrary, the process is that of cutting out the metal, leaving the original contour undisturbed. The workman cuts in with his etching tool only enough to bring the teeth to a sharp edge, without bringing this edge below the original surface. For this reason, in any curved shape where an accurate outline

Fig. 10. "Etching" Machine.

is desired, etching is the process used. Teeth coarser than No. 1 cannot readily be formed in this way, owing to the difficulty of applying enough pressure, and at the same time guiding the tool with precision.

The Hardening Department.

After the forming of the tooth, either by cutting or etching, the maker's name and the number are stamped on the file, and the extreme end, where the teeth are not perfectly formed, is sheared off. Then it goes to the hardening department. As before remarked, much mystery is made by some file making firms of the heat treating process. There is no mystery visible here, nothing but an application of common sense and long experience in the hardening of tool steel. The equipment of the room consists of two hardening furnaces, with lead baths, suitable brine tanks and brine cooling apparatus, and appliances for cleaning the files by a steam blast carrying a powdered earthen material. This is all shown in the general view of the hardening room, Fig. 11.

In hardening, the following procedure is adopted: A boy stands at the left of the furnace man, as shown in Fig. 12, the furnaces themselves appearing at the right of Fig. 11. The boy has at his left a pile of the files to be treated, and on the table back of him a supply of iron handles with sockets having holes pierced in them to match the tapered shanks of the files. At regular intervals, at such a rate as to always keep a certain number of files in the furnace, he inserts the shank of a file in the socket handle, which he lays on top of the furnace with the file hanging down into the pot of melted lead. The surface of the lead is covered with

coke dust, to prevent oxidation, and the temperature is kept constant at about 1600 degrees by a Bristol pyrometer.

As each piece of work becomes thoroughly heated, the operator removes it, plunges it into the brine tank and then into lime water, where it is cleaned, and then holds it for a moment under a steam jet. This latter heats it so that it dries immediately, thus obviating the danger of rusting. In small files especially, the transfer from the furnace to the brine tank has to be made very quickly, in order to prevent cooling before the water is reached. For this reason two tanks are provided. The small one, close to the furnace, is for small files, which cool too rapidly to permit a long journey through the cool air. The large one, a little further back, is used for larger work. The body of water in the large tank does not heat up so rapidly, and there is less danger of cooling with these files in carrying them the greater distance required.

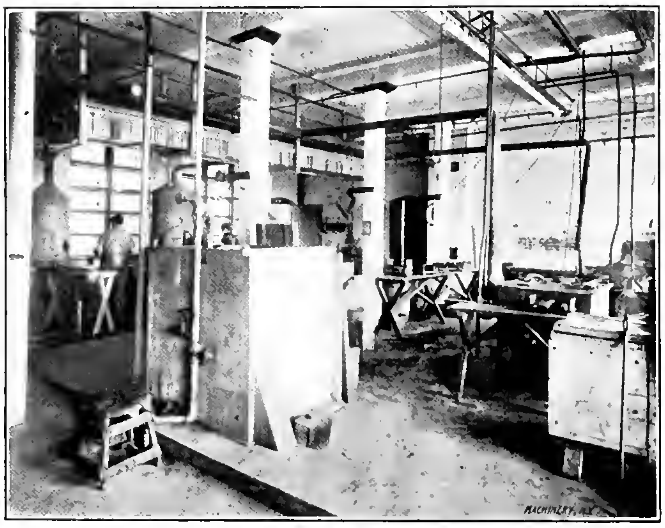


Fig. 11. General View of the Hardening Department.

Mr. Reichhelm is much pleased with the work of the Bristol pyrometer. It seems to do its work very accurately, is comparatively inexpensive in the first cost, and in renewal of the "elements," or that portion of the instrument which is subjected to the heat it is desired to measure. In his work, however, the pyrometer is used fully as much for keeping the temperature from fluctuating as it is for indicating absolute temperature. The condition of the work, as to color and hardness, is the prime consideration. When the bath is of such temperature as to give the required color and hardness, the pyrometer reading is noted and the bath is tried from time to time to see that that temperature, whatever it may be, is kept constant.

The provision for furnishing a cool supply of brine is worth noting. The apparatus used is shown, diagrammatically, in Fig. 13. The underground reservoir contains a saturated solution of salt and water. This tank is of wood, on which, of course, the brine has no injurious effect. Located within it is a box of sheet lead, with an inwardly opening valve of the same material at the bottom, and an air supply pipe and an outlet pipe, also of lead, entering the top. The latter of these two pipes comes nearly to the bottom of the box. The operator at either of the two hardening furnaces, by pulling a cord, can open a three-way valve, which admits air under pressure at the top of the box. The box being full of brine, which has flowed in through the check-valve at the bottom, the air pressure closes this valve and forces the liquid through the outlet pipe into the cooling and supply tank above. This latter tank, seen in the foreground of Fig. 11, is high enough so that the brine flows from it by gravity to the bottom of the tanks at the furnaces. The cooled brine entering at the bottom of these tanks rises and displaces the warmer fluid, which runs through an over-flow at the top back to the reservoir again. In the cooling tank is a coil of pipe, through which water flows continuously from an artesian well sunk on the premises. This serves to keep the supply of brine cooled.

After the hardening there is a slight oxidation of the surface of the file, little more, however, than a stain; it could scarcely be called scale. To remove this the work is taken to the cleaning apparatus shown in the left background of Fig. 11. The sheet metal cases shown contain a quantity of water mixed with a fine clay. This clay is almost impalpable, with no perceptible grit that can be felt between the thumb and finger. A steam ejector draws the mingled water and clay from the bottom of the casing and directs it in a stream upward against the files, of which several at a time are grasped by the operator in a pair of long-jawed tongs. A few seconds' exposure to the blast, first on one side and then on the other, removes the stain from the cutting edges and leaves them bright and sharp. From here the files go to the packing department where they are inspected for hardness and accuracy of cutting, oiled, and wrapped in suitably labeled boxes ready for marketing.

Special Forms of Files.

What we have said of the methods of manufacture followed relates to files with more or less regular outlines, which readily admit of being formed and cut by machinery. Great numbers of special shapes have to be made, however, in which the use of machinery is impossible. In the case of the various forms of rifflers for instance, used by toolmakers and diemakers in working out otherwise inaccessible corners, the whole work of forging, stripping, cutting, etc., has to be done by hand, the surface being too irregular to admit of any other procedure. Other special forms of files are made here for various purposes. One interesting product is a form used in sharpening pins. It will be news to many mechanics, doubtless, to know that the points of pins are filed. The filing is done by square blocks of steel with single cut teeth formed in them, fastened to the sides of rapidly revolving disks. Large quantities of these are made here.

Swiss vs. American Files.

The Swiss file is the outgrowth of the Swiss watch industry, which is nearly or quite 200 years old. These watches have been and are now made quite largely by hand, so that the production of files of the very finest grade early became a vital necessity in that country. To this demand the high standard of the Swiss file may be traced. This excellence is due to the manual skill of the men who form the teeth, and the careful inspection which rejects all which are below the required standard of quality. As intimated, great skill is required to produce teeth of uniform depth and sharpness with the comparatively crude annealing methods used. The workman must be continually varying the force of his blow as he reaches spots of greater or less hardness. In cases where the variation is too great, the file has to be rejected. In a similar way, with the hardening process used, the inspection weeds out a considerable percentage of failures. This care, and the expertness of the help, accounts for both the excellence and the highness of the price of the European product.

Fig. 12. Heating Files in the Lead Bath.

The conditions which make it possible to compete with these makers are: the scientific method of annealing which reproduces the same conditions day after day, and year after year, giving a uniform product requiring the discarding of very few pieces; the use of machinery in cutting the teeth, made possible by this uniformity of annealing and making

possible the cutting of good teeth at a not prohibitive cost; the ability to reproduce the same conditions in hardening day after day by careful attention to the uniformity of the steel, the tempering of the lead bath, and other qualities; and finally the exercise of the same old-fashioned care and conscience that show themselves so plainly in the product of the standard Swiss manufacturers.

In making these files in America, it was decided that no improvement would be attempted, for the present at least, in the shapes and sizes of the blanks and the fineness of the teeth. These designs have been the result of filling the gradually developing needs of some of the most skilled hand workmen in the world, so it is not the task of a day or a year to

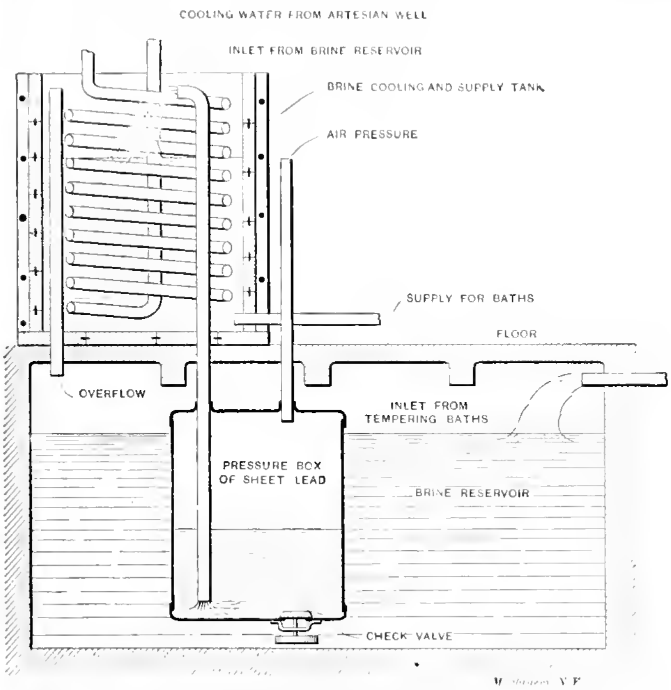


Fig. 13. Diagram showing Apparatus for Storing, Cooling and Transferring Brine.

devise anything better. For this reason, the product of this firm follows exactly in these particulars the product of the best Swiss makers.

This article has been given up largely to a description of machines and processes. Looking at the business in the way Mr. Reichhelm does, these machines and processes, important as they are, take a second place when compared with the necessity of having capable and efficient men to look out for them. It is fitting then that some of these men should be mentioned—the more, from the fact that the writer is indebted to them for the cheerfulness and intelligence with which they answered every question he saw fit to ask. Mr. Hermann Neff, superintendent, Mr. Ibach, the foreman of the forging and annealing rooms, Mr. Poncheron, the foreman of the etching department, and Mr. Kerr of the cutting department, may be mentioned in this connection, though, so far as the writer could judge, the name of every workman he met should also be included in the list. Mr. Joseph Broome, of New York, was the engineer responsible for the design of the buildings and the power plant.

* * *

A hammer, pliers, a cold-chisel or two, and a vise, in almost any old shack may, by courtesy, be called a shop, but the average owner of such an outfit seems to think that it will not be so regarded unless he scrawls somewhere on the inside or outside the legend "No admittance." So, wherever one goes, in town or country, the identity of the little tinker shop is revealed by this insulting and discouraging sign. Scarcely no other business would or could repel business in this foolish way, and why does the mechanic? His tools are not so enormously valuable, and of trade secrets he has none. Is the practice caused by an exaggerated idea of self-importance, or is it a custom inherited as part of the trade? Whatever may be its reason, it is a custom that is best honored in the breach. Common courtesy demands it, and a mechanic should not brand himself a boor by observing it.

THE BURGLAR AND THE SAFE-MAKER.

In the September, 1906, issue an editorial under the above caption appeared, dilating on the struggle that is constantly going on between the burglar and the safe-maker. In view of the statements then made, the following letter on safe-blowing from Consul Thomas H. Norton, Chemnitz, Germany, is of considerable interest to safe makers and users:

The confidence of German manufacturers of safes in the resistance of their wares against ordinary safe-blowing operations has been rudely shaken by the recent achievements of a single unaided robber in Dresden and other cities. The details of his last operation are as follows: A room was secured in a hotel, which was situated immediately above the office of a money changer. At night a hole was pierced in the ceiling of this office. By the use of a drill and saw a circular piece of the flooring was easily raised. Beneath lay a thick layer of cement. A small orifice was made in this and an umbrella shoved down into the space below. The umbrella was attached firmly from above, and when opened received without noise all the fragments of cement which were dislodged as the hole was enlarged so as to allow of the easy passage of a person. By means of a rope ladder the descent was readily made into the office below. Curtains were drawn, and with heavy blankets a tent was constructed around the safe, so thick that no ray of light could pass through. Next the robber brought down two cylinders of compressed oxygen and an acetylene generator charged with calcium carbide and water. With these he was able to produce a blowpipe flame of such intensity that steel fuses in it like lead in an ordinary gas jet. It required but a brief space of time to melt away so much of the door that all the contents of the safe were accessible. They were carried to the room above. At an early hour the robber left his lodgings and disappeared without trace.

The suggestions of the Consul for means to foil the efforts of the safe-cracking gentry are also of considerable interest:

It is evident from this experience that the builders of safes must provide for new contingencies in their constructions. The simple, light, acetylene generators, now in widespread use, and the equally simple oxygen generators, charged with water and sodium peroxide, or the heavier cylinders of compressed oxygen, place at the service of the intelligent crook the possibilities of opening the strongest safes in existence rapidly and noiselessly, provided the operator can be screened from observation.

Some large safes are so disposed that they are under frequent observation by watchmen looking through windows. Usually this observation is confined to the doors of bank vaults or the like, although in the case of the globular safes it practically extends to all exposed sides. In the greater majority of cases existing safes would offer next to no difficulty to a skillful cracksman if able to work without being seen. It is evident that owners will be forced henceforth to adopt such measures as will reduce to a minimum all possibilities of access to free-standing, movable safes, or the hidden sides of safes, embedded in cement or masonry.

Manufacturers of safes will, on the contrary, be impelled to fight the scientific burglar with his own weapons. In somewhat the same fashion by which time-locks prevent the opening of the lock of a safe during certain hours, it will be comparatively easy to introduce into safe construction chemico-mechanical devices which, during a limited time, would render it either fatal or physically impossible to remain in the vicinity of a safe or vault, were the walls or doors tampered with to such an extent as to allow access to the interior. By the use of a very simple form of apparatus containing potassium cyanide and sulphuric acid, a robber would expose himself to the deadly fumes of prussic acid.

Less dangerous, through possibilities of accident to those regularly using a safe, would be the employment of substances crippling a safe-blower or forcing him to an instantaneous retreat. The volatilization of a few drops of ethyl-dichlor-acetate would cause such profuse and persistent weeping that one in the neighborhood would be temporarily blinded if he persisted in remaining. The breaking of a tube of liquid ammonia would render immediate withdrawal imperative under peril of suffocation. Several similar compounds are at the service of constructors. Eventually the daring burglar, with sufficient scientific training, might venture to face the unknown dangers of a safe well provided with more or less effective neutralizing agents for the concealed possibilities of defense; but certainly for some time, at slight expense, effective protection can be devised against the attack of the scientific cracksman with his portable oxy-acetylene blowpipe.

Some of the measures suggested would be more dangerous to safe users than common prudence would permit, and as for all it is scarcely necessary for us to say that the ingenuity displayed by safe-breakers would probably enable them to readily overcome everyone of the obstacles suggested, for the Consul has practically admitted it, already.

REAMERS.—3.

ERIK OBERG.

Jobber's Reamer.

The jobber's reamer, Fig. 11, constitutes a class of reamers by itself. It is provided with a long fluted body and a taper shank, for use in machine; the corners at the point of the reamer body are slightly rounded, as shown at *a*. The radius for this rounded part should be about 1/32 inch for reamers smaller than ¾ inch in diameter, and 1/16 inch for larger

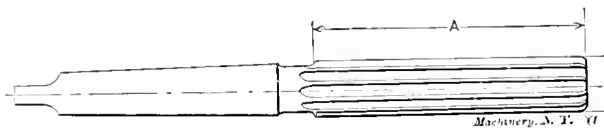


Fig. 11. Jobber's Reamer.

sizes. A neck is provided between the fluted portion and the shank, in order to permit of clearance for the grinding wheel when the shank and the fluted portions are ground. The length of this neck varies according to the size of the reamer. It is customary to make it about ½ inch long for a ¼-inch reamer, 1 inch for a 1-inch reamer, 2 inches for a 2-inch reamer, and 3 inches for a 3-inch reamer. The shank is nearly always made a Morse standard taper shank; the size of the shank used for different sizes of reamers is as follows:

Size of Reamer.	No. of Morse Taper.
From ¼ to ½ inch....................	1
From 17/32 to ⅞ inch....................	2
From 29/32 to 1¼ inch....................	3
From 1 9/32 to 1¾ inch....................	4
From 1 25/32 to 3 inches....................	5

Jobber's reamers are fluted with the same kind of cutters as hand reamers. The number of flutes is also the same as given for hand reamers in the August issue.

Dimensions of Jobber's Reamer.

As the length of the neck usually given to this class of reamers has already been stated, and as the number of the Morse taper shank determines the length of the shank part of the reamer, the only additional dimensions necessary are the length of the fluted portion and the diameter of the neck. The latter should be about 1/32 inch smaller in diameter than either the reamer itself or the largest diameter of the

TABLE X. DIMENSIONS FOR THE LENGTH OF FLUTED PORTION OF JOBBERS' REAMERS.

Diameter of Reamer.	Length of Flute.	Diameter of Reamer.	Length of Flute.	Diameter of Reamer.	Length of Flute.
D	A	D	A	D	A
¼	2	¾	4	1¾	6 11/16
5/16	2¼	⅞	4½	1⅞	6⅞
⅜	2½	1	5	2	7
7/16	2¾	1⅛	5½	2¼	7 5/16
½	3	1¼	6	2½	7⅝
9/16	3¼	1⅜	6¼	2¾	7 15/16
⅝	3½	1½	6⅜	3	8¼
11/16	3¾	1⅝	6½	..	...

Morse taper shank, depending upon which of these dimensions is the smaller; the only object is that the grinding wheel shall clear the neck when grinding the teeth as well as when grinding the shank. The length of the fluted portion may be determined from the formula:

$$A = 4D + 1 \text{ inch},$$

for sizes up to and including 1¼ inch, and from the formula:

$$A = \frac{5D}{4} + 4\tfrac{1}{2} \text{ inches},$$

for larger sizes. In these formulas, A = length of flute, and D diameter of reamer. Dimensions for the length of the flutes, approximately figured from these formulas, are given in Table X.

Shell Reamers.

In order to save the amount of stock which goes into the shank, shell reamers, having a hole through the center by means of which they are mounted on arbors, are quite largely used. As one arbor can be used for a number of reamers, the saving is quite considerable. An ordinary fluted shell reamer is shown in Fig. 12. The arbor on which it is used is shown in Fig. 13. The reamer has a keyway *A* which fits the key *B* on the arbor freely; the reamer, when at work, is rotated by means of this key and keyway. The hole through the reamer tapers, the taper being ⅛ inch per foot. Manufacturers of reamers have adopted certain standard sizes of arbors, and each arbor corresponds to a certain number of different sizes of reamers. Thus, several sizes of reamers are provided with the same size hole through them, and can be used with the same arbor. The arbor, as well as the hole in the reamer, must be ground after hardening, to insure that the reamer will run true. When hardening, if the

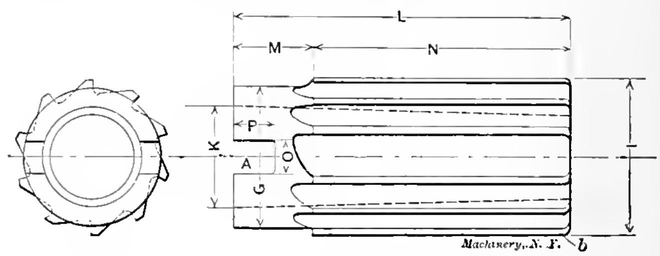


Fig. 12. Fluted Shell Reamer.

reamer is larger than 1¼ inch in diameter, its should be removed from the hardening bath, the same as large hand reamers, when it ceases "singing," and be plunged into a tank of oil, where it should remain until cool. When the tool is removed from the oil bath, or in the case of smaller reamers, from the water bath, it should be held over a fire and slowly revolved until at least partly relieved of the internal stresses, tending to crack the tool, which are due to the hardening process.

The outside of the reamer is provided with flutes and cutting edges for the greater part of the length of the reamer. A short distance at the end provided with the keyway is turned down below the diameter of the cutting edges. This is done in order to prevent any burr which may be set up by

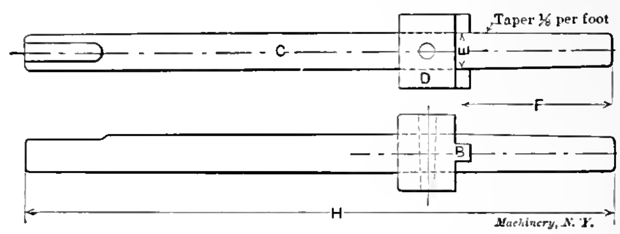


Fig. 13. Arbor for Shell Reamers.

the driving key on the arbor from interfering with the hole reamed, or spoiling the cutting edges of the reamer. Besides, this turned-down portion provides space for marking the reamer with its size, and gives a finished appearance to tool.

Fig. 14 shows a shell reamer fluted in the same manner as the rose chucking reamer. This reamer is termed a rose shell reamer. The cutting edges, fluting, and back taper are the same as described before under rose chucking reamers, September issue, but in all other particulars the tool is the same as an ordinary shell reamer.

Arbors for Shell Reamers.

The arbor used for driving shell reamers when at work consists of a stem, or arbor proper, *C*, Fig. 13, provided with a collar *D*, which is fastened to the arbor by means of a taper pin. On this collar a tongue *B* is milled on the end so as to provide for a key to fit the keyway in the reamer, as mentioned. Precaution must be taken in milling this tongue so that it is exactly in the center of the collar. The same care must, of course, be used in milling the keyway in the reamer, which must be exactly in the center. When grinding the outside of the reamer to size, it should be ground on an arbor similar to those on which it is to be used, and the edge at the front end slightly rounded as at *b*, Fig. 12.

Arbors, as well as driving collars, should preferably be made out of tool steel. The collar should be hardened. The arbors, as manufactured, are made in fourteen sizes, the diameters of each being measured at *E*, halfway between the end

of the key and the solid part of the body of the collar L. The arbor is provided with a flat milled on the shank for the set screws, by which it is clamped when held in position for work. In Table XI are given the most important dimensions for these arbors.

Fluting Shell Reamers.

The cutters used for fluting regular shell reamers are the same as for hand reamers. Rose shell reamers are fluted with the same kind of cutters as rose chucking reamers. The number of flutes in shell reamers must necessarily be greater in the smaller sizes than in corresponding sizes of solid reamers, because the flute cannot be cut so deep, owing to the thin walls of the shell. The number of flutes for regular shell reamers are as follows:

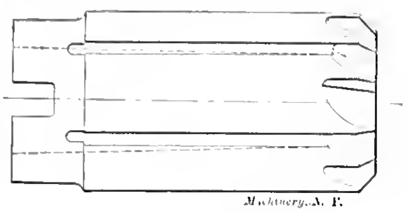


Fig. 14. Rose Shell Reamer,

Size of Reamer.	No. of Flutes.
From 1/4 to 3/8 inch	6
From 13/32 to 5/8 inch	8
From 21/32 to 1 1/2 inch	10
From 1 17/32 to 2 1/4 inches	12
From 2 9/32 to 2 3/4 inches	14
From 2 25/32 to 4 inches	16
From 4 1/32 to 5 inches	18

The number of cutting edges on the beveled end of rose shell reamers are equal to the nnmber of flutes in the regularly fluted kind. The number of grooves on the cylindrical part of the rose reamer is, of course, half that of the number of cutting edges, there being one groove for every second cutting edge.

TABLE XI. DIMENSIONS OF SHELL REAMER ARBORS.

(See Fig. 13 for dimensions denoted by letters.)

Diameter at Size Line.	Length from Size Line to End of Arbor.	Total Length.	Diameter at Size Line.	Length from Size Line to End of Arbor.	Total Length.
E	F	H	E	F	H
1/8	1 1/2	6	1	3 1/2	12
3/16	1 3/4	7	1 1/4	3 3/4	13
1/4	2	8	1 1/2	4	14
3/8	2 1/4	9	1 3/4	4 1/2	15
1/2	2 1/2	9 1/2	2	5	16
5/8	2 3/4	10	2 1/4	5 1/2	17
3/4	3	11	2 1/2	6	18

TABLE XII. DIMENSIONS OF SHELL REAMERS.

(See Fig. 12 for dimensions denoted by letters.)

Diameter of Reamers.	Diameter of Hole, Large End.	Total Length.	Length of Turned-down Portion.	Length of Flutes.	Width of Keyway.	Depth of Keyway,
I	K	L	M	N	O	P
1/4 — 5/16	1/8	1 1/2	3/8	1 1/8	1/16	1/8
11/32 — 7/16	3/16	1 3/4	3/8	1 3/8	3/32	1/8
15/32 — 9/16	1/4	2	1/2	1 1/2	7/64	5/32
19/32 — 11/16	3/8	2 1/4	1/2	1 3/4	9/64	3/16
23/32 — 15/16	1/2	2 1/2	1/2	2	11/64	1/4
31/32 — 1 1/4	5/8	2 3/4	5/8	2 1/8	13/64	1/4
1 9/32 — 1 5/8	3/4	3	5/8	2 3/8	1/4	5/16
1 21/32 — 2	1	3 1/2	5/8	2 7/8	1/4	5/16
2 1/32 — 2 1/2	1 1/4	3 3/4	3/4	3	5/16	3/8
2 17/32 — 3	1 1/2	4	3/4	3 1/4	5/16	3/8
3 1/32 — 3 1/2	1 3/4	4 1/2	1	3 1/2	5/16	3/8
3 17/32 — 4	2	5	1	4	5/16	3/8
4 1/32 — 4 1/2	2 1/4	5 1/2	1	4 1/2	5/16	3/8
4 17/32 — 5	2 1/2	6	1	5	5/16	3/8

Dimensions of Shell Reamers.

The over all length of the shell reamer must evidently be the same as the length F on the arbor (Fig. 13), from the size line to the extreme end. As the same arbor is used for a number of different size reamers, these arrange themselves in certain groups with the same total length. The length of the fluted portion in each such group is, of course, also the same, as well as the dimensions for the keyway. The only dimension which varies in each group besides the size of the reamer itself is the diameter of the turned down part G (Fig. 12). This dimension should be as much less than the diameter of the reamer, as stated below:

Diameter of Reamer.	Amt. Diam. of Recess should be less than diam. of Reamer
1/4 — 3/8 inch.	0.006 inch.
7/16 — 3/4 inch.	1/64 inch.
13/16 — 1 inch.	1/32 inch.
1 1/16 — 1 1/4 inch.	1/16 inch.
1 5/16 inch and upward.	1/8 inch.

In Table XII are given the dimensions for the various groups of shell reamers corresponding to the different arbors.

* * *

PATCHING DRAWINGS.

In the January, 1906, issue of MACHINERY was described the drafting-room practice of a large machine tool building firm in the matter of making extensive changes on drawings. In the drafting-room in question tracing cloth is not used, bond paper being employed instead. On this paper pencil drawings are made, which are afterward inked in and used to take blueprints from. Paper can be used of such quality as to be not much inferior to tracing cloth in the matter of rapidity and clearness in printing. The writer of that article referred to the matter of the ease of making changes as being one of the points of superiority of bond paper over tracing cloth. The method employed is to cut out with a sharp knife the portion affected, if the change is at all extensive. With the removed portion as a templet, a new patch is cut out from unused paper, about 1/16 inch larger in every dimension than the hole it is to cover. This is pasted in place on the back of the drawing by the margin thus left around it.

Since seeing the above, the writer's attention has been called to the practice of another large drafting-room engaged in machine tool design in which, also, bond paper drawings are largely used. Here, when drawings have to be patched, a sheet of clean paper is laid under the affected portion, which is removed by cutting with a sharp knife. The knife passes through both sheets of paper, thus providing a patch to fill the opening at the same time. To fasten this to the main body of the drawing, a sheet of transparent paper spread with clear mucilage is used, if the patch is small. If of considerable size, the joint is neatly covered with thin strips of gummed transparent paper about 1/8 inch wide.

The advantage of this method is the smoothness of surface produced. The patch is flush with the main body of the drawing paper and the drawing instruments pass over the joint between the old and new portions without difficulty. It would be especially useful in cases where alterations are made on thick drawing paper. When neatly done with a sharp knife, the joint in such cases is almost invisible. The writer has employed it on tracings, where it worked very well, although it has been found that ordinary library paste is not permanently effective in making the joint. A good clear mucilage should be used.

* * *

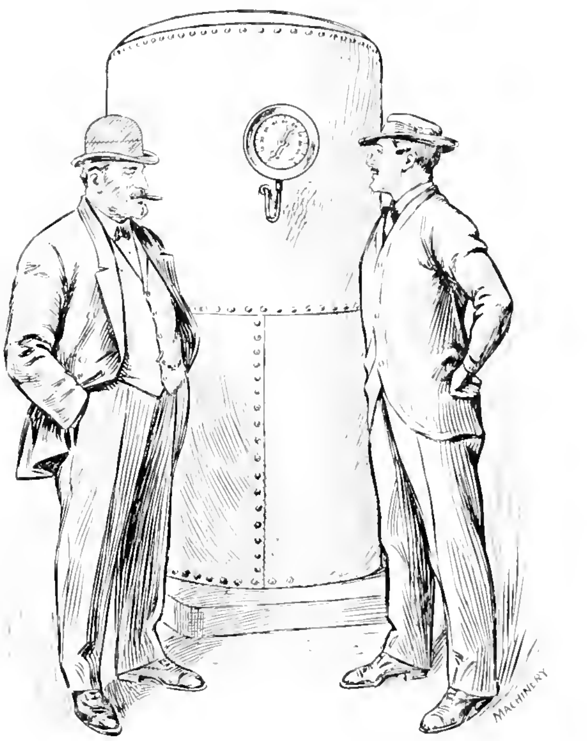
In our September issue we described a course of instruction for draftsmen at the American Locomotive Co., Schenectady, N. Y. The General Electric Co. at Schenectady also has an apprenticeship system for the training of draftsmen, conducted along similar lines. For admission, the apprentice is required to pass a stiff examination in arithmetic, which most of the candidates fail to pass. Those admitted first spend about three months in the blue-printing department, then six months in the tracing department, this latter period being considered sufficient for turning out an expert tracer. After that the student is kept for a year in the factory, being transferred as a rule from department to department every three months. After that the final two years are spent in the drafting room. During the whole time the student is required to study algebra, geometry, trigonometry, projections, strength of materials, etc., and to draw and trace fifty instruction sheets from sketches furnished to him. The pay of the apprentice during the four years' training ranges from \$3.40 per week during the first six months to \$7.50 a week during the last year.

PIPING AN AIR GAGE.

M. E. CANEK.

Jim Peters learned his trade at Clark Bros.' engine works, and continued to work there after his apprenticeship was served. He was considered a good man, capable of doing almost any job from boring a cylinder to setting up an engine, hanging a boiler or running a line of steam pipe. He was steady, sober and industrious, but had one fault that sometimes led him into blunders; and that was, he did not always find out the "reason why." He had learned almost everything he knew about the trade by experience, and had accepted many shop practices without fully knowing why they were followed. One of his blunders—the last—was piping an air gage, and what he learned from that experience was much more valuable than the actual facts, for after that day he made it a rule never to do anything without knowing *why* he did it.

Ben Clark, the junior member of the firm, was the superintendent and general foreman of the machine shop. When an



". . . the air gage showed not a pound of pressure, although the pneumatic hammers were making a merry din."

air compressor plant was put in to operate pneumatic hammers and riveters in the boiler shop, the "super" put Jim on the job, which included the erection of the air compressor in the engine room, lines of piping to the shops, and a big storage drum in the boiler shop. An air gage on the drum was called for by the specifications, and Jim duly put it up in the usual manner that he had learned was the correct thing for steam boilers, that is, with a siphon-shaped pipe connection. Why the pipe was made this way Jim did not know or care—then.

The job was completed late in November, and all went well for several weeks, until one frosty morning in December the foreman of the boiler shop called the super's attention to the fact that the air gage on the drum showed not a pound pressure although the pneumatic hammers were making a merry din. One glance at the pipe connection told the super what was the matter. Going into the machine shop he walked up to Jim and said:

"Did you ever stop to think?"

"W-w-what's the matter now?" said Jim, growing red in the face, for he "smelled a rat," as the boys say.

"Why do you connect a *steam* gage with a siphon pipe?"

"I-I-I don't know," confessed Jim.

"Just what I thought," said the super, "for if you did you wouldn't have been such a fool as to put one on an air gage, especially in a cold boiler shop. Have you worked all these years here without learning that the siphon loop is simply a trap for condensation to protect the works from the hot steam? Pretty thing, though, to put on an air drum to freeze up over night. Looks nice, doesn't it—and *so-o-o* useful—but you'd better straighten it."

The super said no more; the boys attended to that very well, and Jim did not hear the last of his air-gage siphon for many months.

Jim is nearly through with his correspondence course now, and he is growing to think that perhaps the air gage job was a good thing after all. A mental jolt sometimes works wonders on the right sort.

* * *

TINNING CAST IRON.

J. E. K.

The process of tinning cast iron is not understood by a great many persons who it seems would be familiar with the process, and for the benefit of these, I will briefly outline the method generally employed for this work. Of course, the castings must be absolutely clean and free from sand or oxide. Time spent in thoroughly cleaning the castings at the outset is time well spent, because many troubles which sometimes occur later in the process, causing loss of time and material, could be obviated if the castings had been thoroughly cleaned. The scale or oxide should be removed so the clean metal will be exposed to the tin. After passing through a "rattler" which removes a great deal of the scale, the parts are placed in a pickle of dilute muriatic acid until a clean surface is obtained. This pickle is warmed in some shops by means of a steam jet, and a quicker result is obtained. The castings can be examined occasionally while in the pickle, and any sand or black spots removed by means of a wire brush. The castings after coming from this pickle are washed in clean water. If for any reason it is desired to keep the cleaned castings for any length of time, they may be preserved from oxidation by being left under water. For a flux, the castings are dipped in a mixture composed of four parts of a saturated solution of sal-ammoniac and one part of muriatic acid.

The best block-tin should be used for tinning. Melt this in an iron pot, taking care that it is not burned or overheated in melting. After the tin is melted, it should be cleaned of all impurities. This can be done by taking a piece of green or wet wood secured to a pointed iron rod, and fastening it so that the wood will be kept at the bottom of the pot of melted metal for one or two hours, depending on the amount of impurity in the metal. The surface of the metal is skimmed occasionally by means of a perforated iron skimmer. To protect the surface of the metal from oxidation it can be covered with sal-ammoniac. There is nothing to be added to the tin. Tallow or palm oil may be used for covering the surface instead of sal-ammoniac.

The casting is taken up by means of suitable tongs, dipped in the flux, and then immersed in the melted tin, and held for a sufficient time to allow the surface to be tinned. The tin should not be so hot as to discolor when the casting is removed. If desired, the casting can be held for a time in another pot, which is kept partly filled with tallow or palm oil and kept at a temperature that will melt tin. The bath of grease will allow the casting to retain an even coating of tin, and allow any superfluous metal to drain off. The castings may be cleaned from the grease by rubbing with sawdust and then with bran.

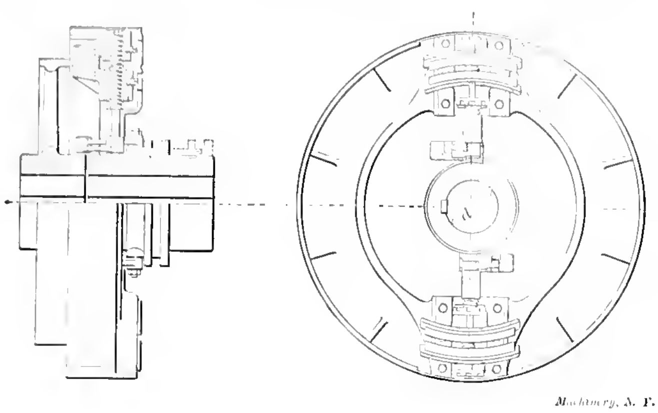
* * *

The Arthur Co. has a clock face on the exterior of its building on Front St., New York, the hands of which are driven by a "grandfather" type clock in the office. A novelty of the arrangement is a face with hands on the "back" of the clock facing the interior, the numbers being arranged in reverse to the usual clockwise order, of course. This very unusual feature never fails to attract the attention of visitors—and that is its principal object. The reversed clock face may be made to serve another useful purpose, according to an exchange. A barber in St. Louis has a clock so arranged for the benefit of his customers who when in the chairs can thus readily tell the time from the reflection in the mirrors. Ordinarily one so situated has to perform a mental somersault to tell the time from the reflection, but this innovation makes the reflection the same as the real thing.

ITEMS OF MECHANICAL INTEREST.

NEW FORM OF GRIP-JAW CLUTCH COUPLING.

A German firm, the Peniger Maschinenfabrik und Eisengiesserei A. G., Penig, Saxony, is manufacturing a new form of clutch coupling based on the old principle of jaws, actuated by a right- and left-hand screw, gripping the rim of a pulley. The cut herewith shows plainly the construction and action of this device. A sleeve, traveling back and forth on the hub of the pulley which is keyed to the shaft, and actuated by a shifting lever, not shown in the cut, turns by means of a lever

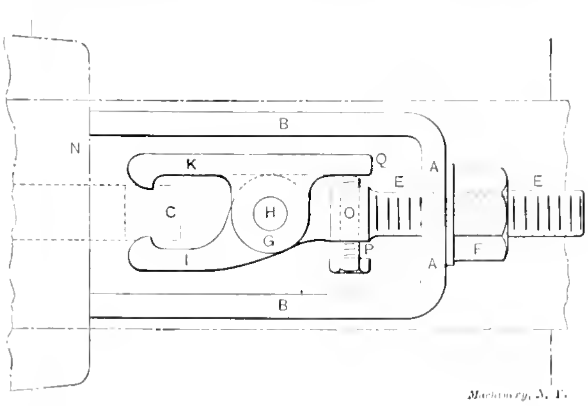


Grip-jaw Coupling.

and crank, the right- and left-hand threaded screw, thereby causing the jaws to grip the loose pulley and drive it. The jaws are made of wood, and fastened by wood-screws to cast iron brackets in the driving pulley. The dotted lines at the end of the hub of this pulley indicate the position of the operating sleeve when the jaws release the loose pulley, and the sectional view of the sleeve indicates its position when the jaws are brought in contact with, and drive, the loose pulley. The cut shows a pulley with only two pairs of jaws, but larger sizes are made with four pairs of jaws also, to provide for greater efficiency.

KEY-EXTRACTING DEVICE.

The accompanying cut, taken from the *Mechanical Engineer*, August 10, 1907, shows a device for extracting keys from their seats in pulleys, etc. It has been patented by Messrs. T. Barnes and J. E. Walpole, of Chester, England. The device consists essentially, as seen from the cut, of a bridge piece, a screw supported by the bridge piece, and a clamp adapted to grip the key. The bridge piece *A* has two legs *B*, the ends of which rest against the boss of the pulley or other object from which the key *C* is to be ex-



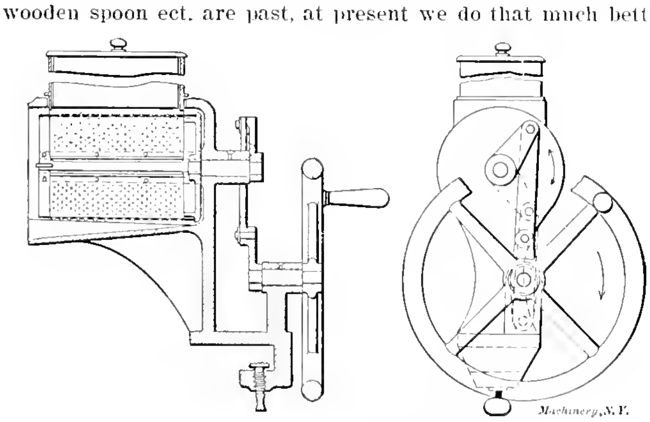
Key-extracting Device.

tracted. A screw *E*, provided with a fine pitch thread passes freely through a hole in the bridge piece *A*. On the outer end of the screw *E* is mounted a nut *F*. The inner end of the screw is provided with a boss *G*, and with an arm *I*, for gripping the key. Through a hole in the boss *G* is passed a pin *H*, which pin carries the arm *K*, forming the gripping jaw opposite the arm *I*. The extreme ends of the jaws are provided with inwardly projecting V-shaped edges which engage with grooves formed in the vertical sides of the key *C*. These grooves must be provided for in the key before it is originally driven into the keyway of the pulley. The screw *E* is also provided with a boss *O* through which passes a set screw *P*, bearing against the heel *Q* on the arm *K*, so that on turning the set screw the jaws are caused to grip the key. The device can lay very close to the shaft when it is required to extract a key from a boss located on the lineshaft. When the parts are engaged in the manner just stated, the nut *F* is turned on the screw *E* with a wrench, and the legs *B* are forced against the boss *N* of the pulley or other object from which it is wanted to extract the key. A further turning of the screw withdraws the key from the keyway. The device, during use, rests upon the shaft carrying the pulley.

A POTATO-RASPING MACHINE.

The following cut and description are taken verbatim from the English edition of a German periodical called "The Sun." This typographical luminary radiates information relating to German patents, with the hope of attracting American and English investors to them. We feel no hesitation in reproducing this matter, being given *carte blanche* for so doing by the following note on the title page of the paper: "For the press: The original essays published in the *Sun* may be used and copied, without mentioning the authority at will. Stereotypes to the reddition of the drawings are send with obligation for free sending back gratis and frank, if wanted."

Here follows the description: "To Mr. Gieler, Weida, has been granted a patent for a new potatoe-rasp in Germany and other countries, as it is shown in the drawing. The times where the potatoes in the kitchen had to be squashed with a wooden spoon ect. are past, at present we do that much better



German Potato-rasping Machine.

and quicker with a machine. Till now we have made known with several rasps, but we can say, without enlargement that Gielers' system belongs to the best ones. It is indeed emminent simple and comfortable too. It has the profit that the pap can be made refined and grossly. You only have to change the raspingroll. Except this the machine is to make in pieces very easily, to clean it in the most commode manner, what also is a great profit. You spend not too much time by cleaning it and it is absolutely necessary. Each lady of the house, who has been acquainted with Gielers rasping-machine can not be without it."

We can't help wondering if the translations into German of some of *our* trade literature, may not be almost as interesting as the sample given above.

* * *

In a paper presented before the annual convention of the National Electric Light Association by Mr. Paul Lüpke of Pittsburg, some reference was made to the question of selecting help and building up an organization, and the ideas put forth are well worth being repeated. "The right time," said Mr. Lüpke, "to look out for your head fireman is when you hire a coal passer; for your chief engineer when you hire an oiler; for your chief electrician when you hire a machine wiper. This plan avoids much shifting. Floating help is a most serious hindrance to economy and good service. Any bully can discharge a man, but it takes a sage to hire a better one in his place."

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

OCTOBER, 1907.

PAID CIRCULATION FOR SEPT., 1907, 23,967 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

The yearly indexes of the engineering and shop editions of MACHINERY and RAILWAY MACHINERY are now ready, and copies may be obtained upon request.

* * *

VALUE OF SAFETY APPLIANCES.

The steam gage, the safety valve and the water gage of the steam boiler are essentially safety apparatus, but they are no longer looked upon as simply safety appliances, but as necessary features of any complete boiler installation. So it should be with many other features of mill and factory equipment. The tendency is to regard a feature which is designed merely to prevent injury to employes as something of a philanthropic nature, which is to be grudgingly applied, perhaps. A reason that the safety appliances of a boiler are regarded as necessary is because that the enormous damage done by boiler explosion is something to be feared, and most factory owners seek to safeguard their property in this and other respects as much as possible. In the same way they should seek to safeguard the safety of employes, for it is as much to common interest, directly and indirectly, that they be protected from injury, as it is that the plant itself should not suffer. Employers are slow to learn that in a well-established business their most valuable asset, oftentimes, is the employes rather than the plant. The fact that one is a tangible asset, and the other an intangible asset, does not alter the fact.

* * *

THE REACTION.

The present business situation is more than ordinarily perplexing. Some lines of trade report business good and orders ahead of last year. From many points, especially in the West, we hear that money is plentiful and not a speck visible on the business horizon. New York seems to be the only point where money is scarce, although we have managed to subscribe several times over for the last city loan.

The opinions of machinery manufacturers agree that a recession of business in our line is actually here; but they also agree that this recession will be a benefit instead of an injury, because it will allow them to get down to a normal basis, to handle their orders more promptly, and to reduce the cost of their product so that it can be marketed at prices more satisfactory to purchasers, especially those abroad, than has been possible for the past year or two. Very few people of good judgment expected that business would continue at the recent pace, and now that the pendulum has begun to swing backward, all prudent manufacturers will put their business in such shape that, when the inevitable upward swing starts, they will be prepared to take advantage of it.

The immense amount of wealth accumulated in this country during the past ten years or more has made impossible a recurrence of the panics and hard times we formerly had. The changing conditions imply a moderate reduction in total output and a healthy readjustment of values, which will enable us to continue on a firm basis.

* * *

THE EXTRA DATA AND SHOP OPERATION SHEETS.

The popularity of the data sheets and of our shop operation sheets, and the large amount of matter contributed for use in this form, have made it necessary for us to issue extra sheets of both, which, on account of the additional cost, cannot be included in the paper, but which MACHINERY readers can obtain by merely extending their subscriptions. The data sheet in this issue of MACHINERY (engineering edition) is No. 80, although the September data sheet was numbered 73, the intervening numbers, 74 to 79, representing six 4-page data sheets, comprising twenty-four 6 x 9-inch pages, published during October.

The twenty-four extra shop operation sheets are now ready, and are numbered 19 to 42, following numbers 16, 17 and 18 in this number of MACHINERY. The shop operation sheets in the November number will begin with 43, the intervening numbers representing, as we explained above, extra sheets which will be furnished without charge to MACHINERY subscribers who continue their subscriptions.

MACHINERY'S regular data sheets, as our readers have noticed, are now bound in the paper instead of being folded in as supplements. This change enabled us to comply with certain restrictions of the post-office governing supplements issued with periodicals, and allows us to furnish our readers with a great amount of valuable data which we were not permitted to mail in the loose supplement form.

* * *

MISPLACED ECONOMY.

The tendency of some people to begrudge every expense for shop equipment is so old and well-known a condition that it is needless to repeat it, excepting as a matter of fact. This tendency, however, has had an unfavorable influence on the estimation of the actual value of the milling machine. The successful operation of this machine depends to a great extent, or one might well say chiefly, upon the kind of tools with which it is used. In the successful use of the milling machine on anything excepting the very plainest class of work, the cutters and fixtures used play a role fully as important as that of the machine itself. The firms who begrudge every penny that is spent upon accessories, and simply install a milling machine in the shop provided with plain cutters and arbors, and one or two ordinary vises, and then expect the operator to take any kind of a job and prove the excellence of the machine as compared with a planer or shaper, are greatly mistaken as to the best way of getting the full efficiency out of a milling machine. In such a case one might even say that a great deal of the money paid out for the machine itself is practically wasted. Still, the idea that when a high-grade milling machine is installed in the shop, all that is necessary has been done, is a greatly prevalent view, and one which is altogether too common where men, not directly acquainted with the mechanical operations of a shop, and all the little details combined with it, consider themselves able, with little or no advice from the actual operators, to equip the shop in the manner tending to give to each machine its greatest efficiency. In such cases a good machine, which would prove an excellent tool if equipped in the best way, might prove less efficient than older methods. The result is a greatly reduced output and the machine, and sometimes the operator as well, are blamed, when really the cause of the trouble is to be found in the inexperience, and perhaps stinginess, of the very persons who would be most benefited by the additional outlay necessary for proper cutters and fixtures.

AN APPALLING BRIDGE FAILURE.

Never has the engineering world been so inexpressibly shocked as by the awful collapse of the partially built Quebec cantilever bridge spanning the St. Lawrence River. On August 29 the completed south cantilever span, with a section of the suspended span went crashing down into a mass of inextricably tangled wreckage. Of the 85 men at work 74 lost their lives and all the remaining 11 were badly hurt. The loss of life and property is enormous, but still greater is the loss of engineering reputation and prestige. The world regards with amazement and horror an engineering work costing millions, on which years of presumably the best engineering talent of America had been employed with a result so pitifully futile. One-half of the greatest bridge of its type ever designed, having a clear span of 1,800 feet and requiring 38,500 tons of structural steel in its entirety has collapsed of its own weight.

The disaster loses little of its stunning force or reproach to the engineering profession because it apparently suggests that an unknown source of weakness exists in very large and long compression members. That such a condition may exist is what the *Engineering News* would have us believe from reading its seven-page report and masterly editorial (issue of September 5) which are technical efforts seldom surpassed. But it is hard to understand how the deductions of engineers in regard to members carrying compression loads could have been so signally at fault, notwithstanding the absence of experimental data on very large columns. Such an admission would suggest that our entire theory of the strength of materials may need revision. Rather would we accept the suggestion that chord *A9L* had been structurally or molecularly disorganized by the several accidents befalling it before erection, or that a serious mistake was made in its design, especially in the matter of side-staying. The fact that it was the apparent initial source of failure will go a long way with the layman, notwithstanding any engineering testimony to the contrary implying that its various mishaps were of no important ultimate effect.

* * *

THE STATUS OF THE DRAFTSMAN.

From several points of view, the draftsman occupies a more peculiar position in the modern shop than many of the other workers who make up the organization. The draftsman is considered by many a manager as a kind of necessary evil, a dead expense, which he cannot avoid. For behold! the drafting-room is a non-productive department. At the same time the drafting room of any well-organized shop is recognized as the heart of the industrial end of the business, in which the planning and systematizing forces, at least to a large degree, are located. The draftsman himself occupies a very different ground in different shops, according to whether the former or the latter view expressed is the prevailing one in a particular organization. Of course, there are draftsmen and draftsmen. There are those that are valued at $10 a week or less, and those that are valued at $40; and this fact, too, tends to place the knight of the T-square in a peculiar position. There are no very well defined limits to his trade. He is more or less what one might call a free lance. In many a case he is not even a distinct part of the regular organization. He is called in when a new design is to be turned out in the drafting-room, and when that is done he is "laid off." At least, this is the case in the majority of smaller shops, specializing on one or a few kinds of standard machines. The last contention may, perhaps, not apply to the leading designer, but it most certainly applies to the ordinary draftsman.

The conditions outlined are by no means very satisfactory, but it is difficult to propose a remedy. It has been suggested that men in the shop, having training in drafting, be temporarily taken into the drafting-room to help out when business there is pressing, rather than to hire draftsmen for short terms. But this course would be subject to many objections. In the first place, nobody does the draftsman's work as well as a trained draftsman, constantly working at his trade. In the second place, it is not at all sure that the very men with drafting experience, wanted from the shop, can be spared there at a particular time, and last, but not least, the man, who at first would be only temporarily taken from the shop for drafting-room work, would soon find a certain attraction in his new occupation, and, in nine cases out of ten, he would not return to the shop again, but continue on what, at first sight, seems to him the rosy road of the draftsman. To the ordinary shop worker, the drafting-room has at first many attractions. The work is cleaner, the duties, at first, less exacting, the surroundings more pleasing, and the hours generally shorter. In the long run, however, it is evident that the draftsman, having passed through the stages of assistant to that of independent designer, finds the limitations greater in this department than in the productive departments in the shop. That is why we find so few old draftsmen. We do not realize where they go to; all we know is that they disappear from the drafting-board as they grow older.

The cause for this is perhaps the kernel of the matter of the comparatively unsatisfactory status of the draftsman. After long years of close attention to business, he has become an expert designer, and his work requires all the mental qualities present only after years of training and experience. His general intelligence, measured in units of logic, is greater than that of most of his cooperators in the industrial organization. He is the ingenious planner and schemer of profit-making devices, and even though, in certain cases, some ideas are furnished him by "the man higher up," these ideas, as a rule, are furnished in such a crude form that the draftsman is but little helped in his work. When the device is completed, however, the honor of the successful working does, curiously enough, not fall upon the one to whom the most of the credit is due. When we also consider that the compensation paid to the most skillful of machine designers is often, not to say nearly always, less than that of department foremen, many of whom in intelligence and general ability are far inferior to a trained designer, then it is easily seen why we find the draftsmen leaving the chosen trade, as soon as they have reached middle age, to seek more congenial occupations. This, however, is a distinct loss to the industries as such. The best and ablest men, the most experienced designers, are lost to the craft at the very time when their services would become most valuable. If the draftsman were considered a more integral part of a shop organization, if his merits were recognized, rather than usurped, by his superiors, and if his compensation stood in a more equitable proportion to his achievements, he would be less tempted to leave that place in the industrial organization where he serves the best, for other occupations, far better compensated, but requiring no more intelligence, judgment or ability.

* * *

An item of mechanical interest appeared in the June issue illustrating the power of a small force to displace plastic substances such as asphalt, cobbler's wax, etc. Another illustration that is of considerable scientific interest is the alleged cause for the winding grain of certain trees. It is asserted that the cause for the twisting grain of trees having wide-spreading branches is the rotation of the earth on its axis. It is well known that the rotation of the earth causes whirlwinds or cyclones in the air, and vortices in water. In the northern hemisphere these always move in a counter-clockwise direction, and it is claimed that the trees are twisted in the same direction by the same force. The cause of whirling motion in air and water is the slight difference in the earth's motion between any two points on a line of longitude. A railroad train, for example, running on a straight track toward the north, in the northern hemisphere, crowds over to the right-hand or eastern rail, and when running to the south it again crowds to the right-hand rail, but which is now the western rail. The reason is that the inertia of the train causes it to move ahead of the earth's motion, or fall behind it, depending upon whether the travel is north or south, on account of the velocity of the earth's surface decreasing as we approach the poles, or *vice versa*. The influence of the counter-clockwise air currents and the inertia of the sap, rising from the roots and flowing from the trunk out towards the limbs, is believed sufficient, though slight, to give tree trunks, plants, etc., a twist counter to the motion of the hands of a clock.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

On the German state railways accumulator cars have been running since last February on three railway lines. The new cars run four to six times a day over a distance of about eight miles. The cars are three-axle cars built especially for this purpose. The batteries consist of 180 cells of 200 ampere-hours capacity. A car battery weighs about 10 tons and yields 685 kilowatt-hours. The car complete weighs 38 tons.

In our issue of May, 1907, we gave a general description of the system of transmission of photographs which has been developed and brought to comparatively high perfection in Germany. It is now reported that successful experiments have been carried out over a line of 320 miles from Munich to Berlin. The photographs were clearly transmitted over a commercial wire loaned to the experimenters by the government.

Speed trials were made during the month of August with the first-class battleship *Connecticut*, the first battleship of this class built at a government shipyard. In a series of fourteen runs over a measured mile, she averaged, according to *Engineering News*, for the best five runs, a speed of 18.73 knots. The *Louisiana*, her sister ship, built by the Newport News Shipbuilding Company, attained only 18.59 knots as the average speed of her best five runs.

Liquid fuel for locomotives is becoming more and more common in the southern portion of the United States as well as in Mexico. It is reported by the *Torreon Star* that the Mexican Central Railway is using 4,000 barrels of fuel oil daily, and is steadily increasing the number of oil-burning engines in its service. All new engines purchased are equipped for the burning of oil, and old engines are constantly being remodeled.

As a result of the Postal Union Congress held at Rome in 1906, when international postage stamps were authorized, France issued an international postage stamp on October 1, and it is expected that a British stamp will also be issued. The stamp can be sent to most of the countries in the Union to prepay a reply to a letter, and also in payment of small accounts (up to 20 cents). Orders for four million stamps were placed, and if the experiment is a success the issue will be continued.

In a recent issue of the *Annales des Ponts et Chaussées*, Mr. M. H. Le Chatelier contributes an article regarding the action of sea water on cement and concrete, in which he states that all hydraulic binding agents without exception may be decomposed by sea water, although the rate of this action varies within wide limits. The most essential condition to render cements immune from decomposition in the sea is to reduce as much as possible the volume of water employed in gaging the cements.

The navigable dimensions of the Suez Canal have been practically doubled during the last twenty years. Taking the canal as a whole, its width at the water level in the northern half is from 300 to 360 feet, and in the southern half from 240 to 300 feet. In 1902 the maximum draft was raised from 25 feet 7 inches to 26 feet 3 inches, and in 1906, to 27 feet. The mean duration of transit is about 18 hours for all vessels, but the general effective rate for mail steamers is 15 hours. The length of the canal is 100 miles, and the ordinary rate of speed thus is 6 2/3 miles per hour.

A miniature head telephone has been developed in Sweden, according to a consular report. The receiver is said to measure ½ inch by ⅝ inch, and over the diaphragm may be screwed a cover continued into an ear tip. The connection to the receiver may be a fine flexible cord carried like an eye-glass cord. No helmet or other attaching device is required to hold the receiver in place. The instrument is thought to be valuable both to telephone operators and to individuals with defective hearing, the latter also carrying a transmitter, etc., on the person. The device was invented by the chief of the government telephone department.

The immense 41-story tower of the Singer Building on Broadway, New York, is rapidly going upward, and by the time this item is printed the entire framework will be completed. When the tower is completed, the flag-staff will be 652 feet above the ground. The unique appearance and great height of the structure will make it one of the most noticeable buildings in New York. On account of the great wind pressure that the structure will be required to withstand, the tower is built in a manner somewhat analogous to a bridge on end, so far as the bracing is concerned. It was designed to withstand a maximum wind pressure of not less than 30 pounds per square foot.

A correspondent to the *Times Engineering Supplement* describes the results of the trials of the Field-Morris system for increasing the thermo-dynamic efficiency of the steam engine. He states that by this system a saving of 24 per cent in fuel has been effected. The system consists of adding to the steam a certain proportion of air under pressure, this mixture then being superheated before being allowed to pass into the steam cylinders. The theory, upon which the saving claimed for this invention is based, is not manifest, but it is stated on good authority that the saving in several tests has been considerable, after due allowance has been made for power expended in compressing the air.

The new steel plant of the United States Steel Corporation at Gary, Ind., will be developed immediately on even a greater scale than was originally contemplated. It was originally intended to appropriate $75,000,000 for the construction of the steel plant and the adjoining new industrial town, but it has been decided that an additional $45,000,000 shall be set aside to be used in widening the scope and extent of the steel plant itself. When it is considered that in the neighborhood of $120,000,000 is to be expended in the establishment of what might be called one single industrial plant, the magnitude of the new steel works can hardly be compared with anything else of that kind that has so far been contemplated in this or any other conntry.

A subterranean canal, 4.3 miles in length, is, according to news dispatches from Paris, projected to connect the valley of the Rhone with the port of Marseilles. This tunnel will be, in point of quantity of material excavated, the largest in the world. It is estimated that 2,840,000 cubic yards will be excavated, against about 1,375,000 cubic yards for the Simplon tunnel. The latter is 13.8 miles long, but only 24 feet wide and 18 feet high; while the canal tunnel would be, with the towpaths on either side, 66 feet wide and 42 feet high. The canal would permit two barges to pass at any point. The cost of the tunnel, rendered necessary because the hills between the Rhone and Marseilles are too high for lock operation, is estimated at $6,900,000. The total cost of the canal will be $15,200,000.

A remarkable performance of a steam locomotive on a run between Munich and Augsburg is reported from Germany. The engine drew a load of 165 tons (150 metric tons) and developed 2,000 horse-power, maintaining for a considerable time a maximum speed of 96.5 miles per hour (154.5 kilometers). The whole journey of 40 miles was performed at an average speed of 81 miles per hour. It is claimed that the speed of 96.5 miles per hour is the highest speed that has ever been attained on a European railway with a regular train. The locomotive weighs 90 tons, and with its tender 147 tons. The Bavarian minister of transportation made the trip on the engine during the trials. The locomotive is of the 2—6—0 type, four-cylinder compound. The general

dimensions of the locomotive are: Diameter, high-pressure cylinder, 16 inches; low-pressure cylinder, 24 inches; stroke, 25 inches; diameter, driving wheels, 7 feet 2½ inches; diameter, truck wheels, 3 feet 3½ inches; total heating surface, 2,702 square feet; steam pressure, 210 pounds.

The vibration of the after-part of high-speed ocean liners driven by reciprocating engines is a serious trouble that has not been successfully overcome by any system of engine balancing. One of the swiftest of the ocean greyhounds, the Deutschland, has been most troublesome in this respect, although the engines are balanced by the Schlick system. The defect was recently largely overcome in an interesting manner. The pitch of the blades of the port propeller was reduced slightly, the effect being that the port engine runs eight revolutions faster than the starboard propeller in order to give the same effective thrust and speed of propulsion. This throwing of the engines out of step minimized the vibration of both the engines and the propellers. It long has been known by marine engineers that throwing the engines of twin-screw ships out of step tends to reduce vibration, but the trouble of doing this with propellers of the same pitch is the difficulty of steering, there being a tendency of the vessel to run in a circle, owing to the difference in thrust of the two propellers.

A peculiar action affecting the status of apprentices in Pennsylvania has been started by Thomas Carlin Sons Co., of Allegheny, Pa. The company has sued the fathers of six apprentices for $2,500 damages each under a law passed in 1713 which is known as the "White Slave Act." The boys were apprenticed to the firm for a term of 10,800 hours, divided into eight periods of 1,350 hours each, the pay being graded from 7½ cents per hour up to 16 cents per hour. Under the agreement the boys had the privilege of breaking the contract during the first period only, and after that they were bound to continue until the end of the term. The boys quit at the time of a machinists' strike, and refused to complete their contract; hence the action of the company to establish the rights of employers in apprentice indentures. If the suits fail, a precedent will be established that will make such contracts valueless in Pennsylvania, and will probably affect their standing in other states also. The defense will be that the contracts were burdensome, and that it would be an injustice to the minors to hold them to fulfill an indenture made by their parents.

The accompanying table, taken from *Zeitschrift des Vereines deutscher Ingenieuren*, gives some interesting figures regarding the estimated life of electric power and light installations. While being primarily of interest to electricians, this table has much of value for any one having to deal with depreciation of machinery and plant of this or similar character. The figures are collected from six different sources, from two English and two German authorities, and from the practice of English municipalities. On some points they will be found to vary widely, but, in general, all the various sources seem to agree fairly well.

Length of Life in Years of	Robert Hammond.	J. F. C. Snell.	Local Government Board.	London County Council.	German Sources.	
Buildings	60	60	30	50	66	100–150
Boilers	20	20	15	20	15	10–15
Steam Engines	20–25	25	15–25	20	20	20–25
Steam Turbines	..	..	..	..	20	..
Gas Engines	..	..	..	..	17	..
Water Turbines	..	..	..	..	22	20–30
Dynamos	25	25	20	20	20–22	18–30
Accumulators	15	10	5–7	20	10	5–10
Transformers	15	20	15	20	..	30
Switches	20	20–25	15	20	15	15
Conductors	25–30	15–60	12–15	12–30	25	10–30
Meters	10	15	5	10	..	..
Arch-lamps	10	15	7–10	..	..	..

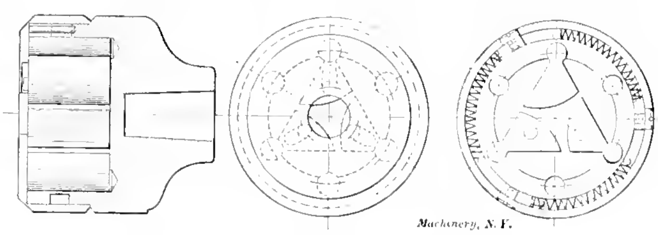
WIRELESS TELEGRAPHY ADVANCE.

The Poulsen selective system of wireless telegraphy, to which we referred in our engineering review in the February and March issues of MACHINERY, seems to be making rapid strides, and in one instance even to have established a record. The Poulsen system has been installed on board the *Hellig Olaf*, a liner belonging to the United Shipping Corporation of Copenhagen, and recently when that vessel was more than 2,000 miles distant in mid-ocean, a message of 21 words was despatched by her transmitter and successfully received at the Steglitz wireless telegraph station near Berlin, Germany. This is claimed to be the greatest distance a wireless message has ever been sent from ship to shore. In its career it passed over the ocean, across Great Britain, the North Sea, and again over the Continent to Berlin. This is the first time the Poulsen system has been worked on board ship. The American De Forest Company has, it is stated, covered 1,500 miles—from the West Indies to New York—and the Marconi system is continually doing long-distance work. But such messages have been from station to station or from shore to ship, not, as in the present case, from ship to shore, which is considered to be a much more remarkable feat.

GRIP CHUCK FOR STRAIGHT SHANK DRILLS.

Engineering, May 10, 1907.

A drill chuck working on the well-known eccentric clamping principle has recently been placed on the market by Ludwig Loewe & Co., Ltd., Farrington Road, London, E. C. The principle of this chuck is plainly shown in the accompanying cut. It is intended for instantaneous and automatic gripping of drills with straight shanks. The chuck takes drills from ⅛ inch to ½ inch in diameter. No key is employed to tighten or loosen the jaws, and there are no internal gears or screws in its construction. The milled cap covering the jaws has three radial slots in its inner face, which engage with pins on the respective jaws. The jaws terminate in cylindrical portions, about which they rock when the cap is rotated. Inside the cap are springs, which, acting



Grip Chuck for Straight Shank Drills.

between stops on the body of the chuck and other stops fixed to the cap, tend to cause the rotation of the latter, and so to close the jaws. The latter are serrated on their working faces, and these faces are so curved that the torque of drilling will clamp the drill and increase the tightness with which it is held. It is claimed that the grip is so efficient that high-speed drills may be driven with their full cutting efficiency, and in actual tests ½-inch drills of high-speed steel have failed under the work before the shanks have slipped in the chuck.

THE COST OF POWER PRODUCTION.

Western Electrician, June 8, 1907.

Prof. Charles E. Lucke, of Columbia University, having made a study of the subject of the comparative cost of various methods of producing power, with special reference to electric power stations, has collected some figures which he presented in a paper read before the American Electrochemical Society. He compared water-power development, oil engines, gas engines and producers, and steam engines, assuming a 24-hour continuous load in each case. In the case of the oil engines, 250-horse-power units coupled to 160-kilowatt generators were taken for example, and the station was supposed to contain six such units. As typical of steam engines, a plant of six 5,000-kilowatt units was selected, while for gas engines a station containing six 1,000-horse-power units

driving 600-kilowatt generators was chosen. Steam turbines were not considered in the steam plant, the author saying that the net result would not be very different from that of the reciprocating engines. Under these assumed conditions the comparison of power cost was figured as follows:

Water-power—First cost per kilowatt rating, \$75 to \$200; total power cost per kilowatt-year, \$8.50 to \$25.

Oil Engines—First cost, similarly, \$217; cost of power per kilowatt-year, \$78.64.

Gas Engines and Producers—First cost, \$270; annual cost of power per kilowatt-year, \$65.54.

Steam Engines—First cost, \$110 to \$150; power cost per kilowatt-year, \$85.50 to \$97.50.

The hydro-electric plant shows up very favorably, although it is to be noted that the cost of transmission is not included. The author thinks it likely that gas power will be cheaper than steam when the load factor is high, and that the difference will be greater as the cost of coal is greater. The figures given, of course, are only correct in a general way, "for," says the author of the paper, "the determination of power costs is not only a question of geographical location, a question of the generating system, a question of the size of the apparatus, a question of the perfection of its design, a question of the load location, but it is also a question of accounting, and the engineer engaged upon a question of this sort must not only be an engineer, but something of a financier and an accountant."

CENTRIFUGAL PUMPS FOR DEEP WELL PUMPING.

Abstract of Paper read by Mr. C. B. Burdick before the Western Society of Engineers, June 5, 1907.

This paper contains some interesting information relating to a new development of the centrifugal pump—namely, its use for lifting water from deep, driven wells. The first one built in this country was made by Mr. John W. Alvord as an experiment for a client, in 1902. The pump was so designed that various forms of impellers could be tried. This pump, fitted with the best impeller, showed an efficiency of 50 per cent when operating at 1,640 revolutions per minute, and discharging 835 gallons per minute against a head of 38 feet. The experimental pump had one impeller only and was designed to be used in a 12-inch hole. One of the most satisfactory features of this design was the means taken for handling the down thrust. Not only is there the weight of the long shaft and the wheel to be considered, but the reaction as well, due to the lifting of the column of water against the static and frictional head. The balancing was effected by means of a chamber in which pressure was maintained by leakage from the discharge side of the pump. When the pressure became great enough to lift the impeller and its attached shafts from the thrust bearing, by which it was hung at the top, discharge ports were opened by this movement which relieved the pressure so as to allow the parts to settle again. In the tests it was found that as soon as the pump came up to speed, the shaft was lifted about 1/16 inch and rode entirely clear of the balls in the thrust bearing provided at the top of the shaft. In this design both the impellers and the balancing chambers can be compounded for high lifts.

The water works at La Grange, Ill., are supplied with centrifugal pumps of this kind built by Mr. Byron Jackson, of San Francisco, Cal. His company is believed to be the first to place this type of machine on the market. The preliminary investigations seem to indicate that the pump efficiency is about 50 per cent, and the efficiency of the motor by which it is driven about 85 per cent. The motor is, of course, a vertical one, being a 25-horse-power Westinghouse three-phase induction type running at 112 revolutions per minute. It is connected to the shaft by a flexible leather link coupling.

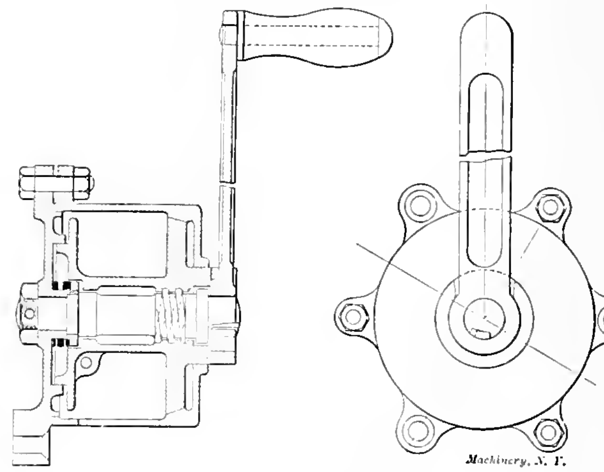
The obvious advantage of a pumping equipment of this kind is in its simplicity and compactness. It also has the advantage over the reciprocating pump of moving the column of water at a constant speed, not requiring it to be started and stopped at each end of the stroke.

SELF-SUSTAINING WINCH.

Page's Weekly, June 28, 1907.

The accompanying cut shows an ingenious, but simple, form of winch, originated in Great Britain. The chief features of the winch are that it is direct-driven, and that the drum is forced against and locked to the casing by the tension on the wire rope. In consequence of the latter feature, the greater the weight suspended, the more secure the hold will be.

The winch is provided with a common casing. This casing has at its central part a bearing, which supports one end of the shaft. The outer portion of the shaft is provided with a screw which engages with a corresponding screw thread in the drum. The periphery of the outer flange of the drum is coned and normally engages with a coned surface on the inner side of the outer part of the casing. The outer portion of the drum has a central boss which is supported in the casing and slightly projects beyond it. The end of the boss is recessed at its center to receive a crank handle. The hole



Self-sustaining Winch.

of the crank handle has an inwardly projecting lug, which engages with a slot cut in the end of the threaded shaft. This slot is made wider than the lug to allow the crank handle, during winding, to first move freely on the shaft, while the drum is being unlocked from the casing before the two move together. A portion of the metal around the recess in the center of the boss is removed so that the crank handle can drive the drum in one or the other direction, the gap so formed being of such width as to allow, during unwinding, an initial movement of the shaft with respect to the drum. A spring is placed between the inner end of the shaft and the casing to create a slight retarding movement on the spindle.

To use the winch the handle is placed on the outer end of the threaded shaft, the lug or key in the handle passing into the slot of the threaded shaft, and the web of the handle into the gap in the outer portion of the boss. To raise a load the handle is turned forward. This causes the handle to engage with the forward face at the end of the gap, and the drum to be turned on the shaft until the lug in the hole of the handle comes against the forward face of the slot in the shaft, when the drum and shaft will revolve as one. To unwind the drum, the handle is turned in the opposite direction. In this case the lug in the boss of the handle first bears against the forward face of the slot in the shaft, and forces the drum inward, after which the drum and shaft revolve together. Immediately the handle is released, either during winding or unwinding, the tension on the cord causes the drum to be turned on the shaft and to be forced against the casing. This device is made by Bernard Metz, Great Winchester St., E. C., London, England.

ROPE DRIVE FOR MACHINE TOOLS.

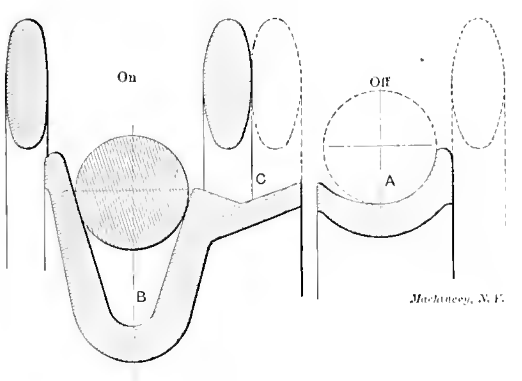
The Engineer (Chicago), July 15, 1907.

Hitherto rope drive has not been practical for machine tools of the variable speed type, such as lathes, shapers, drills, and drilling tools, because speed changes were usually procured by coned pulleys modified by throwing in or out the back gear. While a power rope can be shifted from one groove to

another, the operation is so tedious and time consuming, that it cannot be applied to the often swiftly succeeding speed changes of modern machine shop practice. Hence belts have generally been used for these varying transmissions.

Of late, however, a number of single pulley drives have been introduced on tools of this class, in which speed changes are effected by lever-controlled change gears. This system has the great advantage of increasing the power delivered to the cutting tool by high initial belt speed. With a constant speed for the driving shaft, the cutting power is the same at high or low speed. Speed changes can be made very quickly, and a far greater range of changes can be obtained than with stepped pulleys. As the new design of speed changing is meeting with much favor among manufacturers on account of its advantages, and as transmission rope offers the ideal means for supplying power to constant speed shafts, we may look for a great increase in rope driving in future machine shop installations. This will result in marked economy of space, as the rim surface for rope sheaves is much less than that required for belting, which in turn means more rigidly supported shafts, as there will be less spring between the closer spaced bearings. It will also greatly decrease the noise of driving, and the loss of power from slipping. Properly laid and lubricated rope is not only much cheaper than belting, but requires no expense to speak of for dressing, lacing, cleaning and taking up slack.

Though we are not accustomed in this country to see driving rope shifted from an idle to a working pulley, it can be done just as well as with a belt, and is a matter of common occurrence in England. In a number of large cotton mills in the Lancashire district, the power is conveyed from a line shaft running the whole length of the room to numerous ring frames by means of ropes instead of belts, the ropes operating on fast and loose pulleys mounted within guard boxes.



Rope Drive for Machine Tools.

In this combination a shifting arrangement is used, illustrated in the cut, which could well be adapted for the drive of constant speed machine tools. The idle or loose sheave *A* has practically all of its flange cut away on the side towards the working of fast sheave *B*. To throw the machine into action, a curved rope shifter or fork is used, shown in section in the cut. It is bent to the curve of the sheave with very small clearance above the sheave flanges, and is operated with a pivoted hand lever. Referring to the cut, as the arm of the fork engages the driving side of the rope, it pushes the latter clear of its reduced flange onto the intermediate groove *C*, cut in the fast sheave. The shifter continuing toward the left, presses the rope into the groove *B*, whence it is readily forced out by reverse movement of the fork whenever the machine is to be stopped.

One objection is that to secure sufficient speed, the sheave on the lathe would have to be so small in diameter that quite a number of ropes would have to be used, which would make the face of the sheave as wide, if not wider, than a belt pulley for the same power. As the drive contemplates a lathe equipped with gears for changing speed, this objection falls away because one single rope can carry a great deal of power to a tool provided with a large sheave, and as gearing is going to be used anyhow, the speed of the first driver shaft can be varied at will. That almost any machinist can lace a belt, whereas practically none can splice a rope is an objectionable feature of constantly diminishing weight, because in the first place a rope does not need to be spliced nearly as often as a belt needs to be laced, and with the rapidly increasing use of transmission rope, the practice is growing of having at least one expert drive rope splicer attached to each large industrial establishment.

METAL AND RAW HIDE PINIONS FOR MOTOR DRIVES.

Wilfrid L. Spence, in *The Mechanical Engineer*, July 13, 1907.

In regard to the question of pinions, ordinarily a raw hide or paper pinion is much better than a metal one. Both materials named, apart from their surroundings, are utterly unmechanical; they depend absolutely on outside support to carry load, and whenever axial compression is relieved, the teeth bend over, lose their true form, become noisy, and rapidly deteriorate unless the load is light out of all proportion to dimensions. The weak point of most built pinions is the shrouding—the side plates are not usually stout enough to hold the hide or paper up to its work.

The very few failures (all several years ago) out of an extremely large number of applications of which the author has cognizance, were due to thin side plates necessarily accompanied by inadequate compression. This question is, of course, very much one of the point of view, for if, as indicated, the general wheel dimensions are chosen so large that the tooth load is light, then correspondingly lighter side plates may answer, but unquestionably that is expensive design. The author's practice, which has been quite successful in respect of smallness of wear, has commonly been to load the pinion as if it were of cast iron, and under such conditions the standard side plates are not adequate. Without being able to justify it theoretically, he has found that the empirical formula

$$t = 0.5\ P + 0.025\sqrt{D} + 0.25 \text{ inches,}$$

where

t = thickness of side plate, in inches,

P = circular pitch of teeth, in inches,

D = pitch diameter of pinion, in inches,

agrees closely with heavily loaded successful pinions designed in a wide range of sizes by eye—*i. e.*, to look right mechanically when drawn out full size.

In the design of any pair of motor gears the determination of the ratio, width of face to pitch of teeth, is of prime importance. For cheapness, the ratio must be small; for every other consideration it should be large. The old mill-wrighting proportion of 3 to 1 or thereabout, appropriate with cast wheels, is inadequate to meet present-day requirements, and it is no uncommon thing to find the working width of wheels equal to or greater than six times the circular pitch. The problem is to find a mean between the cheap, but noisy, and the more expensive silent wheels. The determining factor is the peripheral velocity in ordinary wheels and the speed of meshing in complex forms. Starting with a minimum ratio of 3 to 1 for no velocity, ending with $6\frac{1}{2}$ to 1 for 2,500 feet per minute, and aiming at between 5 and $5\frac{3}{4}$ to 1, which are known to be good proportions for the range of moderate speeds ordinarily met with, the author sketched out some years ago a curve to systematize his work. This curve agrees with

$$R = 3 + 0.05\sqrt{V}$$

where

R = ratio of wheel face to pitch of teeth,

V = peripheral velocity or speed of meshing in feet per minute.

This rule is again empirical, and has no other justification than that it agrees with a lot of successful and economical examples, and cannot in any case be very far from basic fact. In applying it the limitation of available shaft length has to be kept in view, as also the possibility that with great overhang an outer bearing may be necessary.

Regarding the strength of, or permissible loads on, spur gear teeth, the writer has for many years used with complete success the methods of Wilfred Lewis, and would confidently recommend their adoption to those who, and their number is legion, in the design of gearing have hitherto relied

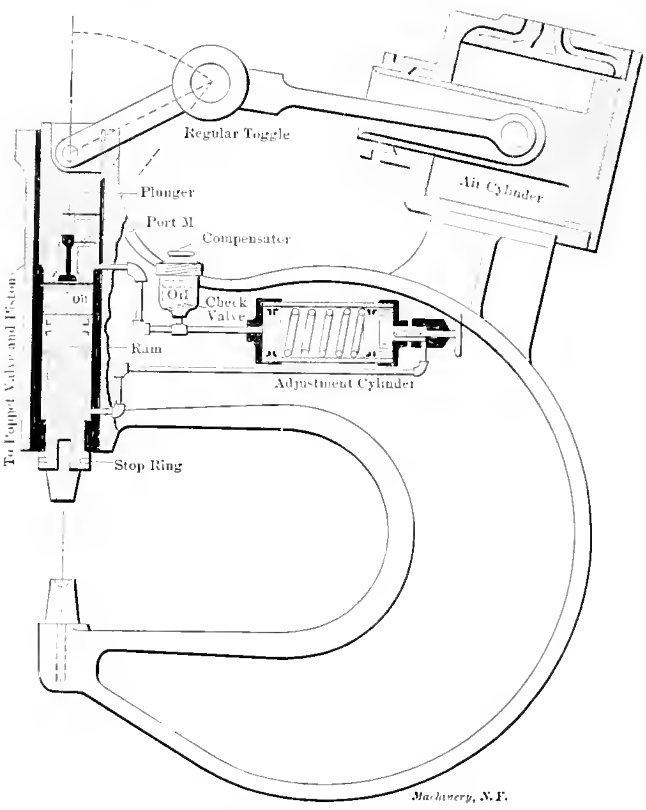
on mill-wrighting data which take no account of either peripheral velocities or of the number of teeth as affecting the permissible tooth load.

[The Lewis formula and tables for the strength of gear teeth are given in the following MACHINERY DATA SHEETS: No. 22, July, 1903; No. 62, October, 1906; and No. 64, December, 1906.]

SOME LATE IMPROVEMENTS IN COMPRESSIVE RIVETERS.

Paper read before Engineers' Society of Western Pennsylvania by Chester B. Albree

The comparative advantages of the various forms of compressive riveters—hydraulic, hydro-pneumatic, direct pneumatic and pneumatic toggle-joint—have been considerably discussed and are fairly well understood. Each of them has certain advantages not possessed by the other. In a paper read by Mr. Chester A. Albree before the Engineers' Society of Western Pennsylvania is described a new riveter in which some of the advantages of the various forms are combined.



Pneumatic Toggle-joint Riveter, with Automatic Adjustment for Thickness of Work.

together with some additional improvements not hitherto attained. This riveter has the action of the toggle-joint type, with its increasing pressure towards the end of the stroke, where pressure is most needed in heading the rivet. It also has the valuable feature of the plain hydraulic machine in not requiring adjustment of the riveting jaws for work of different thicknesses. The machine is self-adjusting in this respect, and always gives the same terminal pressure, even though the thickness riveted may vary from one stroke to another. The following paragraphs are a digest of the paper referred to.

In the cut is shown the perfected form. The piston in the air cylinder is connected to the plunger by a toggle mechanism of the usual construction. The pressure from the toggle is transmitted to the top of the ram and also through a pipe to the adjusting cylinder. The ram being small in area and free to move, advances rapidly and continues until the rivet die on its extension strikes the projecting rivet. As the plunger continues, the pressure in the cylinder is limited by the pressure due to the spring in the adjusting cylinder, there being free communication to it through port *M* and the pipe shown. This pressure is only 20 pounds per square inch, insufficient to upset the rivet beneath the ram. Hence the liquid will now displace the piston in the adjusting cylinder, the ram remaining stationary.

Referring to the cut it will be noted that the extension of the plunger, when fully up, still projects into the smaller area of the ram cylinder; and that cup leathers are used to pack it. In the interior of this extension is a valve of the poppet type, but having a stem carrying on its end a small piston. This valve is normally held open by a spring. So long as the pressure above and below this small piston is the same, the spring holds the valve open, but when the pressure below is greater than above the piston will move up, closing the poppet valve. This occurs only when the port *M* leading into the space below the small piston is closed, due to its passing from the large diameter bore to the smaller ram bore. When closed, the toggle pressure acts on the liquid below the plunger extension, raising the pressure sufficiently to move the small piston and connected valve, and later exerting very high pressure on the poppet valve, shutting it perfectly tight.

During the downward motion of the ram the liquid beneath it is forced into the opposite end of the adjusting cylinder, against the spring pressure. It is obvious that the ram may move its whole adjusting stroke, or not at all, up to the time when port *M* is closed by entering the smaller diameter of the cylinder; after which the further travel of the ram is that of the plunger, until the ram meets opposition greater than the pressure of the toggle, when it will stop. This arrangement, therefore, automatically adjusts the point of maximum pressure to suit the work. On the return stroke we have the direct pressure beneath the ram, as well as the suction of the plunger, to raise the ram to its original position.

Leakage of the liquid is made up from a small storage, or compensating cylinder, full of liquid, having a piston with a spring behind it, connected to the larger bore of the plunger by a pipe, having a check valve in it. Whenever there is pressure in the plunger cylinder, the check valve remains closed; but when the toggle is fully back, and the piston in the adjusting cylinder is against its cylinder head, so that no pressure due to its spring is exerted on the liquid, any loss of liquid will tend to create a vacuum in the plunger cylinder, and then the check valve will open, and oil flow out of the compensating cylinder, under the pressure of the spring acting in its piston, to replace that lost.

This riveter is built by the Chester B. Albree Iron Works, Pittsburg, Pa.

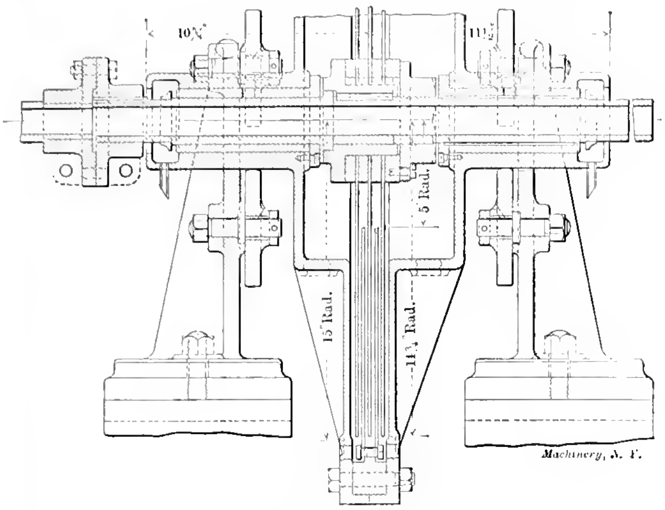
ABSORPTION DYNAMOMETER.

Engineering, May 31, 1907.

A novel form of dynamometer, made by Peter Brotherhood, Belvedere Road, Westminster Bridge, S. W., London, England, is illustrated in the cut herewith. This device is intended for comparatively high speeds, say from 300 to 1,200 revolutions, and is specially suitable for the testing of petrol motors, but its uses extend to the testing of motors of all classes. It is self-contained and independent, and may be made portable and be used anywhere, provided only that a supply of water is available. The dynamometer has been designed to supersede the unreliable and crude brakes of the Prony type, and at the same time to avoid the necessity of external appliances, and consequent complications of calibration associated with electrical and other forms of absorption brakes. As regards electrical testing sets, those most extensively in use require external resistances, volt and ammeters, etc., for the proper adjustment and reading of the load, and all these parts are liable to damage and deterioration. In the form of brake illustrated, there is no part liable to injury through neglect or rough usage, and the only external fittings required are flexible pipes for water supply, and a spring balance. Further, all the work given to the brake is definitely recorded, and no losses have to be reckoned. The principle employed is that of skin friction between plates and moving water.

The apparatus consists of a cast iron casing carrying long trunnions, supported on friction disks or ball bearings, about which the casing is free to rotate within limits. An arm, not shown in the cut, which is attached to the casing and projects to a fixed distance from the center, carries a spring balance to register the turning effort of the casing. The

shaft runs in bronze bushes in the trunnions, and carries one or more smooth disks of steel plate, of a diameter sufficient to occupy nearly the full diameter of the interior of the casing, there being placed between each pair of plates a ring of similar plate fixed in the joint of the casing. The fixed and revolving disks are separated and never come into contact. The brake is partially filled with water, and on the disks rotating, the water is carried out to their extreme edges, rotating with the disks, but at a slower speed. The energy of the motor under test is entirely dissipated by the friction of the fluid against the fixed and moving plates. Tho moment of this force tends to rotate the casing about the trunnions, the effort being measured by the spring balance fixed to the arm. It is evident that any friction of the



Absorption Dynamometer.

water, as well as of the shaft bearings, is duly shown on the spring balance, and the readings, therefore, always give a true record of the work given to the brake.

The water is introduced at the center of the casing, through a regulating cock, and drawn off at the rim. The quantity of water is adjusted, when the brake is in use, by a tube which may be set to project inward to any point toward the center of the shaft. The water inside this radius is discharged by centrifugal force, thus regulating the depth of the ring of fluid round the periphery of the disks. With a given quantity of water in the casing, and at all but the very lowest speed, the torque on the casing bears a fixed relation to the speed of rotation of the shaft, so that by increasing or reducing the water contents any conditions of torque and speed can be obtained.

MILLING MACHINE OUTPUT.

P. V. Vernon, in *The Engineer*, (London), May 31, 1907.

The reputation of the milling machine as a metal removing tool for enginering work is spreading, and it is, therefore, important to ensure that further progress shall be along the right lines. It is with this object that the following observations are offered, not with any intention of advocating a particular type of machine, but to note some of the conditions to be observed if the best output is to be obtained from any reasonably well designed machine.

The early milling cutter was called a fraise from a fancied resemblance of the toothed surface of the cutter to the rough exterior of the strawberry, and it may be owing to this that many milling machines are operated so as not to remove much more material than could be rubbed off with a hardened steel strawberry, instead of a properly designed milling cutter. The fact that each tooth is a cutting tool, with capacity for removing metal in much the same way as other metal-cutting tools, has been obscured by the association with it of many similar teeth on the same cutter, very little inquiry being made, as a rule, as to whether each tooth is doing fair duty, and the output of the cutter, as a whole, being judged by comparison with other milling cutters, and not by comparing the work of each cutting edge with that of other cutting edges of equal strength and with equal power behind them.

An examination into the question of the amount of cut taken by each tooth of a milling cutter shows that even when good milling, as generally understood, is being done, each tooth is taking a surprisingly small cut, and it is very seldom that the cutting edges fail through the heaviness of the cut when properly made and properly run. The accompanying Table I contains particulars of a number of milling cuts which are regularly performed, and which may be said to represent a good output (A. D. 1907) although not by any means the maximum possible output of the various cutters. It will be seen that although the feeds are fairly thick, yet the feed per tooth is quite small, and it may be fairly inferred that the cutters themselves might be made to do a great deal more work if other conditions permitted. The feeds are tabulated in three different ways, showing that the feed per tooth does not bear any fixed relation to the feed per minute, or to the feed per turn, neither of which, therefore, can be taken as a gage of the possibilities of output of the cutter, the feed per tooth and the cutting speed being the really important factors in the problem.

The usual limitations of output, when milling, are caused by spring or chatter due to weakness of the work, lack of driving power, weakness of the machine, or of the cutter arbor; weakness of the feed motion; weakness of the body of the cutter, not of the teeth; or insufficient room for chips. In order to get the maximum amount of work then from each tooth of the cutter, it is necessary to give attention to the following requirements, assuming that the work is massive enough to stand the heaviest cut that will be taken:—

(1) Sufficient driving power.

(2) A strong enough machine.

(3) A stiff enough arbor.

(4) A regular and powerful feed.

(5) Enough metal in the body of the cutter.

(6) Ample room for chips; in other words, teeth of coarse pitch.

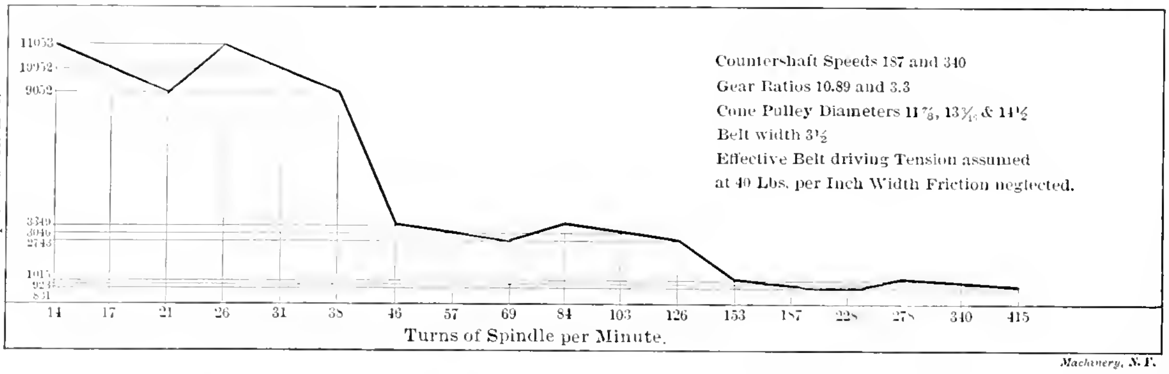
I have no hesitation in stating my belief that the above six factors have very much more influence on the output of a milling cutter than the actual power of the tooth to resist the stresses that come on it. In order to determine the importance of each of these six vital factors in relation to the work of the cutter, it is best to consider them one at a time.

1. *Sufficient Driving Power.*—The maximum power deliverable to the machine is merely a matter of dimensions of its driving parts, but a much more important matter is the power available at the cutter on the different spindle speeds. The accompanying torque diagram is for a modern milling machine of cone pulley type, with all the latest improvements in the way of wide belts, large pulleys and double back gears, and it will be seen that the actual torque or driving effort available at the spindle varies in a more or less irregular manner. Now, assuming the number of teeth in cutting contact with the work to be constant, the torque required for a given cut per tooth is perfectly regular, and varies directly as the width of cut and as the diameter of the cutter. It is, therefore, important when doing fast milling to select a cutter of such diameter that, when running at its correct cutting speed, its driving torque will not be at the bottom of one of the valleys of the curve in the cut unless the power of the machine is enough to give ample torque even in the deepest valley. Subject to this and other reservations to be dealt with later, the diameter of the cutter should be as small as possible.

2. *A Strong Enough Machine.*—That is to say, a machine of which the frame, spindle, slides, and other parts are sufficiently strong to enable the whole of the driving power provided to be utilized at the cutter without chatter, flexure, or vibration. This factor is one of correct proportion, not of absolute dimensions, and a single faulty element will seriously affect the work of the cutter.

3. *A Stiff Enough Arbor.*—A milling cutter arbor must be strong torisionally and transversely, as the arbor is the only connection between the cutter and its driving power. In general terms, it may be said that arbors for heavy milling are often too small to transmit the power which the milling ma-

chines possess, and which the cutters could utilize but for the weakness of their arbors. The torsional stress on the arbor due to driving a given cut varies directly as the diameter of the cutter, whereas both the torsional and the transverse strength of the arbor vary directly as the cube of the diameter. It therefore pays in many cases to increase the coarse pitch teeth occupy less space in proportion to their weight than thin chips, thus further favoring the coarse pitch cutter. Most of the published tables of milling cutter dimensions specify too many teeth in the cutters, and users of modern machines will be well advised not to rely on such tables, but to favor very much coarser pitches.



Variation of Torque with Change of Speed in a Modern Cone Pulley Driven Milling Machine.

diameter of the cutter, provided that the increase in diameter is also added to the arbor. The arbor, in fact, gains very much more than the cutter loses by the increase. Arbors should therefore be large.

4. *A Regular and Powerful Feed.*—The general experience of milling machine makers has decided in favor of a screw feed for heavy milling. It is not necessary to enlarge on various methods of feeding in this article, as the matter has been fully dealt with previously. It is enough to say that the feed must be sufficient in rate and in power to give as much feed to each tooth of the cutter as the other conditions will allow.

5. *Enough Metal in the Body of the Cutter.*—This condition further modifies the general maxim that cutters should be as small as possible. It is often desirable to make the cutter solid, so as to perform the double function of cutter and arbor. This may be said to give the smallest possible cutter with the largest possible arbor. Where, for reasons of cost or interchangeability, this cannot be done, ample thickness should be allowed, as nothing is gained in output by the use of a cutter so thin that it will not survive the maximum cut which the tooth will stand, which the arbor will transmit, and which the machine will drive.

The following table has been found satisfactory for general use, but is put forward more as a suggestion than with the idea that it is a final statement of ultimate possibilities:

TABLE II. NUMBER OF TEETH IN MILLING CUTTERS.

Diameter of Cutter.	No. of Teeth, Ordinary Finishing and Roughing Cutters.	No. of Teeth, Cutters for Heavy Roughing only.
⅛ in. to 3-16 in.	5	—
¼ in. to 13-16 in.	6	—
⅞ in. to 1¼ in.	8	—
1⅜ in. to 1½ in.	9	6
1⅝ in. to 1⅞ in.	10	6
2 in. to 2⅜ in.	12	7
2½ in. to 3⅜ in.	14	8
3½ in. to 3⅞ in.	16	9
4 in. to 6 in.	18	10

With roughing cutters made as per the last column, only one tooth will be cutting at a time on all ordinary roughing work. The spiral must, therefore, be such as to ensure continuity of torque, or the result will be an intermittent cut. A good angle of spiral for general work is 27 deg. with the axis of the cutter. It must not be forgotten that coarse pitch of teeth necessitates short pitch of spiral.

There are many more questions in connection with milling, on which definite information is required, if milling is to take its proper place in the economy of the machine shop, such as the effect of the feed per tooth on the cutting speed for different materials, the proper cutting and clearance angles for milling cutter teeth, and the proper ratio between power consumed and metal removed under the best conditions; but enough has perhaps been said to indicate that there may be points in connection with milling which do not receive attention from the average user, and that the successful use of milling machines depends upon a proper appreciation of these points. The labor-saving possibilities of milling machines properly designed, built, tooled, and handled, are perhaps greater than of any other metal cutting tools, and it is for the present generation of engineers to avail themselves of these possibilities to the fullest extent.

TABLE I. OUTPUT OF MILLING CUTTERS.

Cutter.				Cut.		Speed.		Feed.			Material Removed.	Material Milled.
Type.	Steel.	Diam., in.	No. of Teeth.	Width, in.	Depth, in.	Turns per min.	Feet per min	Inches per min.	Inches per turn.	In. per tooth.	Cubic in. per min.	
Face	High speed	2	12	1.125	0.187	200	105	9	0.045	0.0038	1.9	Cast iron
"	"	3½	12	2.625	0.187	86	79	5.5	0.064	0.0053	2.7	"
"	"	4½	14	3	0.156	60	71	8.5	0.140	0.0100	3.98	"
"	"	6½	16	5	0.125	41	70	10.3	0.252	0.0157	6.45	"
"	"	8	12	8	0.125	30	63	5.87	0.195	0.0163	5.87	"
Side	"	2½	16	2.5	0.25	110	72	6.5	0.059	0.0037	4	"
"	Carbon	2¾	12	3	0.125	48	34.5	12.125	0.253	0.0214	4.55	"
"	High speed	3	8	5	0.312	60	47	12	0.200	0.025	18.7	"
"	Carbon	2¼	18	1.875	0.1	64	38	3.3	0.051	0.0029	6.2	Mild steel
"	High speed	2¾	22	3.5	0.187	48	35	3.5	0.073	0.0033	2.3	"
"	"	3⅞	18	1.75	0.75	64	65	1.375	0.0215	0.0012	1.8	"

6. *Teeth of Coarse Pitch.*—A milling cutter will do more work when each tooth gets well under the surface; in other words, when the feed per tooth is sufficient to enable a cut rather than a scrape to be taken. With coarse pitch cutters, less teeth are cutting at one time, and a given feed power is more effective on each tooth than in the case of fine pitch cutters. There is also more room for chips. The space per tooth available for chips varies approximately as the square of the pitch of the teeth, and the total space for chips all round the cutter varies directly as the pitch. Coarse pitch cutters can also have stronger teeth than fine pitch cutters, as they permit of a wider land behind the cutting edge, without unduly robbing the space available for chips, and incidentally the thicker tooth is not so easily affected by heat generated while cutting. In addition to this, the thicker chips taken by

COOPERATIVE COURSES IN ENGINEERING AT THE UNIVERSITY OF CINCINNATI.

Abstract of Paper by Prof. Herman Schneider, read before the Society for the Promotion of Engineering Education.

The plan of combined theoretical and practical instruction, followed in the mechanical engineering course of the University of Cincinnati, was described in the March, 1907, issue of MACHINERY under the title "Unique Experiment in Technical Education." The paper, of which this is an abstract, gives further information as to the plan of this course, and tells something of the success that has attended it so far.

About six years ago the writer began what might be called a pedagogical research into the problem of engineering education. After a time he sifted the problem down to three question:

What requirements should the finished product of an engineering school fill?

Where and how shall we get the raw material to make the required finished product?

Through what process shall we put the raw material, in order to acquire the finished product?

The thorough investigation of these questions, carried on by visits to the largest manufacturing concerns in the Eastern and Middle States for six years, and still in progress, resulted in certain conclusions which seemed so radical that the writer hesitated to promulgate them until they had been actually tested. The present six-year course at the university is the outgrowth of these investigations, and it seems to have worked well enough so that the writer feels warranted in giving more publicity to the idea.

The length of the course is six years. During this period the students work alternate weeks in shops of the city throughout the scholastic year, and in the summer full time. Two facts are emphasized in this connection. First, the entrance requirements are precisely the same as for the four-years course; second, the university instruction under the cooperative plan is just as complete, thorough, broad, and cultural as the four years course. In fact it is rather more so. The course is not a short-cut to salary.

Young men desiring to enter this course are required to enter the shops in June or July preceding their entrance to the university. The process of elimination takes place during the summer work, which weeds out the weaker and more undecided ones, and leaves a residue which can be depended on for results. Last year 60 young men made application for entrance, and 45 of them undertook the shop work after learning the conditions of the course. Fifteen of these quit after they began, leaving a class of 30 in September. Three of these men have been dismissed for poor scholarship. This year about 400 inquiries and applications for admission to the course were received. Most of these faded away when they learned of the conditions. Up to this writing, 50 men had been placed in the shops for this year's class. There will probably be between 50 and 75 when the class is formed.

It is interesting to note the reasons which prompted these young men not to apply for work, or if they did apply, to quit work. Some of the reasons were: "It looked too hard"; "I had to get up too early in the morning"; "the work was too greasy"; "I'd rather be a lawyer"; "I want to complete my education in four years instead of six"; "my father said they did not pay me enough"; "my mother was afraid I'd get killed'"; "the boss spoke gruffly to me"; and so on. Some of the young men who withdrew from the cooperative course are in the four-year course.

A comparison of the work of the four-year freshman with that of the six-year freshman is interesting. The six-year cooperative students, though but working half the time of the regular students, have accomplished three-fourths of the work done by them, including all the mathematics and science of the freshman year. The course has been applied to the department of electrical, chemical and mechanical engineering. Attention is called to the fact that under this scheme the college is operated at the highest efficiency. Being given a certain sum of money to train a certain number of men, only those who by mental, physical and temperamental adaptability are worthy of the expenditure made, are retained.

[A recent report from the Cincinnati University states that nearly 60 young men have undertaken the course this year. This is double the number that began last year. About half of them are from Cincinnati and its immediate vicinity, the balance coming from all over the United States, as far west as Idaho, and as far east as Connecticut. The machine shops of the city appear to be much interested in the work, and enter into hearty cooperation with the University.]

COMPARATIVE COSTS OF GASOLINE, GAS, STEAM AND ELECTRICITY FOR SMALL POWERS.

William O. Webber, in *Engineering News*, August 15, 1907.

The comparative cost of the various sources of power is a matter of very great interest in installations of small power where any one is equally available and the sole determining factor is expense. In the usual determination of these relative costs it has been assumed that the total cost of a new plant was merely the cost of the machine plus the cost of the material required to run it, and that the additional cost of depreciation, interest, insurance, etc., would be the same in each instance. It is also generally assumed that the power costs just so much per horse-power regardless of the amount used. These are both very erroneous impressions.

The following tables give the itemized cost of 1 horse-power per hour on 2, 6, 10 and 20-horse-power plants, respectively, for gasoline, gas, steam and electric power.

Table I shows the cost of gasoline power, and is based on fact, not theory. All gasoline engines do not run on one-eighth of a gallon of gasoline per brake horse-power per hour, and to get at fair comparative results, proper allowances must be made for depreciation, repairs and insurance, as well as taxes, and the room occupied by the plant must be taken into account.

Table II shows the costs for the same powers driven by electricity It will be noted that proper allowance must be made for attendance, although this item is not generally charged as it should be. In this case nothing is charged for room, as separate power rooms are not required.

Table III gives the cost of gas power, using illuminating gas of 760 B. T. U. No estimate is made on the cost of gas power, using producer gas, as it would not pay to put in a gas producer for so small a unit.

In Table IV are given figures on the cost of steam power, from 6 to 20 horse-power, but no estimate is made on the cost for 2 horse-power, for the reason that such a plant would be too small to consider. The figures in Table V show a summarized comparison between the annual cost of power per brake horse-power for various kinds of motive power.

TABLE I. COST OF GASOLINE POWER.

Size of plant in H.P..	2	6	10	20
Price of engine in place	$150.00	$325.00	$500.00	$750.00
Gasoline per B.H.P. per hour	1-3 gal.	1-4 gal.	1-6 gal.	1-8 gal.
Cost per gallon.....	$0.22	$0.20	$0.19	$0.18
= cost per 3,080 hours	$451.53	$924.00	$975.13	$1,386.00
Attendance at $1 per day	308.00	308.00	308.00	308.00
Interest, 5%..........	7.50	16.25	25.00	37.50
Depreciation, 5%.....	7.50	16.25	25.00	37.50
Repairs, 10%.........	15.00	32.50	50.00	75.00
Supplies, 20%........	30.00	65.00	100.00	150.00
Insurance, 2%........	3.00	6.50	10.00	15.00
Taxes, 1%............	1.50	3.25	5.00	7.50
Power cost.......	$824.03	$1,371.75	$1,198.13	$2,016.50

To these figures should be added charges on space occupied as follows:

Value of space occupied	$100.00	$150.00	$200.00	$300..0
Interest, 5%..........	$5.00	$7.50	$10.00	$15.00
Repairs, 2%..........	2.00	3.00	4.00	6.00
Insurance, 1%........	1.00	1.50	2.00	3.00
Taxes, 1%............	1.00	1.50	2.00	3.00
Total annual charge for space	$9.00	$13.50	$18.00	$27.00
Total cost per annum.	$833.03	$1,385.25	$1,516.13	$2,043.50

Cost of 1 H.P. per annum, 10 hour basis	416.51	239.87	151.61	102.17
Cost of 1 H.P. per hour	$.1352	$0.0780	$0.0492	$0.0331

TABLE II. COST OF ELECTRIC POWER.

Size of plant in H.P.	2	6	10	20
Cost of motor in place	$83.00	$118.00	$216.00	$270.00
With wiring, etc.	100.00	130.00	240.00	300.00
Cost of electricity 3,080 hours	$529.56	$976.00	$1,425.00	$2,450,00
Attendance	20.00	30.00	50.00	50.00
Interest, 5%	5.00	6.50	12.00	15.00
Depreciation, 10%	10.00	13.00	24.00	30.00
Repairs, 5%	5.00	6.50	12.00	15.00
Supplies, 1%	1.00	1.30	2.40	3.00
Insurance, 2%	2.00	2.60	4.80	6.00
Taxes, 1%	1.00	1.30	2.40	3.00
Total cost per annum	$573.56	$1,037.20	$1,532.00	$2,572.00
Cost of 1 H.P. per annum, 10 hour basis.	286.78	172.86	153.20	128.60
Cost of 1 H.P. per hour	$0.0928	$0.0558	$0.0497	$0.0417

The costs for the electric current which are used in Table II are figured from the discount table shown as follows:

COSTS OF ELECTRIC CURRENT.

Base Price = 13½ cents per K.W. hour. Discounts on Monthly Bill.

Monthly Bill.	Discounts.	Monthly Bill.	Discounts.
$5	10%	$100 to $125	40%
$10 to $20	15%	$125 to $150	45%
$20 to $25	20%	$150 to $175	50%
$25 to $50	25%	$175 to $200	55%
$50 to $75	30%	$200 to $500	60%
$75 to $100	35%	$500 and over	65%

For 2 H.P. plant:

$$\frac{3{,}080 \text{ hours} \times 2 \text{ H.P.} \times 0.746}{82 \text{ per cent Efficiency}} = 5{,}604.1 \text{ K.W. hours per annum,}$$

then $5{,}604.1 \times \$0.135 = \$756.55$, annual cost without discount.
Monthly bill = $63. Discount = 30 per cent.

$$\$756.55 \times 70\% = \$529.56 = \text{annual cost.}$$

For 6 H.P. plant:

$$\frac{3{,}080 \text{ hours} \times 6 \text{ H.P.} \times 0.746 \times 0.135 \times 45}{86 \text{ per cent Efficiency}} = \ldots\ldots\ldots \$976.00$$

Monthly cost = $180. Discount = 55 per cent.

For 10 H.P. plant:

$$\frac{3{,}080 \times 10 \times 0.746 \times 0.135 \times 40}{87 \text{ per cent}} = \ldots\ldots\ldots \$1{,}425.00$$

Monthly cost = $298. Discount = 60 per cent.

For 20 H.P. plant:

$$\frac{3{,}080 \times 20 \times 0.746 \times 0.135 \times 35}{88.5 \text{ per cent}} = \ldots\ldots\ldots \$2{,}450.00$$

Monthly cost = $585. Discount = 65 per cent.

TABLE III. COST OF GAS POWER.

$1.50 per 1,000 cubic feet of gas less 20 per cent, if paid in 10 days = $1.20 net, gas 760 B. T. U.

Size of plant in H.P.	2	6	10	20
Engine cost in place	$200.00	$375.00	$550.00	$1,050.00
Gas per H.P. hour in cubic feet	30	25	22	20
Value of gas consumed, 3,080 hours	$221.76	$554.40	$843.12	$1,478.00
Attendance, $1 per day	308.00	308.00	308.00	308.00
Interest, 5%	10.00	18.75	27.50	52.50
Depreciation, 5%	10.00	18.75	27.50	52.50
Repairs, 10%	20.00	37.50	55.00	105.00
Supplies, 20%	40.00	75.00	110.00	210.00
Insurance, 2%	4.00	7.50	11.00	21.00
Taxes, 1%	2.00	3.75	5.50	10.50
Power cost	$615.76	$1,023.65	$1,387.62	$2,237.50
Annual charge for space	9.00	13.50	18.00	27.00
Total cost per annum.	$624.76	$1,037.15	$1,405.62	$2,264.50
Cost of 1 H.P. per annum, 10-hour basis.	312.38	172.86	140.56	113.22
Cost of 1 H.P. per hour	$0.1014	$0.0561	$0.0456	$0.0367

TABLE IV. COST OF STEAM POWER.

Size of plant in H.P.	6	10	20
Cost of plant per H.P.	$250.00	$220.00	$200.00
Fixed charge, 14%	$35.00	$30.80	$28.00
Coal per H.P. hour, in pounds	20	15	12
Cost of coal at $5 per ton	$154.00	$103.00	$82.50
Attendance, 3,080 hours	75.00	50.00	30.00
Oil, waste and supplies	15.00	10.00	6.00
Cost 1 H.P. per annum, 10-hour basis	$279.00	$194.80	$146.50
Cost of 1 H.P. per hour	$0.0906	$0.0832	$0.0475

TABLE V. ANNUAL COST OF POWER PER BRAKE HORSE-POWER.*

B. H.P. of Unit.	Steam	Electricity.	Gas.	Gasoline.
1	$600.00	$312.50	$380.00	$487.50
2	500.00	282.00	312.50	416.00
3	437.50	252.00	260.00	350.00
4	375.00	227.50	220.00	300.00
5	320.00	207.50	192.50	262.50
6	280.00	192.00	172.50	240.00
7	250.00	179.00	160.00	210.00
8	230.00	168.00	152.50	182.50
9	210.00	158.00	145.00	165.00
10	195.00	152.00	140.00	152.00
12	175.00	140.00	132.50	137.50
14	165.00	133.00	126.00	122.00
16	157.50	128.00	120.00	112.50
18	150.00	126.00	116.50	107.50
20	146.00	123.00	113.00	102.00
22	140.00	121.50	110.00	98.00
24	137.50	119.50	107.50	95.00
26	133.00	117.50	105.00	92.50
28	130.00	116.50	102.50	90.00
30	127.50	115.00	102.00	87.50
35	124.00	113.50	100.00	85.00
40	120.00	112.00	98.00	82.50
50	112.50	110.00	96.00	80.00
60	105.00	108.00	94.00	78.00
70	100.00	106.00	92.00	76.00
80	95.00	104.00	90.00	74.00
90	90.50	102.00	88.00	72.00
100	86.40	100.00	86.00	70.00

* Unit costs: Coal, $5 per ton; electricity, $0.135 per K.W.-hour; gas $1.20 per 1000 cubic feet, at 760 B. T. U.; gasoline, $0.20 per gallon.

* * *

UNUSUAL POWER HOUSE.

The most unusual power house of which we have ever heard has recently been completed for the Patapsco Electric & Mfg. Co., Ilchester, Md. This power house is located inside of a dam. The dam is of reinforced concrete and hollow, leaving a considerable amount of waste room which it seemed advisable to make use of in some way. The installing of the turbines and generators in this space reduced materially the cost of the installation, resulting in shorter and more direct passages for the water, and less expense for buildings. The part of the dam used for housing the plant is fitted with a false ceiling, hung 5 feet from the main shell of the structure so as to protect the apparatus from any water that might leak through the deck. The side next to the tail water is fitted with windows. These windows furnish plenty of light, even when the water is flowing over the dam two feet deep. The water for operating the turbines is taken through the deck 5½ feet below the crest of the spill-way. This helps to keep the trash rack free from drift wood, etc. Two waste gates are placed near the bottom of the dam, with the water passages under the floor.

* * *

According to the *Times Engineering Supplement*, Switzerland possesses in all about 1,000,000 horse-power of water power, which can practically be developed. Of this, one-fourth is already utilized, and new installations of large capacity are being erected for the purpose of generating electricity. The generating stations are situated in different places far apart from one another, but the districts served by the systems border on each other and can be connected with very little expense, so that if one generating station is short of power for one reason or another it can be supplied from another system, and *vice versa*. Thus, it is possible to supply current to one part of Switzerland from another part, and this, in general, improves the load factor of the generating stations.

FORMULAS FOR FORCE REQUIRED TO MOVE CRANE TROLLEYS.*

JOHN S MYERS †

In designing crane trolleys and similar constructions the force required to move them is not always calculated to a nicety, and the design then based upon the figures. This may be the conception of the man fresh from college, but it more frequently happens that past experience of a case similar to the one in hand is relied upon entirely.

This is both a safe and quick method, when conditions make it possible, provided good judgment is exercised in allowing for differences between the past construction and the proposed new one. The designer is, however, often confronted by a problem in which he has no past experience to draw upon and for which he has no applicable data at hand, or the design may be of a type similar to that of past experience, but so different as to sizes that he is compelled to calculate from elementary principles. Two troublesome questions then arise: First, what theoretical conditions should be taken into account and what ones may be safely neglected? and second, what values should be assigned to the various constants and assumed factors entering into the calculations? The practicability of his designs will depend almost entirely upon the manner in which the above questions are answered.

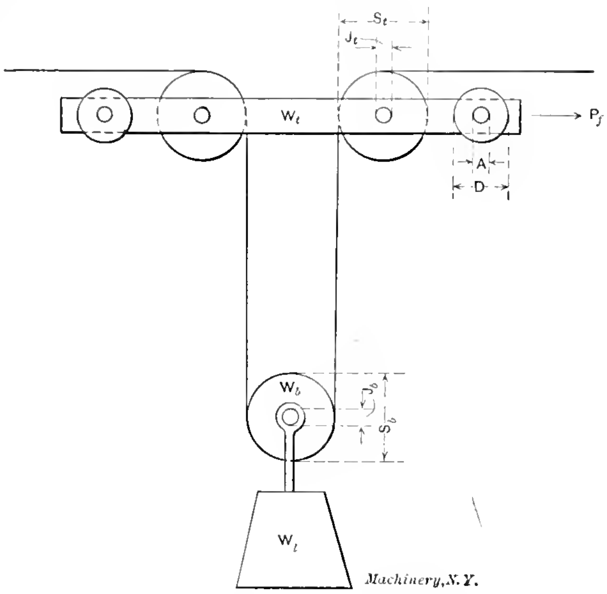


Fig. 1. Trolley with Sheave Suspended by Two Parts of Rope.

Taking up the subject of crane trolleys, of the type in which the load is suspended by ropes passing over sheaves in the trolley and hanging block, as illustrated in Figs. 1, 2, and 3, the above questions may be considered as mutually dependent upon each other, and might be answered as follows:

Take into account journal friction of the trolley wheels, trolley sheaves and hanging block sheaves; also the separate weights of load to be carried, hanging block, and trolley.

Neglect friction of ropes in grooves of sheaves, power necessary to bend ropes over sheaves, and the rolling friction of the trolley wheels on the track, allowing these to be taken care of by the assumed coefficient of journal friction.

Neglect inertia, also, for the usual speeds of crane trolleys, since the difference between the coefficient of rest and of motion is sufficient to produce the necessary acceleration.

In choosing the coefficient of friction consider the general conditions of lubrication as being poor, and consider that it is the coefficient of rest which is required. Assume this coefficient to be the same for all journals. A fair value is 0.1. Having settled these preliminary considerations, general formulas may be developed.

CASE I. (See Fig. 1.) The conditions are: Two parts of rope supporting the load, one sheave in hanging block, and two sheaves in trolley.

Let W_l = weight of load to be carried.
W_b = weight of hanging block.
W_t = weight of trolley.
P_f = pull on trolley to overcome friction.
S_b = diameter of sheave in block.
J_b = diameter of journal in block.
S_t = diameter of sheave in trolley.
J_t = diameter of journal in trolley sheaves.
D = diameter of trolley wheels.
A = diameter of trolley axle journals.
C = coefficient of friction.
F_b = friction of hanging block sheave.
F_{ts} = friction if trolley sheaves.
F_{tw} = friction of trolley wheels.

For Case I,

$$F_b = (W_l + W_b)\, C \frac{J_b}{S_b} \qquad (1)$$

The load being supported by two ropes, the load in each is ½ $(W_l + W_b)$ and, the arc of contact of the rope on the trolley sheaves being 90 degrees (α) the resultant pressure on the journals of each of these sheaves is ½ $(W_l + W_b)\, 2 \cos \frac{\alpha}{2}$ = ½ $(W_l + W_b)\, 2 \cos 45$ degrees.

For the two sheaves the resultant pressure amounts to

$$1.4\,(W_l + W_b).$$

From the above we get:

$$F_{ts} = 1.4\,(W_l + W_b)\, C \frac{J_t}{S_t} \qquad (2)$$

For the friction of the axle bearings of the trolley wheels, the weight of the load, hanging block, and trolley must be considered, thus:

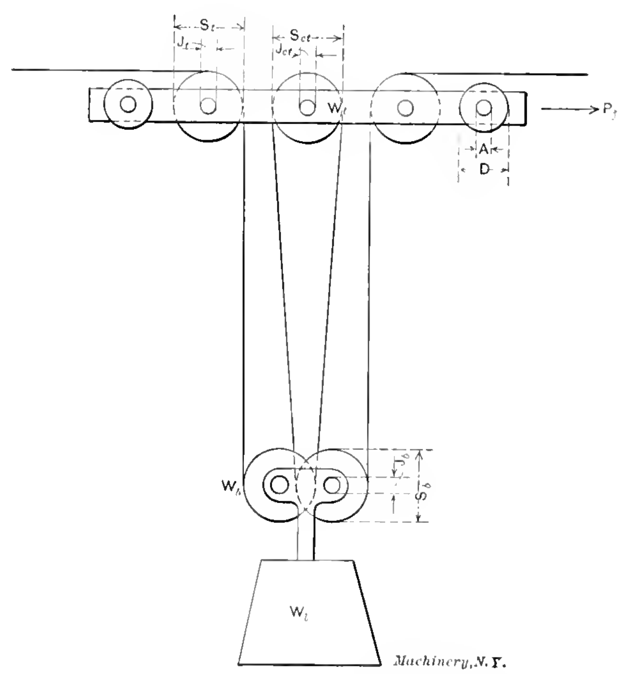


Fig. 2. Trolley with Sheave Suspended by Four Parts of Rope.

$$F_{tw} = (W_l + W_b + W_t)\, C \frac{A}{D} \qquad (3)$$

We have, then, for the total friction

$P_f = F_b + F_{ts} + F_{tw}$, or

$$P_f = C\left[(W_l + W_b)\left(\frac{J_b}{S_b} + 1.4\frac{J_t}{S_t}\right) + (W_l + W_b + W_t)\frac{A}{D}\right] \qquad (4)$$

CASE II. (See Fig. 2.) The conditions are: Four parts of rope supporting the load, two sheaves in the hanging block, and three sheaves in the trolley.

Let the notation be as for case I with the addition of:

S_{ct} = diameter of sheave at center of trolley.
J_{ct} = diameter of journal for this sheave.

Then, F_b = same as for case I (equation 1).
F_{tw} = same as for case I (equation 3).

* For previous articles on this and kindred subjects, see "The Efficiency of Mechanism," by Mr. C. F. Blake, March and April, 1903.
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The friction of the two end sheaves in trolley is one-half of that in case I or

$$0.7\,(W_1 + W_b)\,C\,\frac{J_t}{S_t}.$$

The friction of the central sheave is

$$0.5\,(W_1 + W_b)\,C\,\frac{J_{ct}}{S_{ct}}.$$

The total friction of the trolley sheaves is then

$$F_{ts} = (W_1 + W_b)\,C\left(0.7\,\frac{J_t}{S_t} + 0.5\,\frac{J_{ct}}{S_{ct}}\right) \qquad (5)$$

The total frictional resistance of the trolley is:

$P_t = F_b + F_{ts} + F_{tw}$ or

$$P_t = C\left[(W_1 + W_b)\left(\frac{J_b}{S_b} + 0.7\,\frac{J_t}{S_t} + 0.5\,\frac{J_{ct}}{S_{ct}}\right) + (W_1 + W_b + W_t)\,\frac{A}{D}\right] \qquad (6)$$

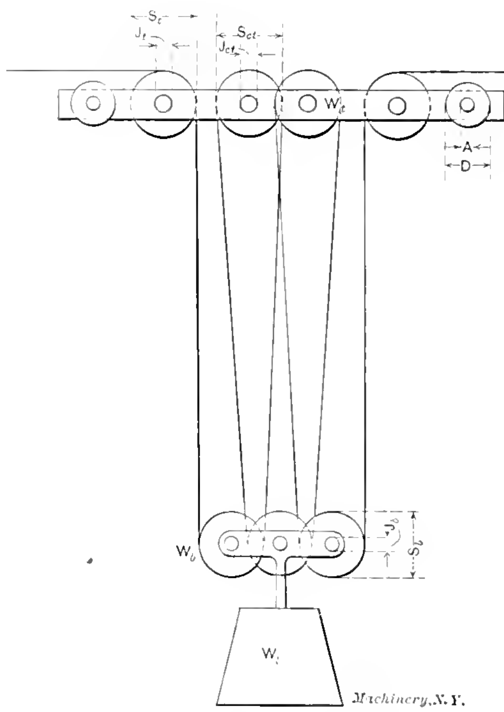


Fig 3 Trolley with Sheave Suspended by Six Parts of Rope.

When $\frac{J_{ct}}{S_{ct}} = \frac{J_t}{S_t}$, as it often will be, equation 5 becomes:

$$F_{ts} = 1.2\,(W_1 + W_b)\,C\,\frac{J_t}{S_t} \qquad (7)$$

Under these conditions equation 6 reduces to

$$P_f = C\left[(W_1 + W_b)\left(\frac{J_b}{S_b} + 1.2\,\frac{J_t}{S_t}\right) + (W_1 + W_b + W_t)\,\frac{A}{D}\right] \qquad (8)$$

CASE III. (See Fig. 3.) The conditions are: Six parts of rope supporting the load, three sheaves in hanging block and four sheaves in trolley.

Notation the same as for cases I and II.

F_b = same as case I and II. (equation 1).

F_{tw} = same as case I and II. (equation 3).

The load in each rope is 1/6 $(W_1 + W_b)$.

In case I the load in each rope was 1/2 $(W_1 + W_b)$.

The frictional resistance of the two end sheaves is therefore 1/6 ÷ 1/2 = 1/3 as much for this case as for case I, and is equal to $0.47\,(W_1 + W_b)\,C\,\frac{J_t}{S_t}$. The friction of the two central sheaves is $2/3\,(W_1 + W_b)\,C\,\frac{J_{ct}}{S_{ct}}$. The total friction of the trolley sheaves is then

$$F_{ts} = (W_1 + W_b)\,C\left(0.47\,\frac{J_t}{S_t} + 0.67\,\frac{J_{ct}}{S_{ct}}\right) \qquad (9)$$

The total friction of the trolley is $P_f = F_b + F_{ts} + F_{tw}$, or

$$P_f = C\left[(W_1 + W_b)\left(\frac{J_b}{S_b} + 0.47\,\frac{J_t}{S_t} + 0.67\,\frac{J_{ct}}{S_{ct}}\right) + (W_1 + W_b + W_t)\,\frac{A}{D}\right] \qquad (10)$$

When $\frac{J_{ct}}{S_{ct}} = \frac{J_t}{S_t}$, as would usually be the case, equation 9 reduces to

$$F_{ts} = 1.14\,(W_1 + W_b)\,C\,\frac{J_t}{S_t} \qquad (11)$$

Under this condition equation 10 becomes

$$P_f = C\left[(W_1 + W_b)\left(\frac{J_b}{S_b} + 1.14\,\frac{J_t}{S_t}\right) + (W_1 + W_b + W_t)\,\frac{A}{D}\right] \qquad (12)$$

If we assume that the ratio of journal diameter to sheave diameter is the same for all sheaves and also the same for the trolley wheels and their axle journals, *i. e.*, that $\frac{J_b}{S_b} = \frac{J_t}{S_t} = \frac{J_{ct}}{S_{ct}} = \frac{A}{D}$, or that this condition is approximately true, and let R = this ratio, the foregoing formulas for the value of P_f may be reduced to the following form:

For case I, $P_f = C\,R\,[3.4\,(W_1 + W_b) + W_t]$ (13)

For case II, $P_f = C\,R\,[3.2\,(W_1 + W_b) + W_t]$ (14)

For case III, $P_f = C\,R\,[3.1\,(W_1 + W_b) + W_t]$ (15)

It is seen from the above that the friction is nearly the same for the three cases, provided the value of R be the same. Equation 14 being the intermediate condition may then be considered as representative of all.

* * *

UNIQUE MEANS FOR POWER PRODUCTION.

Mr. Frank Shuman, Tacony, Pa., has developed a power scheme that is attracting some attention. It works on the principle of the common hot-bed used for growing vegetables in winter, the heat rays of the sun being concentrated in exactly the same manner. The power hot-bed is 18 x 60 feet, and is covered by a double top of glass with 1 inch air space between the layers. In the bed are coils of iron pipe painted black. These pipes are filled with ether and are connected with a 3½-horse-power engine. The circuit is closed, the ether after having been evaporated in the pipes passing through the engine thence to a condenser and back to the hot-bed pipes. It is claimed by Mr. Shuman that this apparatus in the tropics could use water successfully as the high temperature acquired from the direct rays of the tropical sun would be amply sufficient to boil water under considerable pressure. It is probable, however, that this idea, while productive of small power, can scarcely be of any great commercial value because of the large investment necessary. Greenhouses might utilize the idea profitably if there is need of small power for pumping, etc., but to deliberately construct a power plant on this plan would seem quite out of the question.

* * *

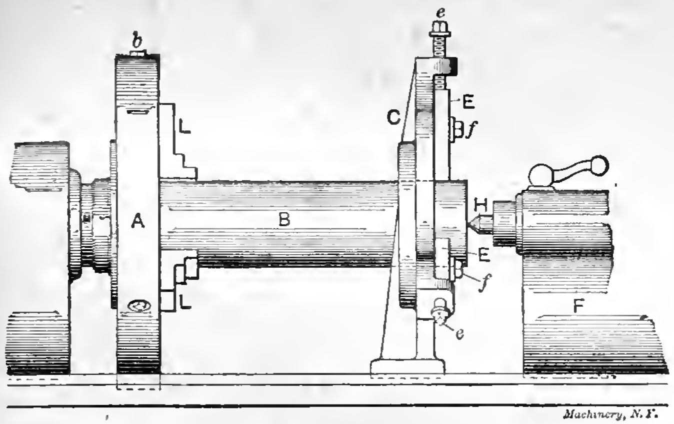
The *Mining World* describes a new remedy for burns discovered by one Dr. Thierry, a physician in the Paris Charity Hospital. He was in the habit of using picric acid as an antiseptic, so that his hands were impregnated with the solution. One day in lighting a cigarette he dropped a portion of the burning match on his hand, but instead of it hurting him, he felt no pain whatever. A short while afterward, while sealing a letter, some of the burning wax stuck to his finger, and though it cauterized the skin, he felt nothing. He began a series of experiments in healing burns with a saturated solution of picric acid. All pain instantly was suppressed. After having bathed the wound in a solution of this acid, blisters did not form, and a cure was effected after four or five days. The only inconvenience was that the acid colored the skin yellow, but this is rapidly remedied by washing with boric acid. The cheapness of picric acid, and the ease with which a proper solution is prepared, have induced many Parisian manufacturers to place jars within easy reach of their workmen.

PUNCH PUNCH PUNCH PUNCH PUNCH PUNCH

These operation sheets, covering every class of shop work, are a feature of all Editions of MACHINERY, and appear every month. They may be cut along the top and margin lines for filing and binding. Suitable binders of sufficient capacity to hold four years' issues will be supplied by THE INDUSTRIAL PRESS, 49-55 Lafayette Street, New York, for 25 cents each, including postage.

SHOP OPERATION SHEET NO. 16.

Oscar E. Perrigo. MACHINERY, October, 1907.



To Hold a Piece in Chuck and Center-rest (Steady-rest), for Drilling and Reaming.

1. Provide, if possible, a three-jawed chuck, the screws of which are connected by a ring bevel gear within the casing. This form is commonly known as a "universal" chuck.

2. Clean the threads of chuck and spindle, and screw the chuck firmly in place. Jaws *L* should preferably face as shown.

3. Lay off and prick punch the exact center of piece *B*.

4. Put the opposite end of *B* in the chuck jaws, and tighten screws *b* just enough to support the work in the chuck.

5. Set up center-rest *C* as shown, and clamp it in place; jaws *E* should not yet be in contact with work *B*.

6. Clamp tail-stock *F* in position as shown. Tap the free end of piece *B* until the prick-punch mark is brought to center *H*; then set up the tail-center just enough to hold the work in place.

7. Tighten the jaws of the chuck, in rotation, enough to hold the work firmly in place.

8. Bring the two lower jaws *E* of the center-rest up to a good contact with casting *B* by setting up jaw screws *e* lightly; then bring down top jaw *E*, clamping all three with nuts *f*.

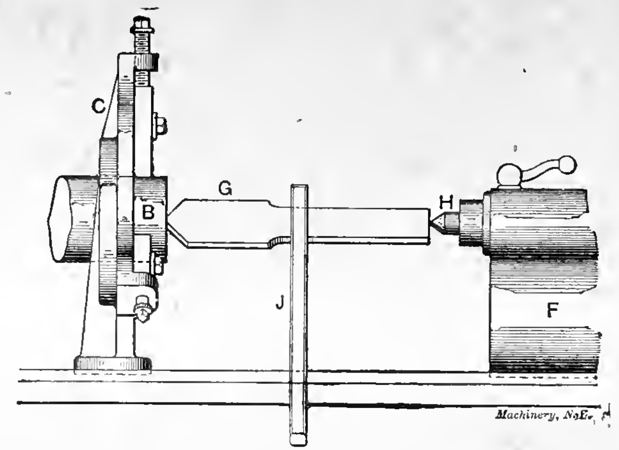
9. Loosen the tail-stock *F*, run it back, remove center *H*, and replace it by any convenient form of centering or starting tool. Move up the tail-stock again, and clamp it as shown.

10. Start the lathe up slowly. Feed the centering tool by the tail-stock hand-wheel until a proper center is made.

Note.—The center-rest jaws must bear as firmly as possible and still permit the work to revolve. Keep the points of the jaws well oiled. For accurate work, the prick-punch mark should be drilled and reamed for a center hole, center *H* inserted, and a short space on the work turned to furnish a true bearing for the center-rest jaws.

SHOP OPERATION SHEET NO. 17.

Oscar E. Perrigo. MACHINERY, October, 1907.



To Drill a Piece Held in a Chuck and Supported by a Center-rest.

1. With the work centered for the drill and properly mounted in chuck and center-rest, move tail-stock *F* to the position shown, and clamp it there, at the proper distance for the drill used.

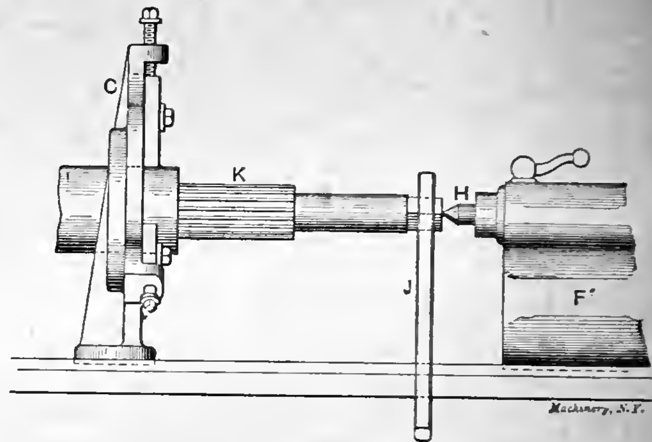
2. Select a flat chucking drill *G*, about 0.005 inch smaller than the finished hole. Place it in position as shown, with its point in the hole made in the work *B* by the centering or starting tool, and with the tail-center of the lathe in the center-hole in the rear end of the drill. Place on the drill a drill-holder or wrench *J*, to prevent it from rotating when the lathe is started.

3. Start up the lathe and bore the hole as deep as desired, keeping the drill-holder *J* in place with the left hand, while feeding the drill by the tail-stock hand-wheel with the right hand. If the hole is deep, the drill must be occasionally removed to clear it of chips. It is best to stop the machine when doing this, to avoid the danger of getting the drill cramped between holder *J* and the hole in the work.

Note.—If the hole in the casting is of considerable diameter, say 2 inches or more, it should be cored out to within 1/4 to 3/8 inch of the finished diameter, in which case a three-lipped chucking drill should be used instead of the flat drill. It will make the hole smoother, and avoid the tendency of the flat drill to chatter. It is often well, when using a flat drill, to bore a small directing hole, say one-fourth the diameter of the finished hole, for the flat drill to follow. This directs the point of the flat drill, and makes the pressure required for feeding very much less, as well. For cleaning the chips from deep holes, it will be found convenient to use a piece of 1/8 by 1/2-inch iron or steel, bent at right angles at a point 1/4 inch from the end.

SHOP OPERATION SHEET NO. 18.

Oscar E. Perrigo. MACHINERY, October, 1907.



To Ream a Drilled Piece Held in a Chuck and Supported by a Center-rest.

1. With the work properly mounted in chuck and center-rest, clamp tail-stock *F* in the position shown, ready for the reamer. The work is supposed to have been drilled ready for this operation.

2. Select a reamer *K*, of the proper diameter for the finished hole. Place it in position as shown, with the center hole in its shank on the dead center of the lathe, and with the slightly tapered end of its cutting edges in the drilled hole in the work. Select a wrench or holder *J* that will fit the squared end of the reamer, and place it in position as shown.

3. Start up the lathe slowly, and proceed to ream the hole, holding the wrench *J* in the left hand to steady it, and at the same time feel the resistance which the material is offering to the cutting action. The reamer is carefully fed forward by the tail-stock hand-wheel, with the right hand. The reamer should be occasionally removed and wiped clean, to prevent clogging with chips and "roughing up" the hole.

4. When the reamer has been fed to depth, remove it, clean out the hole, and test it for diameter with a plug gage or inside caliper, to see that it is of the required diameter.

Note.—If there is a tendency to bind or "squeak" when starting a reamer, we know that the cutting edges are dull. If we are using an ordinary solid reamer, it will be proper to "stone up" the cutting edges, using the oilstone very slightly on the tops of the teeth, and more on the front of each cutting edge. If the reamer is of the expansion type, the blades should be carefully set out, and the cutting edges accurately ground to the proper diameter in a good grinding machine made for the purpose. This is ordinarily done in the tool-room.

OPERATIONS IN MANUFACTURING SMITH'S ADJUSTABLE REAMER.

The "one-lock" adjustable reamer shown in Figs. 1 and 2 is manufactured by the Wm. J. Smith Co. of New Haven, Conn. The accompanying half-tones illustrate operations followed in its manufacture. In Fig. 2, *A* is the body of the reamer;

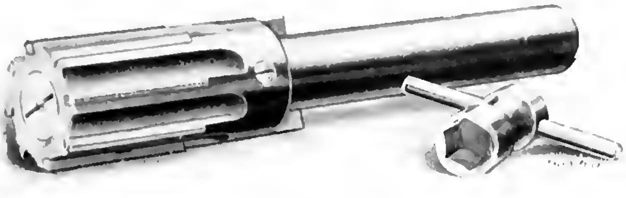


Fig. 1. The "One-lock" Reamer Assembled.

B, the shank; *C*, the driving key; *D*, a screw, loosely fitting a hole in *A*, for holding the parts together; *E*, the blades; *F*, a cam bolt, performing the two functions of adjusting the blades and locking them in place; *G*, the locking nut; and *H*, a wrench used with it.

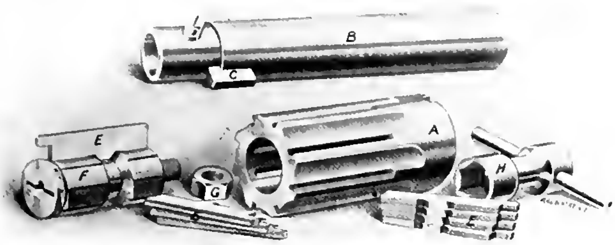


Fig. 2. Details of the "One-lock" Reamer.

Fig. 3 shows the method of holding the stock from which the reamer shell or body is made, for the first operation, that of boring. The work is held at three points, being tightened in place by adjusting the two set screws which back one of the contact strips. The tool on the left is a boring head, fitted with detachable high-speed cutting blades.

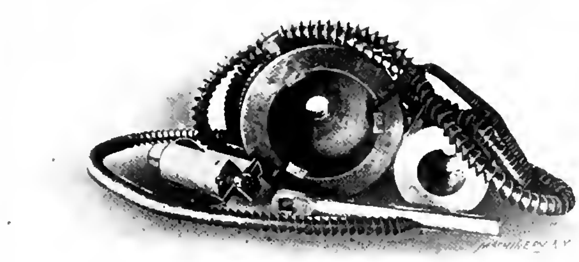


Fig. 3. Three-bearing Chuck, Boring Head, Work, and Chip Produced.

These, it will be seen, are set in the head in such a way as to give a sharp cutting angle. The work shown at the left of the cut has a small hole drilled through it previous to the boring operation. The chip shown is produced by the boring tool.

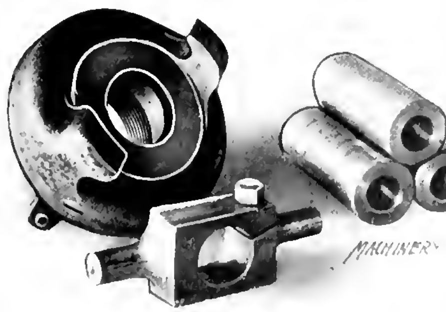


Fig. 4. Special Holder and Two-tailed Driver for Boring in the Turret Lathe.

For boring the other end of the reamer shell, a carrier is used for holding the work in the turret lathe. This carrier, shown in Fig. 4, screws onto the nose of the spindle. It is provided with locking wings which engage the two-tailed dog shown in the foreground. This construction equalizes the strain on the reamer shells, thus preventing cramping, and insuring the alignment of the holes bored from either end.

Fig. 5 shows a special device for graduating the end of the reamer shells. The shell is mounted on a taper split bushing, by which it is clamped to the index plate of the device. This index plate is operated by a ratchet, which accurately spaces the work for the required graduations. On the top of the frame is mounted a cross bar carrying a slide, with a cutter for marking the graduations provided for by

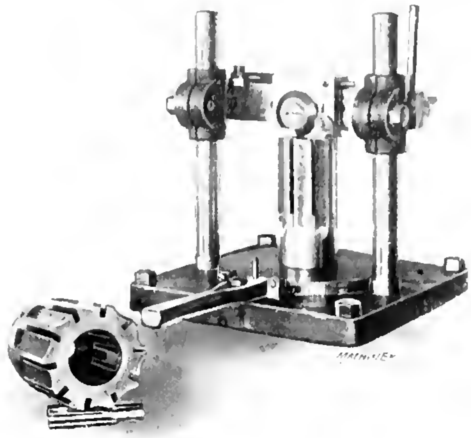


Fig. 5. Fixture for Graduating on the End of Reamer Bodies.

the index plate. The travel of this head is effected by a lever, and the movement is limited by an adjustable stop, varying in position for different cuts, so as to regulate the length of the graduations.

In Fig. 6 is shown the operation of milling the cam surfaces on the cam bolt. As shown, this is held between index centers in the milling machine, and shaped by a form cutter of small diameter. A smaller cam bolt with its cutter is shown on the table of the machine.

For machining the undercut by which the blades engage the cam bolt, the peculiar cutter, shown in Fig. 7, is used. This cutter, which reproduces the outline of the undercut on the cam bolt, has its cutting edge on the interior face. As shown, the work is set up in a hand milling machine.

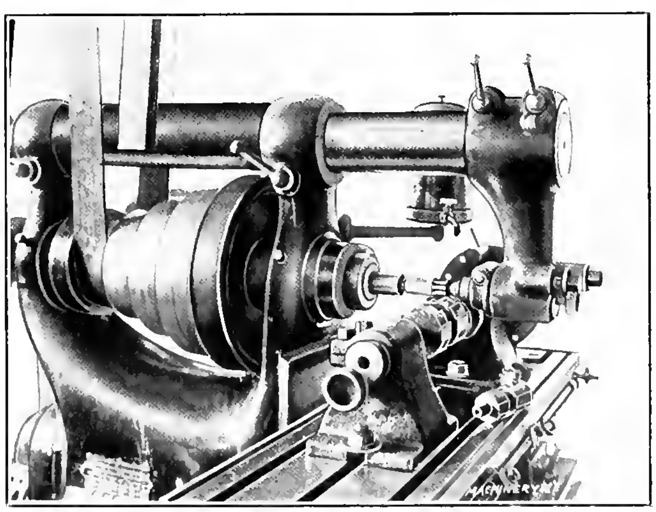


Fig. 6. Milling the Cam Surface on the Cam Bolt.

Fig. 8 shows a fixture used for holding the blades when grinding them. The blades are held in this fixture by the same means as provided for them in the reamer, the same cam bolt being used to engage projections at the bottom of the blades, which are set in slots in a cylindrical shell. These slots, however, are set at a slight angle with the radial position of the blades in the reamer, so that when the fixture with its blades is placed in the grinding machine and finished to a cylindrical surface, the tops of the blades, when replaced in the reamer, will clear the surface of the hole which they ream. This form of cutting surface is much superior to the flat shape given by the ordinary cutter and reamer grinder.

The shank of the reamer is slotted clear through for the

key by which the shell is driven. This operation is performed on the ingenious oscillating miller, built by the Hendey Machine Co., described in the April, 1905, issue of MACHINERY.

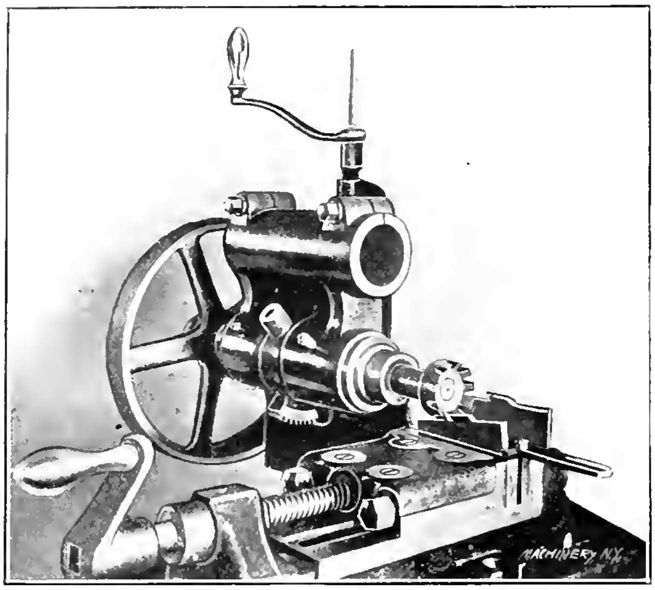


Fig. 7. Milling the Locking Undercut in the Blades.

The operation is shown in Fig. 9. The cutter has fine teeth, forming only a portion of a circle, and is held by a dove-tail in an oscillating bar, operated by an eccentric movement

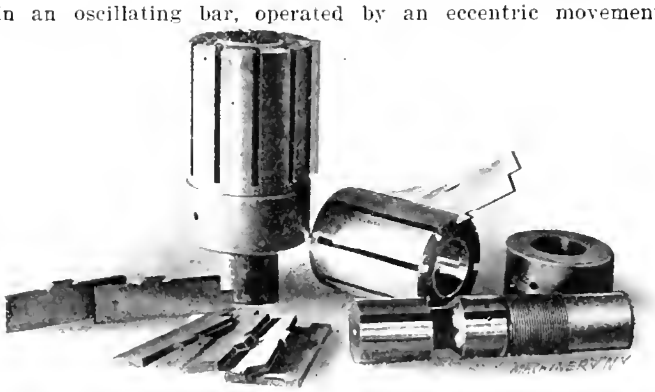


Fig. 8. Special Arbor or Fixture for Sharpening and Grinding Relief on the Blades.

from the spindle. This arrangement is capable of working a rectangular slot clear through a bar in one operation, provided the teeth are kept clear of chips. In the case shown,

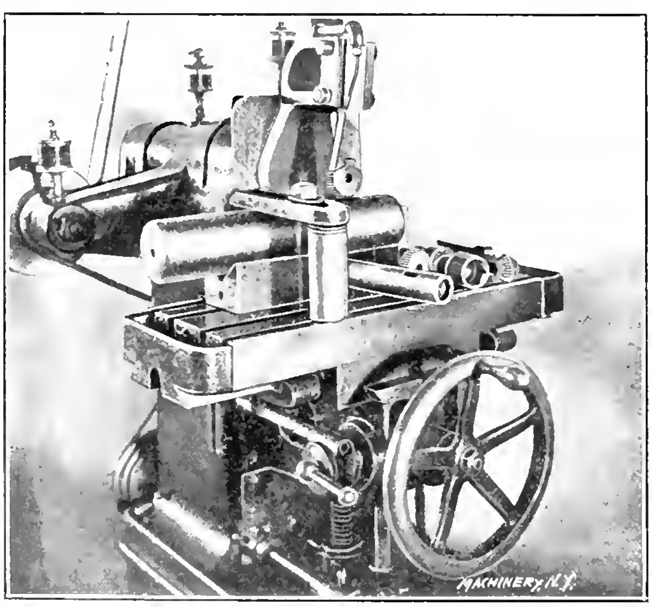


Fig. 9. Cutting a Slot with the Oscillating Milling Machine.

however, the slot is first roughly drilled to shape, and then finished by the oscillating process. The rectangular outline is obtained by this means at one cut.

A DRAFTSMAN'S TOOL CHEST.

I. G. BAYLEY.*

It is no unusual sight to see a draftsman carrying his tools tied up in a sheet of wrapping paper or even newspaper, while other craftsmen such as pattermakers or machinists, for instance, invariably carry their belongings in some kind of a box or case, though their tools are by no means so delicate or in need of so much protection as the draftsman's. The tool chest here described need not necessarily be a standard for size, shape or design; it can be changed to suit each individual taste or whim.

On account of its lightness and the ease with which it can be worked, poplar was chosen to make the box and nest of drawers complete, though it would be better, perhaps, if

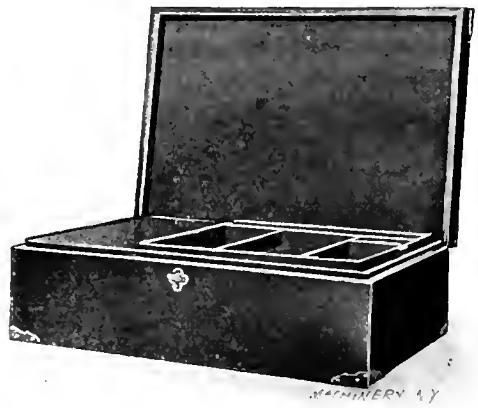


Fig. 1. The Draftsman's Tool Chest Finished.

the box were made of oak or other hard wood, and the nest of drawers and tray of poplar. It may be said, by the way, that the writer made the two latter with no other tools than a penknife and small iron plane; the chest or box was made by a cabinetmaker. Lepage's glue and fine nails were used to join the parts together; brass screws were used for the corner pieces, hinges and the name-plate. These trimmings may be either of brass or nickel. If poplar is used for the box, a mahogany finish outside, and shellac inside would look well, but a dull mission finish would be more serviceable if the box is made of oak.

It is sometimes convenient to have a secret drawer for money, stamps, etc., so one is here shown, though by the time the readers of MACHINERY have read this article it will

Fig. 2. The Tool Chest and its Contents.

be secret no longer. However, the suggestion can be altered or an entirely new design made.

The finished size of the box is 12 x 18 x 6 inches deep, outside dimensions. The box was nailed together, top, bottom, and sides, and then the top of lid neatly cut, one and a half inches down, with a fine saw, following a pencil line accurately drawn all around the box. On account of this saw-cut, the sides are ordered one-eighth of an inch deeper, as noted in the list of material. The bottom was let in, as it were, the sides being nailed around it. The top was made to cover over all. The sides were mitered so as to bring the joints exactly at the corners. After the lid was cut off, the edges were planed and sandpapered down to correct

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dimensions. A strip of wood is nailed part way around the box, one-eighth of an inch from the top, to keep out the dust and help in binding the lid when closed.

The nest of drawers at one end of the box is built up flush with the top of this strip of wood, so that the strips stop where the drawers occur, as shown in Fig. 2. The top, bottom and sides of the box are made of half-inch material. The strip of wood around the top is one-eighth inch thick.

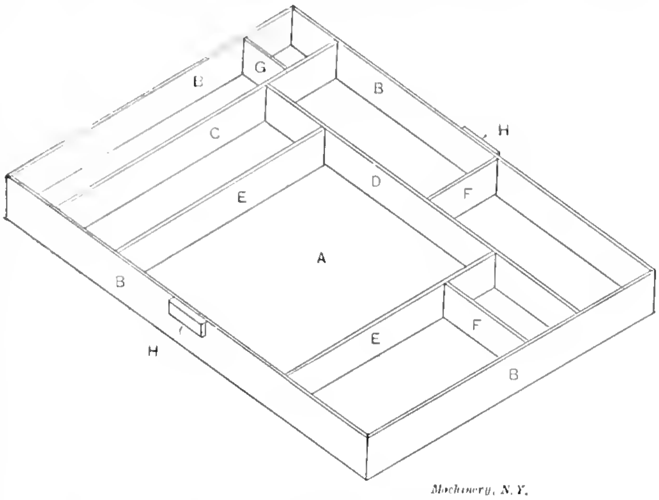


Fig. 3. The Tray for the Tool Chest.

The tray and the nest of drawers were made of one-eighth inch material, except the front of each drawer, which is one-quarter inch to give depth for securing the handles. There are three small drawers and one long one, the latter being for the instruments. The instruments were laid in the drawer in correct position, and blocks of wood, cut to suit, put between. The drawer was then covered with velvet, after the instruments had been removed and the whole given a coat of glue. The other drawers can be divisioned off or not to accommodate the smaller tools described in the list. At the front end of the nest of drawers a recess was made to accommodate the scales, these being a foot or more in length. The large triangles were put in the recess of the lid, the smaller ones kept in the body of the box or in the drawers. At the rear end of the nest of drawers is shown a small cupboard for the inkstand, a block of wood with three holes sunk in, to take as many small Higgin's ink bottles, black, red, and blue.

The secret drawer can also be put in this end, as shown in Fig. 4. This drawer can be omitted if desired and the false front of the small top drawer corrected to take its place. An elastic band holds the door shown, and also keeps the inkstand in place. The holes in the inkstand are three-quarters of an inch deep and one inch and three-quarters in diameter, and they must stagger with each other as shown or there will be difficulty in boring them. The tray, Fig. 3, fits the body of the box and is kept from falling in by the lugs at either end. The longest narrow space is for the penholders; the small space for the pens. The large space in the center is for the instruments. The pencils are kept in the space between this and the one for the penholders; on the other side of the large space is one made the same size as the inkstand; next to it is a smaller space for the tacks, pins, etc., the two remaining divisions being for the rubbers and pencil stubs, respectively. The idea is to fill the tray with the necessary tools, etc., when working, and placing it near the board or table for convenience.

Referring to the half-tones and line-cuts herewith, Fig. 1 shows the box open with the tray in position when not in service; Fig. 2 shows the box open, with the tray to one side to allow the drawers and cupboard to be seen. The inkstand is shown in the tray, and the tools, books, etc., are shown surrounding the box; Fig. 3 shows the tray with the various parts of which it is made, plainly marked, to agree with the bill of material; and, finally, Fig. 4 shows the nest for the drawers, with the latter as well as the cupboard door and the top of the nest removed. The pieces are marked to agree with the bill of material which follows. It would be well to cut all the material first.

Chest or Box. (Figs. 1 and 2.)

1.—Piece 12" x ½" x 18", top.
1.—Piece 11" x ½" x 17", bottom.
2.—Piece 6⅛" x ½" x 18", front and back.
2.—Piece 6⅛" x ½" x 12", sides.
3.—Strips ¾" x ⅛" x 11" (mitre joints).

Tray. (Fig. 3.)

1.—Piece 10⅜" x ⅛" x 10⅜", bottom *A*.
4.—Piece ⅞" x ⅛" x 10⅝", sides *B*.
1.—Piece ¾" x ⅛" x 10⅜", partition *C*.
1.—Piece ¾" x ⅛" x 9", partition *D*.
2.—Piece ¾" x ⅛" x 7¾", partition *E*.
2.—Piece ¾" x ⅛" x 2½", partition *F*.
1.—Piece ¾" x ⅛" x 1¼", partition *G*.
2.—Piece ⅜' x 3/16" x 1", lugs *H*.

Nest for Drawers. (Fig. 4.)

1.—Piece 6⅛" x ⅛" x 11", top *A* (not shown).
1.—Piece 4" x ⅛" x 11", back *B*.
2.—Piece 4" x ⅛" x 6", sides *C*.
(One side to be cut as shown, if secret drawer is used, otherwise both sides will be alike.)
1.—Piece 2½" x ⅛" x 6", side *D*.
1.—Piece 1½" x ⅛" x 6", partition *E*.
1.—Piece 1⅛" x ⅛" x 6", partition *F*.
4.—Piece ⅜" x ⅛" x 8", partition *G*.
2.—Piece ⅜" x ⅛" x 5¼", partition *H*.
6.—Piece ⅜" x ⅛" x 5¼", guides *I*.
1.—Piece 1" x ⅛" x 5¼", guides *J*.
1.—Piece 2⅝" x ⅛" x 4", cupboard door *K*. (Not shown.)
1.—Piece 2⅝" x ⅛" x 5⅞", bottom of cupboard *L*.
2.—Piece, ⅛" x ⅛" x ½", lugs for cupboard door *M*.
1.—Piece 1⅛" x ¼" x 2⅝" front of drawer *N*.
1.—Piece ½" x ⅛" x 1", stop for secret drawer *O*.

The front of false drawer (*N*) must be well secured to allow for the pulling it will get. If no secret drawer is used, the false front must be changed, a regular drawer taking its place.

Drawers.

1.—Piece 1⅛" x ¼" x 8", front long drawer.
1.—Piece 1" x ⅛" x 7¾", back long drawer.
2.—Piece 1" x ⅛" x 5¾", sides long drawer.
1.—Piece 5¾" x ⅛" x 8", bottom long drawer.
1.—Piece 1⅛" x ¼" x 5¼", front top drawer.
1.—Piece 1" x ⅛" x 5", back top drawer.
2.—Piece 1" x ⅛" x 5¾", sides top drawer.
1.—Piece 5¼" x ⅛" x 5¾", bottom top drawer.
1.—Piece 1⅜" x ¼" x 5¼", front bottom drawer.
1.—Piece 1¼" x ⅛" x 5", back bottom drawer.
2.—Piece 1¼" x ⅛" x 5¾", side bottom drawer.
1.—Piece 5¼" x ⅛" x 5¾", bottom drawer.
1.—Piece 1⅛" x ¼" x 5⅝", front secret drawer.
1.—Piece 1" x ⅛" x 5⅜", back secret drawer.
2.—Piece 1" x ⅛" x 2", side secret drawer.
1.—Piece 2⅛" x ⅛" x 5⅝", bottom secret drawer.

Ink Stand.

1.—Piece 2½" x 1" x 5⅞".

Ink stand to have three holes for bottles. Stand to be sandpapered and varnished black. The drawers are furnished with handles as shown; of necessity they must be small, and if flush with the front of the drawers, so much the better,

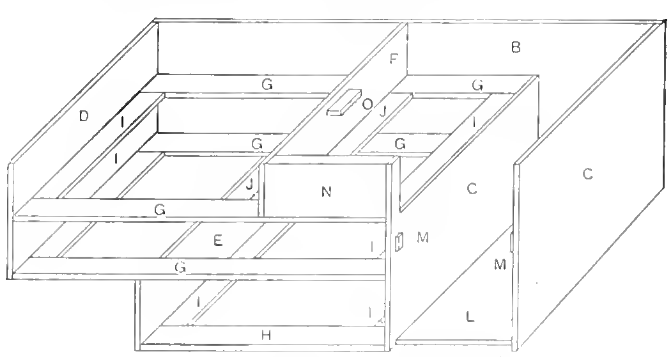


Fig. 4 The Nest for the Drawers.

in which case two lugs will be required to hold the tray up from falling into the body of the box; otherwise one end can rest upon the handles as in the case in hand.

The box can be carried by means of a strap when packed for shipping, or when moving from place to place.

A list of the tools, books, etc., contained in the box is given below.

5½", compass, pen, pencil, and lengthening-bar.
5½" hair-spring divider.
5½" plain divider.
3½" compass, pen and pencil legs.
2½" spring-bow instruments, pen, pencil and divider.

5" ruling pen.
4½" ruling pen.
Proportional dividers.
Small size beam-compass fixed needle-point leg, with pen and pencil legs, micrometer adjustment.
6" protractor, nickel-plated lead case.
Two triangular scales.
Trautwine's, Kent's, and Carnegie's handbooks, Data sheets from MACHINERY.
Instep's tables, sketch and note-books.
Four triangles, large and small, 45 and 60 degrees.
Pentagraph, 2 irregular curves, slide rule.
Three bottles Higgins' ink, black, red, and blue.
Three penholders, assorted pens, penwiper or rag.
Ink eraser, shield, scratcher, soapstone.
Pencils, HB, H, HH, HHH, HHHH, HHHHHH, pencil stubs.
Stub-holder, copying pencil, red and blue pencils.
Sponge rubber, or art-gum, several rubbers.
Tack-hammer, tack-lifter, package of 1-ounce tacks.
One dozen thumb-tacks, paper fasteners, clips, and pins.
6' folding rule, tape measure, calipers, knife.
Oil-stone, oil-can, file, dust brush, pencil sharpener.
Crayons, paint brush, paint box, pallet, magnifying glass.
Sheet horn for centers, fine needles.
Rubber bands (assorted), adhesive tape, pot of paste.
Pair of shears, string, gummed labels, tags, sealing wax.
Fountain pen, writing pad, blotters, small calendar.
Writing paper, envelopes, postage stamps.

Address book and visiting cards, complete the list, with room to spare for needle, thread and a few buttons, if you are an old bachelor.

* * *

METHOD OF GRADUATING IN THE LATHE.

WM. C. FORCE.*

If we have, say, 80 teeth in the cone gear of the lathe, it becomes easy to index for any number by which 80 can be evenly divided, by placing a pawl in contact with the teeth of the gear and counting as many teeth as required for each graduation. Fig. 1 represents the lathe head with the pawl bracket clamped to the bed, and the pawl in such a position

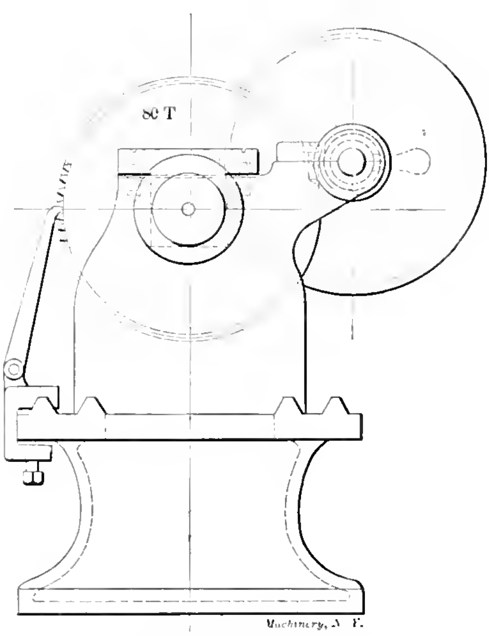


Fig 1 Direct Indexing

that when the gear is pulled forward, the pawl becomes locked between the teeth. The work to be graduated may be placed on the centers, in the chuck or on the face-plate, as circumstances will permit. Supposing, for instance, you desired to lay out a cast iron collar, dividing the circumference into four equal parts. You place the collar on an arbor, put a driving dog on in the regular way, and place the graduating tool in the tool-post, setting the point of the tool about at the same height as the lathe centers. The first thing to do after this is to find out the number of teeth to index, to obtain the four divisions on the collar. Divide the number of teeth in cone gear, assumed to be 80 in our case, by the number of divisions, 4, and we obtain 20 as a quotient, which is the required number of teeth to index on the cone gear. If we have a number of pieces to graduate in this way, it is well to place a chalk mark at each division on the cone gear so that it will not be necessary to count the teeth for each indexing. A cone gear with 80 teeth may be utilized with this method to obtain the following divisions, *viz.*, 2, 4, 5, 8, 10, 16, 20, and 40. If one wishes to graduate long and short lines on the work, it will be necessary to clamp a parallel to the bed of the lathe, using this parallel as a stop for the carriage to go against for long lines and using a distance piece between the carriage and the parallel for short lines.

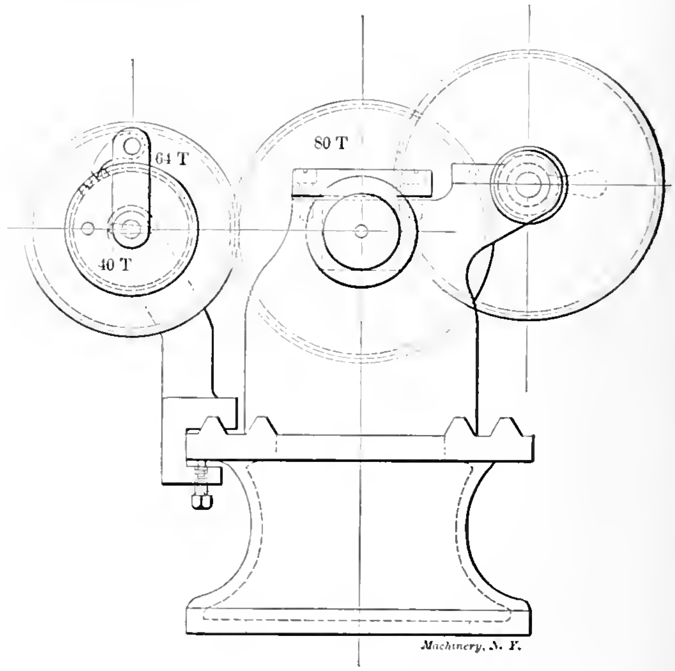


Fig. 2. Indexing through Compound Gearing.

In graduating a dial which is to give measurements of one-thousandth inch, when used with measuring screws having 20 threads and 40 threads per inch, it will be necessary to proceed as shown in Fig. 2. In the first place we will find that the number of thousandths of an inch in 1/20-inch equals 50, and the number of thousandths of an inch in 1/40-inch equals 25. As will be seen from cut, there are two gears keyed or pinned together and mounted on a bracket in such a manner as to be free to revolve on the stud in the bracket, one gear meshing with the cone gear. Fastened to the stud by a taper pin is the pawl-carrying bracket and pawl used to index the number of teeth on the index gear. It becomes a simple example in proportion to find the gears necessary for 50 and 25 divisions. Taking 50 divisions for example, and assuming 64 as the number of teeth in the stud gear meshing with the cone gear, the proportion becomes $x : 64 = 50 : 80$,

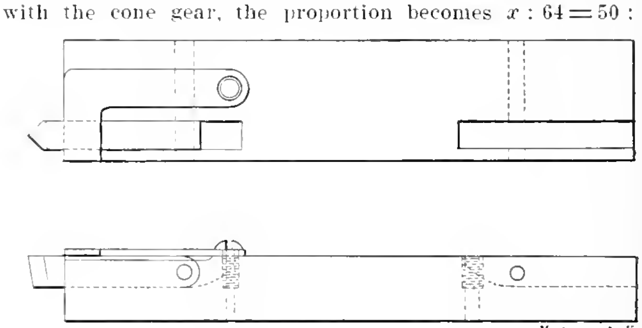


Fig. 3. Graduating Tool.

x being the number of teeth in the index gear. From this we find the number of teeth in the index gear to be 40. By indexing one tooth on the indexing gear we obtain 50 divisions, and by indexing two teeth we obtain 25 divisions. If we desire any other divisions than this combination of gears will give, it will become necessary to figure out a new combination and use another stud and index gear.

In Fig. 3 is illustrated a graduating tool which will be found to give better satisfaction than an ordinary sharp-pointed tool. As will be seen from the cut, it is a spring tool, relieving the tool on the back stroke, thereby preserving the point. It can be used either right or left hand, as the holder has a groove in one side on each end.

* Address: 154 Somerset St., North Plainfield, N. J.

LETTERS UPON PRACTICAL SUBJECTS.

SECTIONAL SUB-PRESS DIE.

In the May issue of MACHINERY appeared a description of a sectional punch and die by A. C. L. There is no doubt that such a die could be simplified by making it on the sub-press principle. Every detail seems to have had attention and everything seems to have been done, except the one fundamental and essential thing necessary for rapid production of accurate work.

In the cuts herewith are shown dies and punches for sub-press work, which may be of interest to the readers of MACHINERY. In the assembled view, Fig. 1, the die is shown.

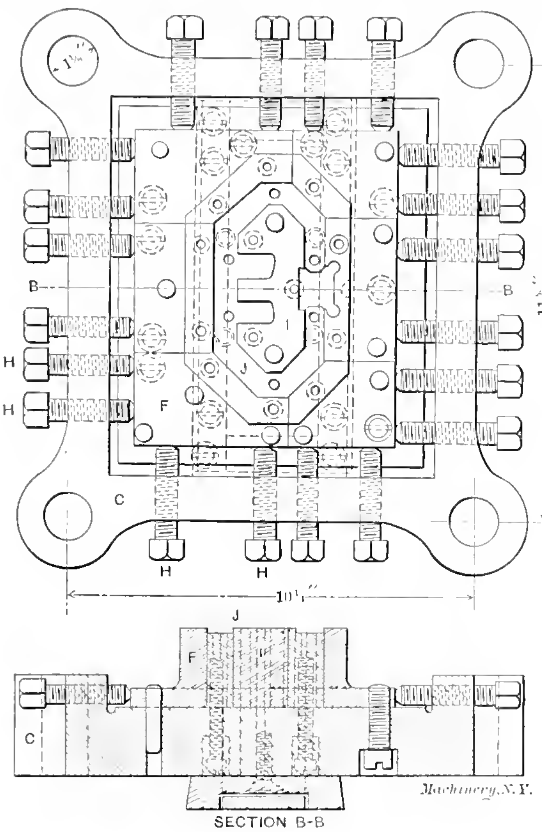


Fig. 1. Sub-press Die

It will be seen that the blanks can be changed to different shapes by simply inserting different die sections in different places of the die. At *A*, Fig. 3, is shown a modification of the blank, possible with this die. Another of the principal features of the sub-press sectional die is the means for stripping the scrap and ejecting, when it is wanted to produce punchings in quantities. The die shown in the cut may appear to be unduly light in construction, but several sets have been built on these lines, and given full satisfaction. Their light weight materially lessens the cost of handling, as well as the cost of making. The holder *C* is of good, close grain cast iron, planed on both sides. At the top, a recess is milled with an end mill in a vertical miller. In this recess are held the sectional parts of the die, which are fastened to the body from the bottom. After having made the necessary templets, the various die sections are shaped. A few thousandths of an inch is left on the adjoining surfaces to permit finishing by grinding. The cutting edge of the die sections must be left as hard as possible. Die section *F* is shown in detail in Fig. 3. It will be noticed that two small holes are drilled in the center of the two screw holes in the piece *F*. This is done to enable transferring the screw holes to the cast iron holder when assembling the die. The bottoms of the die sections are left soft in order to be able to drill all the screw and pin holes through the cast iron holder at the same setting. The dove-tailed slot in the holder *F* is made for the purpose of marking the punching. Each section is reinforced on the two outer sides by four set screws *H*. In the center of the die a solid block *I* is fastened with three screws and two dowel pins. This block is hardened and ground all over to the shape of the templet. The ejecting or stripping device *J* for the die is made of a solid tool steel piece to the same shape as the templet, but is a very free fit, amounting to a few thousandths of an inch on the sides. This part is left soft and is located a few thousandths inch more than the thickness of the punching below the top of the die. When the die is sharpened, the stripper is ground off the same amount. No springs are used with the stripper, it being actuated by two ¼-inch studs fastened with screws on the stripper. These studs pass through the die and holder, and are actuated by a bar fastened to the gate of the press, thereby forcing out the punchings from the die. The six punches *N*, Fig. 3, are upset, as shown, at the end where they are inserted in the holder, while the other end is hardened, straightened, and lapped to size. The holes for the punches are located after the die is finished and assembled.

The cast iron punch holder *K*, shown in Fig. 2, is planed on top and bottom and across the four bosses. The four sub-press pins *D* are of tool steel, hardened as far as the head, ground to a light driving fit on the head end, and ground to a sliding fit in the die holder on the other end. The holes for these pins were located so that they are strictly in line with each other, and at the same time square with the punch and die. When the punch and die parts were hardened, they were placed together with two parallels placed between the castings, the punch placed inside the die,

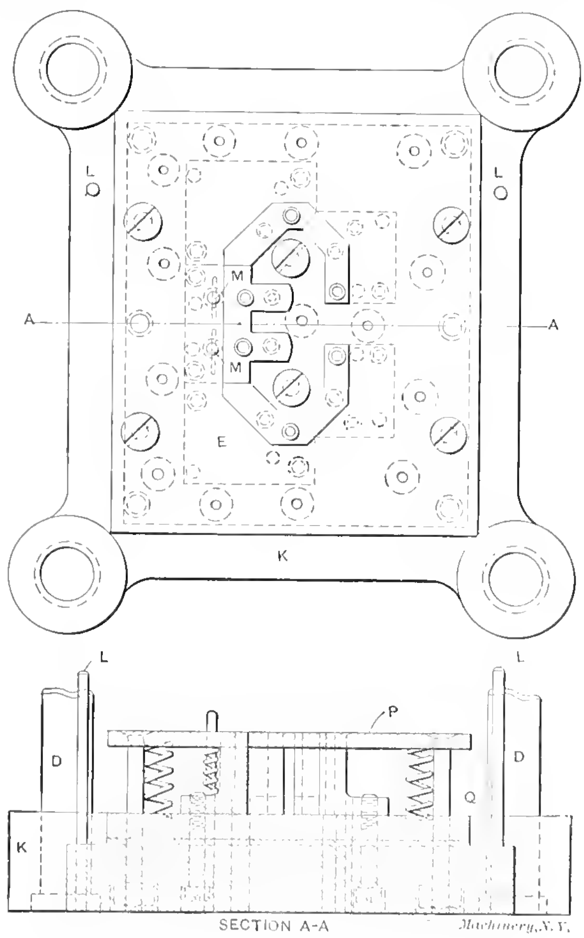


Fig. 2. Punch for Sub-press Die in Fig. 1

and the two clamped together with four C-clamps. In this way the holes, when bored, were bound to come in alignment.

The punch part which is shown at *E*, Fig. 3, is made precisely as the corresponding die section, only that in locating the positions for the piercing bushings *O*, it sometimes happens that the holes for the bushings are so many and so small that they cannot be conveniently bored. The holes are then transferred by a drill that runs through the die, and are of the same size as the piercing plug, the die being used as a drill jig. After drilling, the holes are counterbored to

the right size for driving fit for the bushings. The latter are hardened and ground all over, and the holes in them taper one-half degree. A straight pin, driven in so as to be located halfway in the bushing, and halfway in the section E, holds the bushing in position while in operation. A stripper plate P is placed over the punch sections with a free fit on both inside and outside. It is held by flat head screws which are adjusted with nuts from the bottom of the holder.

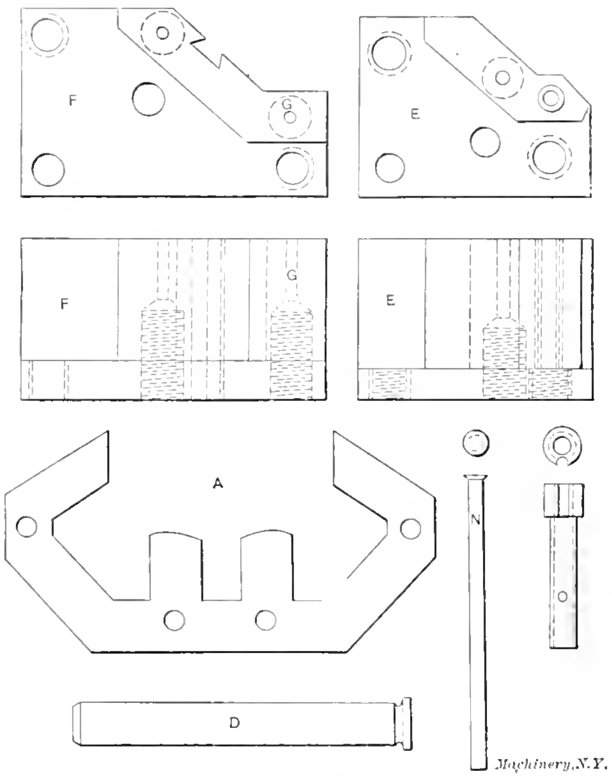


Fig. 3. Details of Sub-press Die.

Between the stripper and the punch-shoe Q, which is made of tool steel and hardened, sixteen spiral springs are placed to strip the metal. The punch-shoes themselves are secured with six screws to the cast iron holder K.

Two guide pins L, Fig. 2, are driven into the top of the cast iron holder K, and two gage pins M are located 1/16 inch from the cutting edge. A small wire is driven through the gage pins, below the stripper, having a spiral spring underneath, seated on the punch-shoe. When the die comes down, forcing down the stripper plate, the gage pins follow, coming up again on the upward stroke.

L. A. DORMAN.

ADDITION AND SUBTRACTION ON THE SLIDE RULE.

It seems to be generally supposed that it is impossible to perform addition and subtraction on the slide rule. This, however, is not so, as it is really a simple matter, and a little practice will enable anyone familiar with the slide rule to perform both operations with speed and accuracy.

Rule for addition: Assume that the scales are numbered in the usual manner, A, B, C, and D, commencing at the top of the rule. If we now wish to add 372 and 284, set the glass indicator to 284 on the D scale, and move the slide until 372 on the C scale coincides with 284 on the D scale and read the quotient 1.31 on the C scale. Add 1 to 1.31, making the sum of 2.31, and multiply 284 by 2.31, the product being 656. Then check the right-hand figure in the sum by adding mentally the right-hand digit on each number, thus, $4 + 2 = 6$. The answer must then be 656, since we read it to be between 650 and 660. The decimal point in the first operation is located in the same manner as in ordinary slide rule operations. That the rule for addition on the slide rule, as given above, is correct is proven in the following manner. Suppose that E represents the larger number; F, the smaller; and G, the quotient of E divided by F. Then

$$\frac{E}{F} = G, \text{ and consequently } E = F G. \qquad (1)$$

In this equation add F to both sides. Thus

$$E + F = F G + F = F (G + 1) \qquad (2)$$

If in this equation we substitute the numbers 372 and 284 given in our example, we have

$$372 + 284 = 284 \ (1.31 + 1)$$

which, we see, agrees with the operations as we performed them.

Of course the figure 1.31 is not exact, but it is near enough to obtain the first two figures exact, and the third figure is obtained exact as has been explained before.

Rule for subtraction: Suppose that we want to subtract 284 from 372. Set the glass indicator to 284 on the D scale, and slide the runner until 372 on the C scale coincides with 284 on the D scale, which leaves the quotient 1.31 the same as in the case of addition. Subtract 1 from 1.31, leaving 0.31, and multiply 284 by $0.31 = 88$, which is the desired remainder. This rule is proven in a manner similar to that for addition. Assume that K is the larger number, and L, the smaller; then

$$\frac{K}{L} = M \text{ and consequently } K = L M. \qquad (1)$$

Subtract L from both sides of equation 1 and we get

$$K - L = L M - L = L \ (M - 1). \qquad (2)$$

If we substitute the numbers which we used in our example in this equation we have:

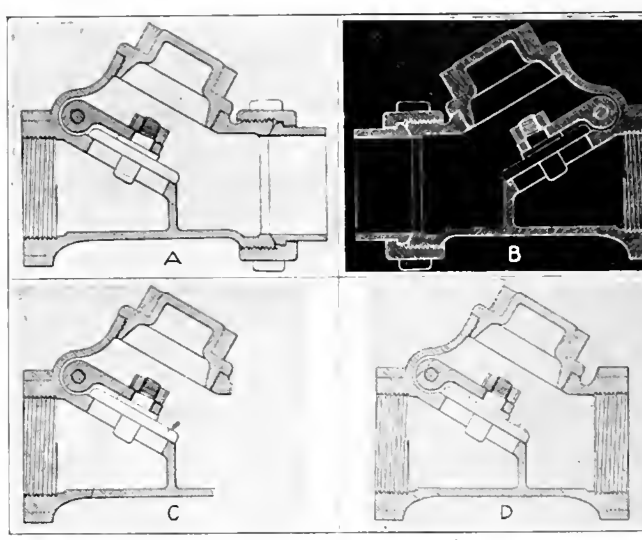
$$372 - 284 = 284 \ (1.31 - 1) = 88.$$

Claremont, N. H. WM. C. MICHAEL.

[The method explained above, while it is interesting as a demonstration of the mathematical principles on which the slide rule is founded, as well as the close connection between all mathematical operations, seems of course of little value for any pratical purpose, because the time taken to perform addition or subtraction on the slide rule in the manner explained will be several times the time necessary to perform this operation in the ordinary manner by adding the digits.—EDITOR.]

CHANGING DRAWINGS QUICKLY.

Occasionally a big change in a drawing is necessary, and a print is wanted at once, or a different style of machine is to be made, having the major portion exactly the same as shown on some previous drawing. The accompanying cut illustrates this case. A rapid method for changing the drawing is as follows: A tracing shown at A is on hand, but we wish a print showing this valve with a female pipe thread on both ends. From this tracing we then make a



Method of Changing Drawings Quickly.

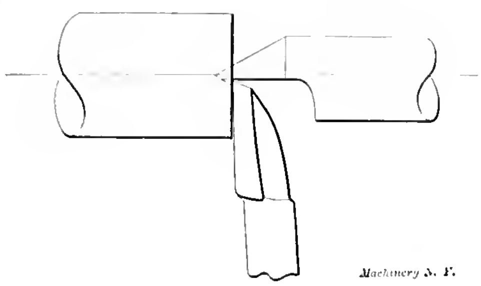
negative, shown at B, using a brown process paper. Now with a piece, or pieces, of brown opaque paper cover up all parts of this negative, B, that should not show on the required print. From this partially covered negative make a new print, C, again using brown process paper. On this new print, C, draw with india ink the special part of the new style valve and use the drawing D, thus obtained, as an ordinary tracing. The brown lines will print as well as the added lines in india ink. HOWARD D. YODER.

Wadsworth, Ohio.

NOTES ON CENTERING.

The letter by W. S. Leonard in the August issue of MACHINERY brings up one of the most important points in good lathe work, namely, properly preparing work for turning. The writer worked seven years at the business in engine shops, having the reputation of doing good work, before he saw a center reamer or learned that 60 degrees was the proper angle for a lathe center, and there are hundreds of mechanics in the country to-day who put in centers with a 90-degree center punch.

In centering a piece of work, the first thing to be done is to file or grind the end straight, if it is a rough forging, or grind off the teat, if it has been cut off in a machine. Then, if you have a centering machine, the work can be centered in that; if not, locate the center with a pair of



Half-center and Facing Tool.

dividers and prick-punch it lightly. Then drill and form the center with the two-lipped combination center drill and reamer, first introduced by J. T. Slocomb Co., and now made by several concerns. With this tool the cut is balanced, and the drill part steadies the reamer, insuring that the clearance hole is true with the angle, and that the centers are reasonably round. If you have not the above, the small hole should be drilled for clearance and lubrication about two-fifths the diameter and about twice as deep as you want the center. The drill is followed with the center reamer, care being taken to make the latter cut concentric with the small hole. A half round reamer is better than the ordinary three-fluted one, as the centers cut by it are always round.

After centering, both ends of the piece should be faced off true, so that, as the center wears, it will wear evenly and not get out of true. Mr. Leonard will find that in using a tool sharpened as he describes the point will not stand up, and if he succeeds in getting out more than one piece without a ridge around the center, and without re-grinding the tool, he will accomplish a miracle. The best method is to use a half-center for the foot-block as shown in the cut. This center has nearly half of the taper point cut away, leaving but little over a half circle to support the work, so that the end can be faced clean. ALLAN.

THE POSITION OF THE CHECK NUT.

Mr. Oskar Kylin's article on the position of the check nut in the August issue of MACHINERY is very interesting and instructive from a theoretical point of view, but under practical conditions it is far better to have the lock nut placed on the top of the regular nut. The reason for this is because the average workman in erecting machinery tightens up the first nut as tight as he considers necessary, which is generally as tight as he can; he next puts on the second nut, which he makes fairly tight, and then passes on to other work. Do you suppose he would hunt up the special lock nut spanner and hold back the lock nuts? No, sir; he wants to get the job finished in good time and monkey business like that "don't go." I know from actual experience with erecting gangs.

Let us see what the effect of this treatment is upon the theoretically correct position of the lock nut. Suppose we have a bolt on which a total strain of 1,000 pounds will be developed when both nuts are tightened up. The lock nut is placed upon the bolt first, according to blue-print, and drawn down to 1,400 pounds strain to make everything tight; then the regular nut is placed on top, tightened up to about 400 pounds, and let go at that. These conditions cause the lock nut to carry 1,000 pounds load and the regular nut only a 400-pound load, which is about the worst condition imaginable. Now let us take the "incorrect" way. The regular nut is put on first, drawn down to the 1,400 pounds strain, then the lock nut is placed on and drawn down to the 400 pounds, and the workman passes on, leaving conditions which, next to a correctly placed and carefully adjusted lock nut, are a very satisfactory distribution of strains, and the regular nut is to all practical purposes thoroughly locked just the same, unless the bolt actually moves forward enough to lift the bottom nut out of contact with the base, which is a rare and special case.

Here then is a point where actual practice is directly contrary to theoretical considerations; but we are dealing with actual conditions and must design our machinery to give satisfaction and results with the average workman's treatment, and must make our average blue-print show the lock nuts on top. By doing this we are sure to get best results, for the general workman will throw the greatest strain on the strongest nut. On all my designing requiring lock nuts I invariably show two regular nuts. The difference in cost is very slight and is offset by the saving in the stock room and avoidance of mix-ups in shipping. I know then also that, no matter how the workman may juggle up the method of locking, a regular full strength nut will always carry the majority of the load. GEO. P. PEARCE.

Williamsport, Pa.

[That practice in the above case is directly contrary to theoretical considerations, as our correspondent contends, is perhaps a rather daring statement to make. Whenever theory and practice seem to disagree, either the theory is wrong, that is, it simply has to be disproved, or the common accepted practice is wrong, in spite of being accepted. In the case in question, if the upper nut is not tightened down so as to place a greater stress on the bolt than that placed on the bolt by the lower nut, then both nuts will bear against the same side of the threads of the bolt, and there will be no real locking action. The check nut in that case does not really act as a check nut at all, but rather as an increase in length to the one nut already in place. When a check nut actually fills its purpose of locking the lower nut in place, it must place a greater stress on the bolt than does the lower nut alone, that is, the two nuts must bear against different sides of the thread in the bolt. This is the condition Mr. Kylin analyses, and that being the practical condition desired, his theory agrees with it.—EDITOR.]

SPRING CHUCKS.

Spring chucks are deservedly popular. They are of numerous designs, some good, some poor. Perhaps the most frequently met with of the poor designs is shown in Fig. 1. This chuck is simple enough, being composed of two parts only, the nut and the jaws or holder. The jaws are a part of the shank. In this case, however, simplicity does not

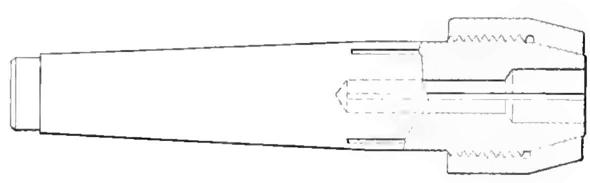


Fig. 1. Common, but objectionable, Form of Spring Chuck

stand for accuracy. The fault with this chuck is evident. By turning the nut, the jaws close, but at the same time the threaded portion of the shank reduces in diameter, becomes a bad fit, and is imperfectly round. The nut thus can assume a faulty position on the thread. Still, where no great accuracy is essential this chuck will answer the purposes for work which does not vary much in diameter.

There are two good designs in common use. One is the draw-in chuck, as found on tool-makers' lathes, and the other the push-out chuck, as found on turret lathes. These are good design, because the taper into which the jaws are forced is a solid ring—usually fixed to the machine spindle.

Even these chucks are true for but one exact diameter, though in practice they work well when the stock is slightly off size.

Sometimes it is difficult to arrive at a correct design for a particular condition. Fig. 2 shows a special design which will probably find appreciation. This chuck is used in an automatic gear cutter. The pinion which it holds is very small in diameter compared with the shaft of which it forms a part. Consequently, there is little room for any kind of holding device. When the gear cutting machine is indexing, the cutter is in the position shown in Fig. 2. Hence the chuck which holds end *A* of the pinion must not extend beyond a certain line.

The general design of this chuck is as follows: The chuck has three spring jaws *J*, produced by slotting the body in three places, part way, leaving the end *S* solid. These jaws are fitted into the taper end of a chuck closer *T*, solid with

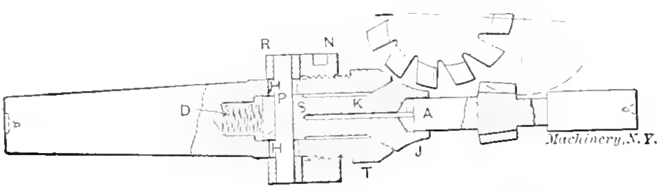


Fig. 2. A Special Spring Chuck for a Difficult Case.

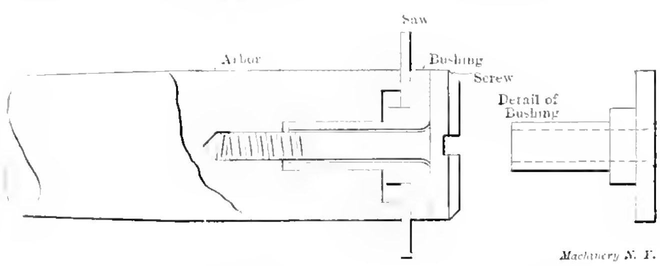
the shank. A nut *N* turns on the threaded portion of the closer or shank. This nut moves a ring *R* which is joined by a stiff pin *P* to the end *S* of the spring jaws. The pin *P* passes through slotted holes *H* in the shank. Hence if the nut is turned in the right direction it draws the spring jaws in on the taper and closes them.

In making this chuck certain points must be observed: The shank must be bored true with the taper; the spring jaws must fit perfectly on the taper, and at the end *S*; the nut must be faced true with the thread; and finally, the spring jaws should be heavy enough at *K* to resist the bending strain which is caused by the grip being beyond the taper, which closes the jaws. An auxiliary spring is shown at *D*. This can be used if it is found that the jaws fail to release when the nut is loosened. A chuck of this design, without the spring *D*, is in actual operation and gives perfect satisfaction. It fits the indexing spindle of the machine on which it is mounted. HARRY A. S. HOWARTH.

New Haven, Conn.

SAW ARBORS.

In reply to the inquiry by "Artebe" in the August issue of MACHINERY, in reference to the best type of saw arbor, would say that in my opinion none of the four arbors shown give the satisfaction and capacity for saws that is desired for gen-



Saw Arbor, permitting Greatest Interchangeability of Saws

eral work. No. 1 arbor will only hold saws of one bore and, rightly, only one thickness with one washer; it is also soft and will soon wear out of true. No. 2 has the same defects, except that the hardened bushing gives it much greater durability. No. 3 depends for its accuracy upon the concentricity of the plain portion of the screw with the thread, which is a poor design because of the difficulty of tapping with accuracy concentric with the hole; should the screw run eccentric, the result will be that the plain portion, or shoulder, will bind on one side of the hole and in a short time cut or wear the counterbored portion oval. No. 4 is also open to the same objections. I would advise the saw arbor shown in the accompanying cut as one that is fairly cheap to manufacture, and yet fills all the requirements satisfactorily. The hardened bushings which are comparatively cheap to manufacture can be changed to suit saws with various sized holes, and variations in thickness of saw require no changes at all. PENNSYLVANIA.

A BLACKSMITH'S DRILL JIG.

In the two accompanying half-tones and the line-cut is shown a special kind of drill jigs, specially designed for small parts which have to be produced in large quantities, and at the same time must be accurate. This jig I term a tong jig. It is forged, but it could be made of cast iron. If it is made out of cast iron, the handles should be made from small gas pipe, and either threaded or pinned to the jig. Making it from a forging, however, gives the advantage that the handles can be drawn down to a taper, giving to the jig the necessary elasticity for holding the work in place when the link *A*, Fig. 1, is slipped into place. This kind of a jig must be hinged at *B*. The lower and larger part *U* is machined for holding the pieces to be drilled, the top piece *D* containing the bushings. For castings or parts which are shaped to a circular segment this jig is very handy, as the

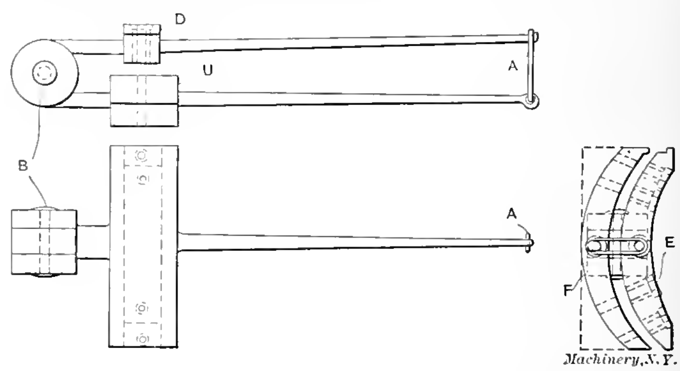


Fig. 1. A Blacksmith's Drill Jig.

operator can, by holding the handles, turn the jig to any angle desired. This jig requires no blocking up or clamping. The jig shown schematically in Fig. 1, is intended for work of a segment shape, but for straight work the bottom *F* should be straight, as indicated by the dotted line. The half-tones, Figs. 2 and 3, show another application of the

Fig. 2. The Jig Open, and the Work to be Drilled.

same principle in jig making. Fig. 2 shows the jig open, together with the piece to be drilled, before putting it in place. Fig. 3 shows the jig closed with a piece in place and the link over the handle. This jig differs from the one shown in Fig. 1 therein that the part holding the work to be drilled runs lengthwise of the handles. Of course, the various jigs will have to be made to accommodate the construction of the parts to be drilled. The angle casting for which the jigs in Figs. 2 and 3 is used is about 3½ inches long, with a small boss on the inside of the angle. Since this jig was put in use, not one part in a thousand has been scrapped.

As will be seen, this jig registers from the proper point, *viz.*, the outside corner, and if any chips are in the jig, the operator cannot put in another piece. Consequently he has to keep the jig free from chips and dirt in order to close the handles before drilling. The tool is very simple to operate. There is no bother with a number of screws and

clamps, two or three different sizes of wrenches, etc., as is usually the case with a box jig, which takes much longer to handle for putting in and taking out the pieces than it does to drill the holes. Another advantage with this tong jig is that, after the part that holds the work to be drilled has been properly machined, the operator cannot drill a piece until it is placed properly where it belongs, as he cannot

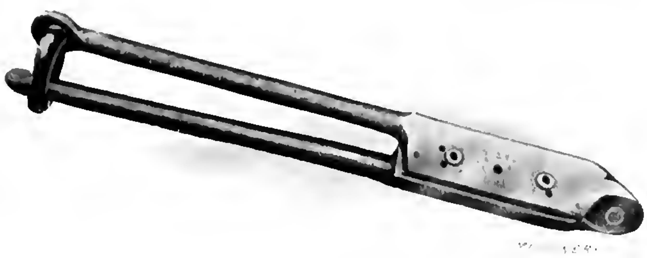


Fig. 3. Jig Closed, Ready to be Used.

close the handle. The writer has known of parts being put in box jigs, bottom side up, and the mistake has been discovered first when the holes have been drilled. Since the introduction of the first of these jigs in this shop, they have been coming rapidly to the front in this factory, and are driving the box jigs out of the business. J. F. SALLOWS.

Lansing, Mich.

CUTTING A SPECIAL CAM.

It often happens, even in well equipped shops, that odd jobs come up for which there are no tools, and which have to be produced in the old-fashioned way with the aid of common sense and a little rigging. Such was the case with the grooved cam, the form and development of which are shown in Fig. 1. It happened that in this case only the end positions of the roll were important, and all that was necessary with regard to the curved part of the path was a reasonably smooth action, the variation of the height of the roll due to the swinging of the lever on its fulcrum not being of enough importance to be taken into consideration.

We decided to cut it on a milling machine, and we first looked up a fixture, shown in Fig. 2, which had been used

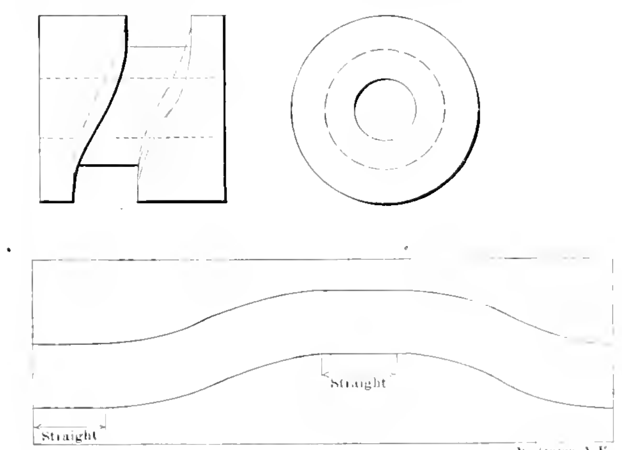


Fig. 1. Cam to be Cut, and its Development

some years before for a similar job, and by good luck had not been scrapped. As will be readily seen, this fixture has provision for clamping on the milling machine column, and a small adjustable slide at the top carrying a pin to follow the former. In addition we had to make the arbor and former, shown in Fig. 3. In making the former, a blank was first made; then the development of the cam was cut out as accurately as possible from a thin piece of tin and transferred to the former by wrapping the tin about it and scratching the outline. The former was then placed on an arbor in the milling machine, and an end mill of the same diameter as the roll was placed in the spindle, the center lines of the mill and roll being exactly in the same plane. The outline was now worked out as close as possible, feeding by hand. The last operation was to smooth up the curves with a file, and we were ready for making our cam.

The fixture was fitted on the milling machine column with the pin in the slide in the same horizontal plane as the spindle of the machine. The table screw was removed, and a rope was attached to the end of the table and run over a

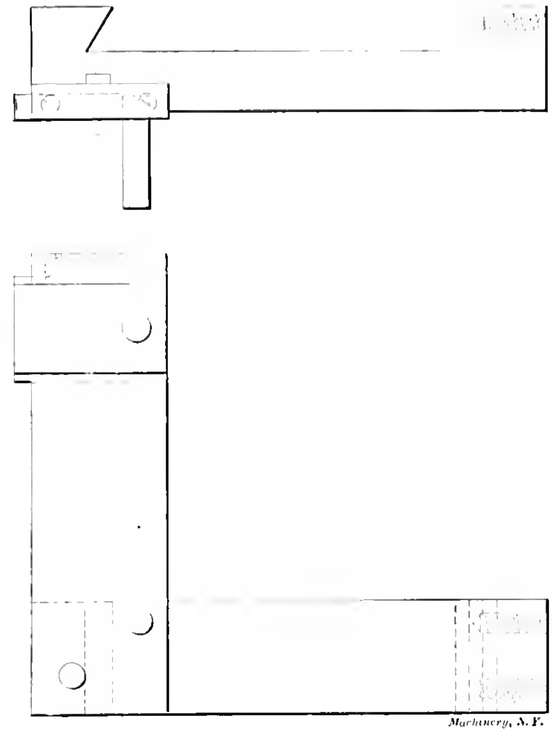


Fig. 2. Bracket to be secured to Milling Machine Column when Cutting Cam.

pulley in a wooden frame placed on the floor. A weight on the other end of the rope supplied the power necessary to hold the former against the pin. With the center line of the cam blank and former set at the same height as the axis of the milling machine spindle, and the blank and former assem-

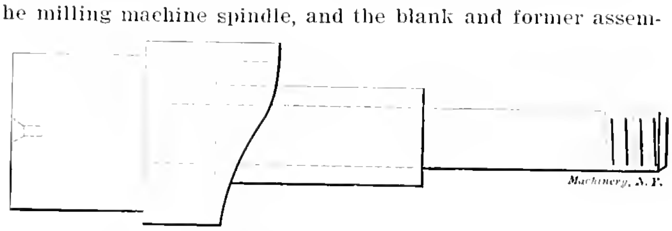


Fig. 3. Arbor and Former.

bled on an arbor, the arrangement was as shown in Fig. 4. The slide carrying the former-pin was adjusted to bring the end mill central with the position desired for the slot, and locked. On account of the spring in the parts, the slot was first roughed out, full depth, with a mill 1/16 inch under-size,

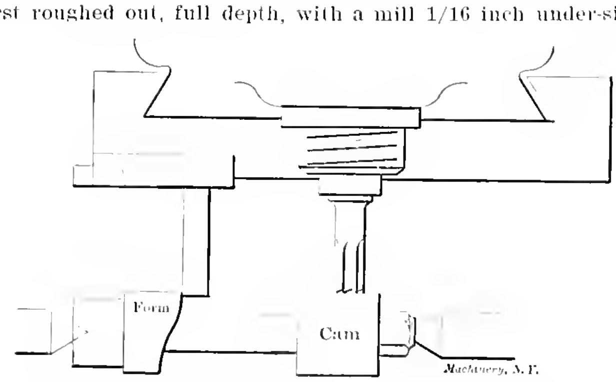


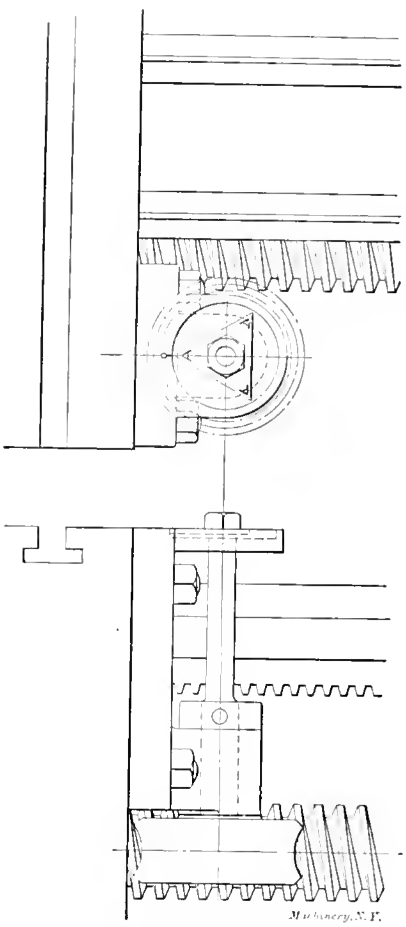
Fig. 4. The Machine as Fitted Up for Cutting Cam

and afterwards finished with a mill the full size of the cam roll. The former-pin must be the same size as the finishing mill. The cams made in this way required very little fixing up in the curved part, and the straight portion came exactly as desired. ALLAN.

INDICATOR FOR THREAD CUTTING.

When cutting a thread in a lathe, if the number of threads to the inch being cut is a multiple of the number of threads to the inch on the lead-screw, the split nut may be

thrown into mesh with the lead-screw at any time, and the tool will follow the first cut. This is not the case, however, when the number of threads to the inch being cut is not a multiple of the number of threads to the inch on the lead-screw. Because of this, lathes are generally equipped with a backing belt, which is thrown in when the tool has made the desired cut, and the carriage is brought back to the starting point without having been disengaged from the lead-screw, which, of course, necessarily brings the tool into the right relation with the work. This is a good arrangement for short threads, say two or three inches in length, but when they are longer, and especially when they are large in diameter (which means slower speed) the backing belt is not a very economical contrivance, because considerable time is wasted while the carriage is being moved by the lead-screw from the end of the cut, back to the starting point. The accompanying illustration shows a simple device which may be attached to any lathe, and used to a good advantage when cutting threads. It can be fastened to the carriage as shown in the cut, and preferably on the side next to the tail-stock, as very often there is not enough thread on the lead-screw to permit its being put on the opposite side. This indicator is used in the following manner: Start the lathe, and when one of the three points marked *A* of the triangular pointer (see plan view), is opposite the zero mark, throw the split nut into mesh with the lead-screw. After the tool has reached the end of its cut, bring the carriage back by hand to the starting point. Wait until either of the points marked *A* is again opposite the zero mark, then throw the split nut into mesh with the lead-screw as before. If this is done with each successive cut, the tool will always come right with the thread. When the pointer is a triangle as shown, the worm-wheel, which is in mesh with the lead-screw, should be so proportioned that its number of teeth is three times the threads per inch of the lead-screw. If, for example the lead-screw has eight threads per inch, then the worm-wheel should have twenty-four teeth. Then, when either of the points marked *A* is opposite the zero mark, the lead-screw and the lathe spindle would occupy the same relative positions. The device does not work for fractional threads.



Indicator for Thread Cutting.

John Bradford.

[This valuable device is not new, however. It is claimed to have been originated in this country thirty or thirty-five years ago by William Gleason, of Rochester, N. Y. In fact, however, it is much older than that, having, we believe, originally been invented in England. See Machinery, December, 1897, May, 1899, and February, 1901.—Editor.]

THE "MONEY-BACK" SYSTEM.

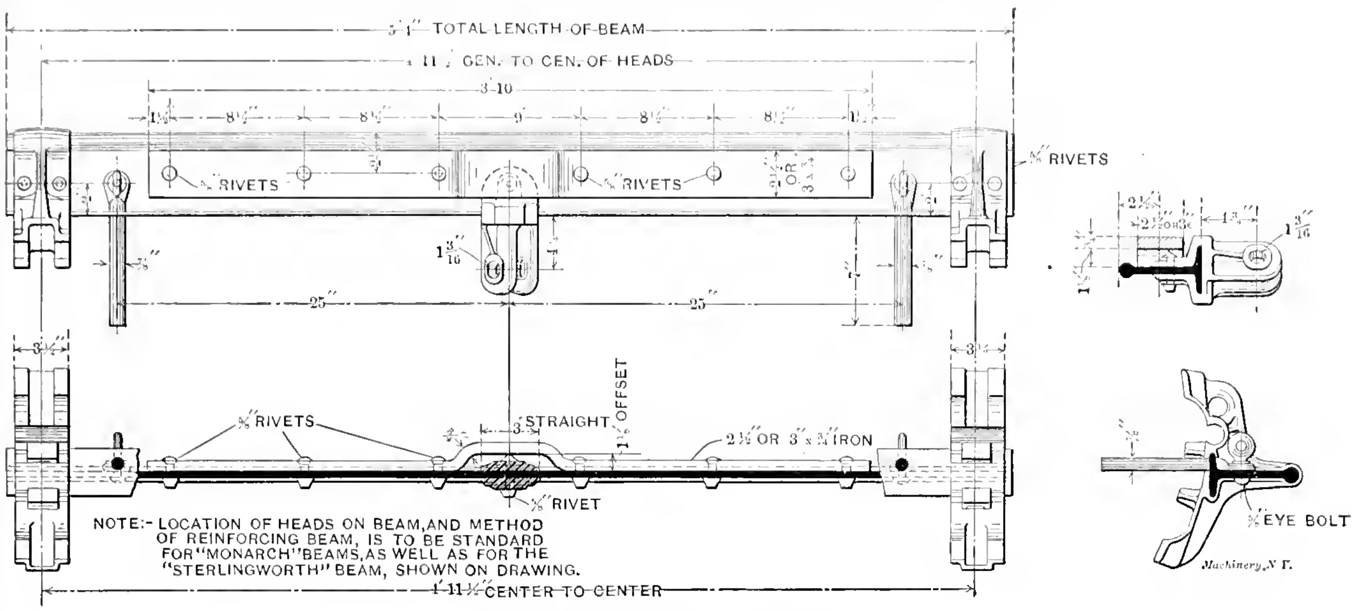
Lately we are seeing a good deal of what Elbert Hubbard calls the "money-back" system. This system simply means that if you don't like what you buy you can take it back and get your money back. Of course, you cannot really expect to use it a great while before you take it back; that is, you would not think you could, but a friend of mine had an experience that made him wonder where some people thought the limit was. He was asked to bid on two or three small machines of a slightly special character. He did so after finding out the requirements. He was asked if he would guarantee the machines to do the work, and he said he would, for in writing his bid he agreed to make the machines "satisfactory," in which he showed a laudable faith in his fellow men, and a lamentable absence of knowledge of law. The machines were delivered, certain defects were found in their working and certain improvements suggested and made, all of which was swallowed by the builder without comment.

About four months after the last alteration was made, the builder wrote and mentioned the fact that he could use some money to advantage, and would Mr. Purchaser kindly send a check? Mr. Purchaser did so for the full amount of the bill, and the builder forthwith spent the money and regarded the incident as closed. After another four months the builder was surprised to see a van back up to the door with two of the machines on it, and a few days later he received a bill for them from Mr. Purchaser. About four months later he found that his property had been attached by Mr. Purchaser and he had been sued for the value of the two machines and some more. Another four months and the case came to trial. Mr. Purchaser recovered about $50 damages for his bother about the machines while they were being altered in the first place, but had to take them back. Mr. Builder paid lawyers' fees, traveling and costs of court, about $150. Now he does not guarantee to satisfy any one. The money-back plan looks on the surface to be all right. It looks to be the only fair way, and it would be, if the man who buys was always as honest as the man who offers this plan. Suppose you build planers. You offer them on the money-back plan. Out of a thousand customers there will be one whose order you had better fill by going down to the freight office and writing your check for the amount of the freight, out and back, and presenting it to the railroad. They are the only ones that will make anything, any way, and you will save yourself a good lot of expense and worry. Then out of this thousand there will be nine who really want a good tool, but who are crafty and think that you will knock off quite a discount rather than take the tool back; then there will be about another hundred that will honestly think that some accident in the shop or carelessness of their workmen is not their fault, but yours. This will leave you with a hundred and ten planers, out of a thousand, second-hand on your hands and worth about 50 per cent less than your price for new ones. Then there are extra freight charges, etc., and you really must figure on about 10 per cent loss. To meet this, you must add about 11 per cent to your prices. Even then you are just as apt to find the whole hundred and ten returned machines in a single year's work, in which case you are bankrupt before you begin to get a show. If your goods are something that you can just take down off the shelves and send out, and that you can put back and sell again, you can do it on a very small margin of extra price, but when, as is apt to be the case, your machinery is saleable to only a few people, and it cannot be thoroughly tested without making it second-hand, then you must go slow. There are usually certain definite things that a customer needs to have a planer do. A guarantee that your planer will do it within a certain time and within certain limits of accuracy is something that we can all meet, and yet if the customer is not pleased with the color of the paint on the inside of the bed he cannot make you suffer.

The most satisfactory sale I ever made was of a gap lathe. The inquiry came for a lathe to do certain specified work, the most serious of which was a cut of a certain depth and feed on a certain diameter. The diameter called for a 36-inch lathe. We had a 24-inch gap lathe on the floor, so we rolled a motor up alongside, belted it up and put in a 36-inch pulley and found out whether it would take the cut, the same was as the Dutchman found out whether he could drink a keg of beer—by trying it. The result was that we sold a 24-inch gap lathe at a good profit, and our customer bought a lathe that would do just what he wanted at a low price compared with the 36-inch lathe that he expected to buy. Entropy.

RECLAIMING OLD METAL BRAKE-BEAMS.

The reclaiming of old bent and damaged metal brake-beams is no small item on a large railroad system, especially with our present heavy equipment putting them out of business regularly. One of the large systems (D. & R. G. Ry.) follows the plan shown in the accompanying cut, of using a ¾ x 2½-inch or a ¾ x 3-inch wrought iron strap as a reinforcing strip on all bulb or I-section beams that fail in service.



Method of Repairing Old Brake-beams.

When bent or damaged brake-beams of this class come into the scrap docks, they are piled to one side, and each month or so a gang of men is set at stripping them of the heads, fulcrums, etc. Then the bare beams are taken to the blacksmith shop to be straightened, after which they are ready to be drilled for the reinforcing strap rivets. They are then taken to an automatic riveter, where the heads, fulcrums, etc., together with the reinforcing strap, are applied. Beams of this type, fitted up in the manner described, give quite as satisfactory service as when they are new, and last much longer.

E. W. Bowen.

Denver, Colo.

THE PROPER ADJUSTMENT OF SPARK COILS.

One of the most important adjustments about a spark coil is that of the vibrator spring. The tendency is to set this spring too tight in order to get a "good" spark. This is usually tested in the air, and when a big, heavy spark is obtained, the operator thinks that everything is all right, and starts the engine. The proper adjustment may be secured as follows: Draw the vibrator back until it does not touch the spring. Set the vibrator so that the iron head is from 1/16 inch to ⅛ inch from the core. Bring the spring up until it touches the vibrator lightly, and start your engine; if it skips, try adjusting the screw a little tighter, but leave the spring just as weak as you can, without the engine skipping. You will find that the battery will last very much longer. Sometimes the battery consumption is increased to three or four times the amount a coil should take by merely setting the spring stiff and getting a "big" spark. Of course, there is danger of setting it too weak, so that when the engine stops, the vibrator spring does not touch the contact screw, and the engine will not start.

We sometimes hear talk of waterproofing coils, but the best plan is to keep them in a dry place, not where they will be hot, but where they will not get damp, as the pressure of the jump spark is so high that it will run along a little streak of moisture almost as well as on a wire, and although the tendency is to dry up this moisture, in so doing it sometimes carbonizes the wood and makes another path for itself. Special care should be exercised on launches to have a good place for the coil and battery. Do not put more than six cells of dry battery or three cells of storage on the coil. If it does not work with this amount of battery in good condition, there is something the matter with it, increasing the voltage will not materially help the spark, and will only burn out the contact points. Secondary or plug wires should not be allowed to remain in contact with a hot pipe or cylinder. They are pretty sure to give trouble sooner or later. Place a piece of wood or fibre between wire and the heated metal. Oil should not be allowed to come in contact with rubber insulation, as oil rots rubber. Do not draw the spark out in the air to see how long it is; this strains the coil, and if there is any weakness, it will be sure to increase the trouble, even if it does not break down immediately.

Another puzzling trouble to find is a wire that is broken inside the insulation. This sometimes happens in the most unlooked for places, but usually where the wires are moved or bent most, as at the commutator, or where there is a great deal of vibration. The break can sometimes be located by bending and pulling, as the wire will be very much weaker and more limber in the broken spot. The spark plugs should be closely watched and kept in good condition. Much of the trouble attributed to the coil may be traced to the plug.

J. E. K.

FACING WORK ON CENTERS.

In the August issue of Machinery the writer finds a kink on the subject of facing work on centers by W. S. Leonard. It astonishes some of his readers why he does not use the so-called half-center for such work. It appears as if Mr. Leonard were totally unacquainted with this appliance. Supposing it is wanted to cup the end of an arbor for holding work between centers, how would it be possible to do by using ordinary centers, unless by slacking the tail-center. For all such purposes the old style of center should be discarded, and the so-called half-center be used.

Beverly, Mass. Clarence E. Simonds.

STEAM WHISTLE OPERATED BY GAS.

In the August issue of Machinery, W. L. McL. suggests putting a steam whistle on the cylinder of a gasoline yacht engine. I would like to inform W. L. McL. that on an ordinary-sized yacht engine that is the best way he can find for spoiling his compression and the efficient running of his engine.

Arthur Knapp.

Ardmore, Pa.

[Mr. Knapp's objection, we suppose, is that screwing a pipe into a gas engine cylinder head will increase the clearance space an amount equal to the space in the pipe up to the valve. Of course it is possible to avoid this by decreasing the original clearance space an equivalent amount. In any case the valve should be close to the head.—Editor.]

* * *

In every work of genius we recognize our own rejected thoughts.—*Emerson.*

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

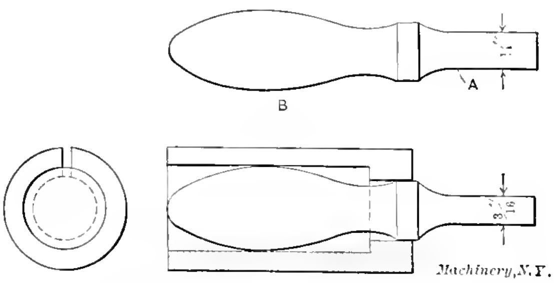
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

BABBITTING KINK.

Another way than that mentioned in the August issue, of babbiting a solid box in a hurry and not have to scrape it, is to take a piece of paper, rub it with Albany grease, and wrap it around the babbitting mandrel. The grease will make the paper stick until the babbitt is poured, and will help it to run freely. After pouring, drive out your mandrel, clean out the paper, and the box is ready. ALLAN.

HOLDER FOR TURNING END OF HANDLES.

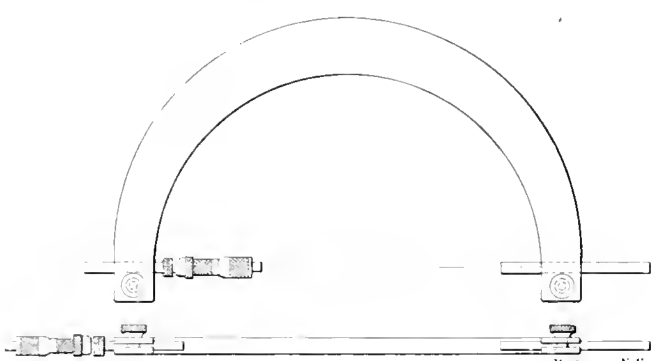
A job came up one day requiring a number of handles, as shown in the cut, to be turned down at *A* from a diameter of $\frac{1}{4}$ inch to 3-16 inch. I tried chucking them at *B*, but found



that it took considerable time to true them up, and very little pressure to knock them out of true again. Finally, I made a holder, as shown in the cut. This holder is simply a split bushing with a shoulder at one end. By this means I could grip the handles firmly, and hold them true for turning with very little trouble. ORIGINAL.

MICROMETER FRAME.

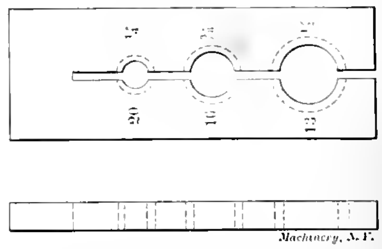
The accompanying cut shows a micrometer frame which I used some years ago at the Westinghouse works. The frame is an aluminum casting, and the anvil is simply a tool-steel pin, which fits well in the hole into which it is inserted, and can be clamped anywhere within the limits of its length. The



micrometer end of the frame is supplied with an inside micrometer head. The tool is adjusted to a gage, either to a standard pin gage, or to an inside micrometer gage. The capacities of three of these micrometers in a set were from about $3\frac{1}{2}$ to 7 inches, 6 to 11 inches, and 10 to 15 inches. When the head was turned outward, as shown in the lower view in the cut, the tool was very handy around a horizontal boring machine where a pin gage could not be used without removing the boring bar. SIRIUS.

A SCREW FILING JIG.

A clever little device for holding screws while filing the ends to shorten the length came to my notice a short time ago in a shop where many varying lengths of screws were needed. It was impracticable to buy all the various lengths, so a file was used. The screw, if held in a vise or hand clamp was sure to have the threads jammed, hence the jig shown was devised. The jig consists of a strip of brass, 3/16 inch thick. Three holes were drilled, tapped and marked. Then a saw cut was taken through the piece to the last hole. The screw can be put into the right hole, then the jig held in a hand clasp or a vise, and the file used without fear of bruising the threads. This works to perfection, and the plate can be tapped for a great number of sizes of screws, if desired. RAYMOND C. WILLIAMS.



Worcester, Mass.

BENCH VISE ANVIL.

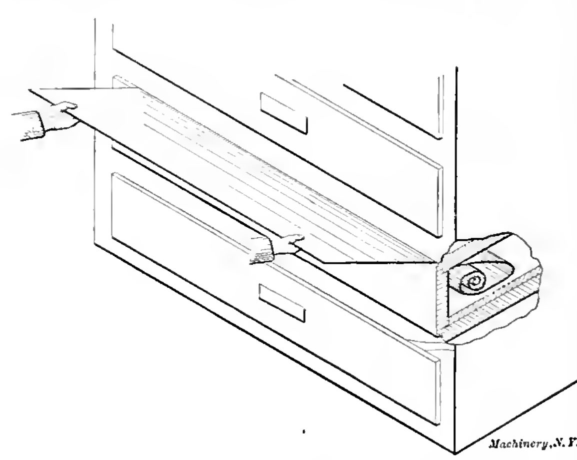
The accompanying cut shows a very handy bench vise anvil for the tool-room, model-maker, or amateur mechanic. The anvil is made from a piece of steel T-rail about 12 or 15 inches long, and as heavy as can be obtained, and the top, edges and ends are planed smooth, true and square. The web is cut out, as shown at *B*, so a clamp or swivel vise of about $1\frac{1}{2}$ or 2-inch length of jaw can be fastened to the end of the rail. There is a taper hole at *A* for different shaped stakes. The top and edges may be case-hardened if so desired. This makes an exceedingly handy outfit, as a great variety of work can be executed on it, and the vise can be brought in the best

position to see the work. The top is a good place for straightening work, and the edges for bending work. Pieces of suitable sized rails can be easily obtained from section foremen on almost any railroad. X. Y. Z.

[Perhaps *some* railway officials might object to X. Y. Z.'s naïve statement as to the ways and means of getting suitable sections of rail as an unwarranted incitement to breaking the eighth (seventh, Douay version) commandment.—EDITOR.]

SMOOTHING WRINKLED BLUE-PRINTS.

The cut shows our method of "ironing" soiled or wrinkled blue-prints after they are dry. The wrinkled print is laid in a cabinet drawer with just enough of it outside to conveniently hold in the hands, and the drawer is tightly closed. After being pulled out the print is perfectly smooth. The



angle of pull should be adjusted to the strength of the paper. Pulling through once will, of course, cause the print to roll up, when released; if this is not desirable, and the print is wanted to lie flat, reverse the print and pull through once more. HOWARD D. YODER.

Wadsworth, Ohio.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

In the July issue of MACHINERY, C. H. A. asks if there is any sure way of plating by dipping in copper sulphate so as to obtain a good plating, and also asks what is the correct solution. The best results are obtained by using a solution of 3 pounds of sulphate of copper to 2 fluid ounces of sulphuric acid. The surfaces to be plated must be carefully cleaned, so as to be free from dirt and grease. With the above solution good results are certain, and any reasonable desired thickness of plating can be obtained.

Scottdale, Pa. M. B. STAUFFER.

DEPTH OF THREAD IN PIPE FITTINGS.

A. B.—Do manufacturers of pipe fitting follow or agree on a common standard in the depth of thread that shall be tapped in fittings supplied to the trade? Is there a published record of same?

A.—The Briggs standard of pipe thread gives practically all the data required. The taper of ¾ inch per foot makes no precise standard of depth necessary, but, of course, where test plugs are used for inspection, certain arbitrary standards are necessary. The extra data sheet No. 78, made ready this month, on pipe threads and gages, gives the tool-room practice of one large manufacturing company.

TO LOOSEN A PULLEY ON A SHAFT.

N. M.—I have a number of 48-inch pulleys rusted fast on 2 7/16-inch shafts. I have tried almost every mechanical means known, short of hydraulic pressure, to start them, and so far have failed. The pulleys appear to be "welded" to the shafts with a dry, hard rust. I have tried to soften the rust with kerosene, gasoline and alcohol, but none of these apparently does any good. What would you advise?

A.—We would advise heating the hubs and lightly hammering them, and the continued use of solvents such as kerosene or alcohol, but probably heavy pressure will be required to start the pulleys loose. This, of course, is best supplied by a hydraulic press, but threaded rods may be rigged so as to obtain almost any pressure that is likely to be required in this case. The question is submitted to our readers.

DISTINCTION BETWEEN PITCH AND LEAD.

E. C. D.—Admitting that a screw and worm are essentially the same thing, why is the pitch of a screw known as the distance traversed during one revolution of the screw, and the pitch of a worm the distance from center to center of adjacent threads, regardless of multiple threads.

A.—This inquiry illustrates why a distinction should be made in the use of the terms "pitch" and "lead." Pitch should always be regarded as the distance from center to center of adjacent threads, irrespective of lead, while the lead should always be regarded as the axial distance traversed by one revolution of the screw without reference to the number of threads. In the case of single-thread screws or worms the pitch and lead are the same, but in the case of multiple-thread screws the pitch and lead are different, hence the desirability of always observing the distinction in meaning.

FEED MOTION GEAR TRAIN FOR BORING BAR.

W. H. S.—I wish to convert an old engine lathe into a boring lathe, using the boring bar shown in Fig. 1. The feed screw in the boring bar has four threads per inch, and is driven by the transmission gears A and B, having 14 and 32 teeth, respectively. The feed motion is to be transmitted to the center gear B by a square end bar C, shown in Fig. 2, which works through the hollow spindle, and is connected to the spindle through the back gear by a suitable train. The pinion D is connected to the feed bar by friction disks, which are released to stop the feed. The feed is reversed by the shifting spool-gear E. The pinion on the back gear shaft has 15 teeth and the spindle gear 73 teeth. What numbers of teeth will be required in the gear train to give the required feed in either direction?

A.—Since the feed screw has ¼ inch lead, and the gears are 14 and 32 teeth, a feed of 3/64 inch per revolution will require a differential movement of the feed bar C of $3/64 \div (\frac{1}{4} \times 32/14) = 21/256$. That is, the feed bar must run 21/256 turn slower or faster than the boring bar to give a feed of 3/64 per revolution. Expressed in another way, the feed bar must make 235 turns for 256 turns of the boring bar to feed the head to the left and 277 turns for 256 turns of the boring bar to feed the head to the right. Aside from the method of finding the proportions of the spool-gears E and E_1, perhaps, there is nothing different from the common trial-and-error operations followed in proportioning feed

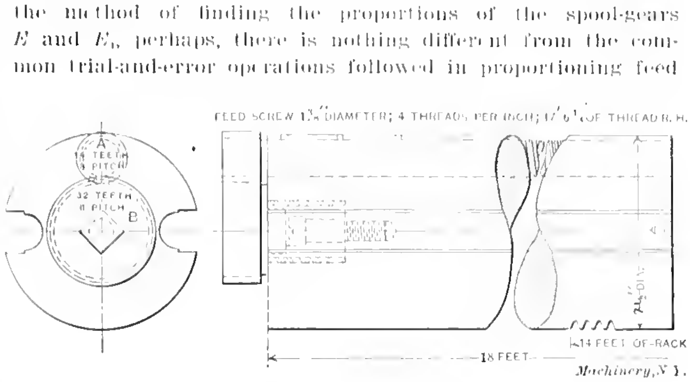


Fig. 1. Boring Bar Used.

gear trains, with which all machine designers are more or less familiar. If we make the two-spool gears with the same respective numbers of teeth, the squares of the tooth numbers must be in the ratio of 235 to 277 in order to preserve the required rate of feed in either direction. The numbers of teeth should be less than 100—preferably from 40 to 60. Hence we will multiply 235 and 277 by some factor which will yield products whose square roots will be numbers between 40 and 60. By a series of trials we find that the near multiples 2209 and 2601 yield roots 47 and 51, which

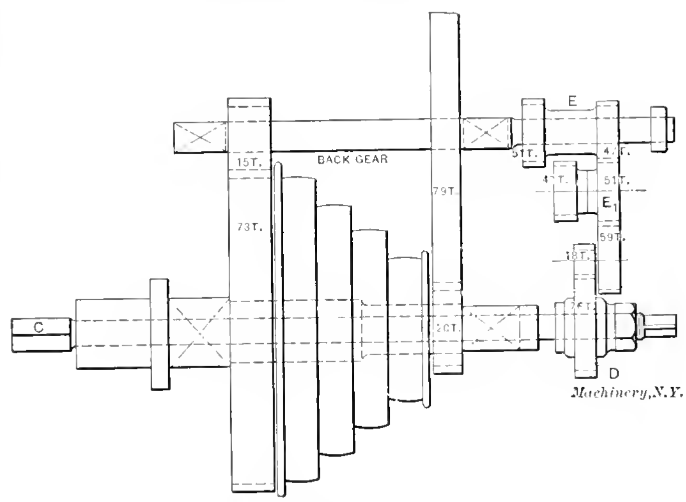


Fig. 2. Diagram o Gearing

are satisfactory. The numbers of teeth in the remainder of the train are given in Fig. 2. The proof for the differential motion of the feed bar for left-hand feed is

$$\frac{73 \times 47 \times 18}{15 \times 59 \times 76} = \frac{10293}{11210} = \frac{235}{256}, \text{ nearly,}$$

and for right-hand feed it is

$$\frac{73 \times 51 \times 51 \times 18}{15 \times 47 \times 59 \times 76} = \frac{569619}{526870} = \frac{277}{256}, \text{ nearly.}$$

* * *

In the August issue a description was published of the Besly disk grinder, having 26-inch steel disks, with the intimation that it was the largest disk grinder ever built. In this we were mistaken. C. W. Burton, Griffiths & Co., London, inform us that they build a 40-inch disk grinder, and that one was exhibited at the Engineering and Machinery exhibit held at Olympia Exposition, London, 1906. This large machine is built either with motor or belt drive. The work tables are about 18 x 27 inches and are carried on ball bearings. They are provided with T-slots and are traversed by rack and pinion. Adjustment in and out from the disks is effected by a micrometer feed screw. The approximate weight is 6,700 pounds, or over three times the weight of the grinder illustrated in the August issue.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

GRANT-LEES GEAR GENERATING MACHINE.

Any one who has followed the trend of development in machine tools in the past few years, must have noted the growing tendency toward the use of generating processes for the cutting of gear teeth. In the past two or three years, especially, much time and thought has been given to the process of generating gear teeth with a hob, whose normal outline has the form of the rack tooth of the interchangeable

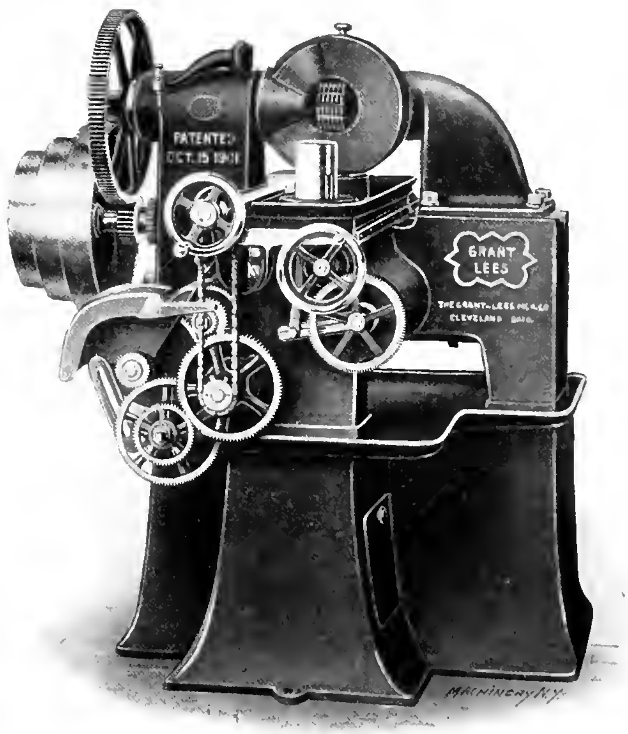


Fig. 1. Grant-Lees Gear Generating Machine. Front View.

set to which the gear belongs. The machine illustrated in the accompanying cuts, and described in the following paragraphs, is the latest product of this kind which has been brought to our attention. So far as we know, it is the first machine working on the hobbing principle for cutting spur gears that has been regularly built for the market in the United States. It is radically different in its constructional features from the European machines which have preceded it in this field, and contains a number of improvements which make a study of its details well worth while.

The general requirements of a hobbing machine for gear cutting are as follows: Means must be provided for driving the hob powerfully and smoothly at any angle with the axis of the work, so that spiral gears as well as spur gears may be cut. A work spindle, stiffly supported, must be provided, driven by a worm-wheel connected to the cutter spindle through change gears, so that the proper relation between the work and the cutter may be established to give the required number of teeth. Either the work spindle or the cutter spindle must be mounted on a slide, so that the center distance between the work arbor and the cutter arbor may be adjusted to give the proper depth of tooth. Either the work must be moved past the hob, or the hob past the work for the feeding motion, suitable means being provided to vary this rate of travel in accordance with the depth of cut and the hardness of the materials used. In addition to this, the feed of the work must be connected with the work-revolving mechanism by change gears, to give the proper movement for cutting spiral gears independently of the rotation of the work with the hob. These various movements and adjustments must be obtained in a way which will still allow the machine to have great rigidity, to prevent the deflections and inaccuracies which must otherwise result from the heavy cutting strain which the process involves. The solutions of these problems offered in the Grant-Lees machine will be understood from the cuts and the description.

As will be seen, the machine has the general appearance of the Lincoln type of miller, which is used so largely for heavy form cutter milling in repetition work. The power is transmitted from the cone pulley through reducing spur gearing to a bevel pinion meshing with the main driving bevel gear. This latter has a wide face, and engages, at the inner ends of its teeth, in addition to the driving pinion, with a second beveled pinion, keyed to the cutter spindle of the machine. The whole arrangement is shown quite plainly in Figs. 1, 3, and 5. The main driving bevel gear is in the form of a ring, revolving on a hub on the cross rail of the machine. The bracket carrying the cutter spindle has a long shank which passes through a hole in the center of this hub, and carries on its back end a graduated dial with suitable handles for setting it at the angle required for the work, and means for locking it in the desired adjustment. These arrangements are plainly shown in the rear view of the machine, Fig. 2.

The work is set on a hardened and ground tool steel arbor on a spindle having a vertical movement for the feed. The power for rotating the work spindle in unison with the hob (necessary in this machine, as we have just seen) is taken from the cone pulley shaft through change gears on the right side of the machine in Fig. 2, to the worm meshing with the index wheel on the spindle. The feed is obtained by a mechanism which raises the spindle as the cut progresses, the feed variation being obtained by change gears at the front of the machine as shown in Fig. 1. When the work has been fed in to depth, by adjusting horizontally the slide which car-

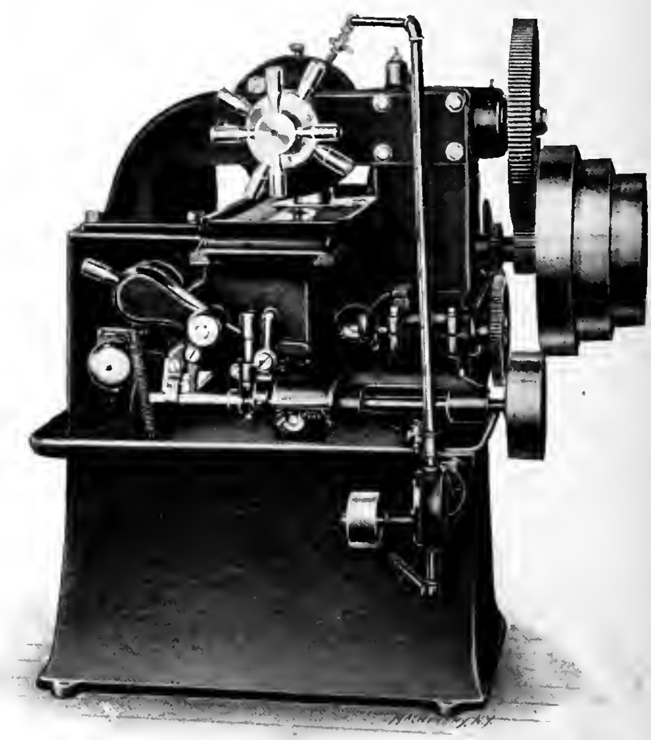


Fig. 2. Rear View of Gear Generating Machine, showing Feed Mechanism.

ries the work spindle, to figures read on the dial of the handwheel governing this movement, the cut may be started, and the work will be fed up past the revolving hob until the full width of face has been cut, whereupon feed will be stopped, the work withdrawn and returned to its previous position, and a gong will be struck to announce the completion of the work. The machine is, to this extent, automatic.

Figs. 1 and 2 show the front and rear views respectively of the machine, giving clear ideas of the general construction, and of the ingenious way in which the driving motion is conveyed to the hob, giving it a powerful drive and still allowing it to be swiveled at any angle. Ordinarily the driving

gear is covered by a case or cover, as shown in Fig. 1. Fig. 3 shows the machine cutting spur gears. The hob used, shown in Fig. 4, has teeth with a normal outline of the shape of the rack tooth, as explained.

Fig. 5 shows the machine cutting spiral gears. This is done as readily as the cutting of spur gears, it merely being

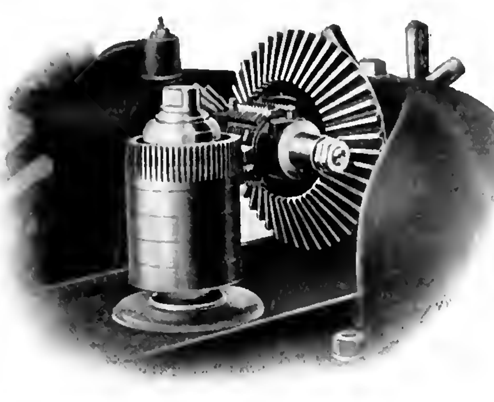


Fig. 3. Cutting a Stack of Spur Gears.

a matter of setting the hob at a proper angle and using the proper change gears for the spiral rotation of the work with the feed. The change gears for this motion are also located at the front of the machine. The connection with the index worm and wheel is presumably through some form of differential or "jack-in-the-box" gearing, so that the rotation of the work for the spiral, in connection with the feed motion, is superimposed on, and independent of, that due to its connection with the hob.

Fig. 4. The Hob Used in Generating Gears.

Fig. 6 shows a worm-gear being hobbed. For this operation the hob spindle is placed in a horizontal position, and the work is fed directly in toward the hob at the proper rate, and stopped at the proper depth, no previous nicking of the blank being required. The feeding motion for this, so far as can be judged from Fig. 1, is of the ratchet type, being adjusted by varying the position of the crank-pin in a slotted link.

Fig. 7 shows an ingenious steady rest, used for work of large diameter. Since the entire work spindle and the work

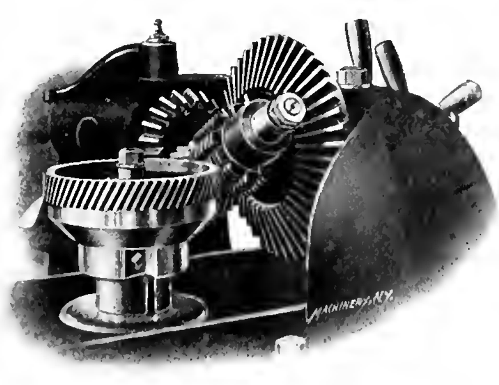


Fig. 5. Cutting a Spiral Gear.

it holds are raised to feed them past the hob, it is necessary also to raise any form of steady rest which might be used at the same rate as the work. The rest takes the form of a threaded post, raised by a nut geared through the worm and chain gearing shown to the vertical feed gearing at the front of the machine. The raising of the work and of the steady rest thus takes place simultaneously, and at the same rate. The attachment is shown in place in Fig. 1.

There are several advantages at once evident in this system of generating gear teeth. One cutter only is needed for each pitch, cutting all the gears from the smallest to the largest number of teeth. The fact that all the gears for a given pitch are cut by one correct hob, eliminates the errors arising from using one cutter for a considerable range of numbers of teeth in the old system. Another consideration which tends toward accuracy is the fact that the heat is uniformly distributed, owing to the fact that the work is continuously rotated. Since each tooth of the hob passes over each of the teeth of the gear, it is impossible for a gear cut on this machine to have thick or thin teeth, since all are cut under exactly the same conditions.

Another advantage of the system is its universality. The same machine is fitted to the cutting of spur, spiral and worm

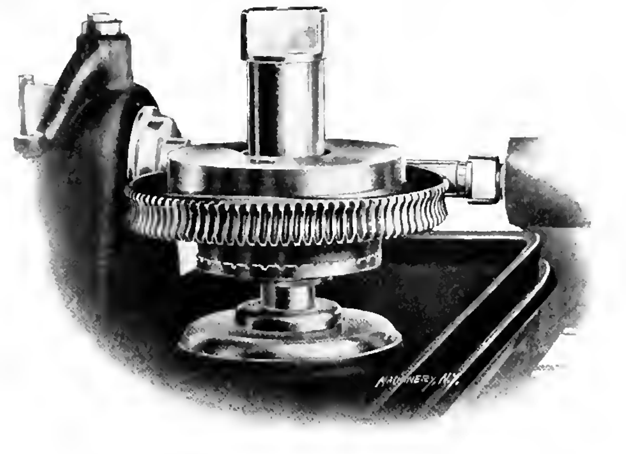


Fig. 6. Hobbing a Worm-wheel.

gears without requiring extraneous attachments, all the movements being provided for in the design of the machine. There is a great gain in simplicity as well, in this process, over the automatic gear cutter of the usual type, which is required to be provided with mechanism for feeding the cutter, returning it at high speed, indexing the work, and repeating the operations with rapidity and precision. Especially does the advantage of the generating machine appear when it is contrasted with a machine of this type adapted to the cut-

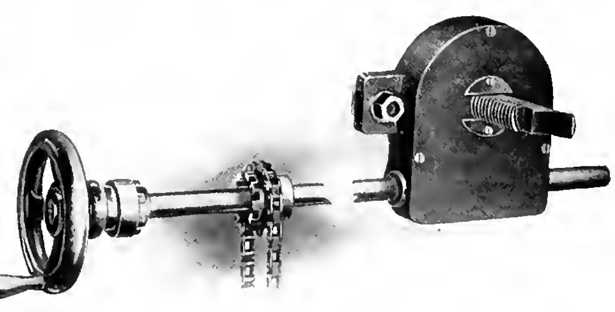


Fig. 7. Automatic Steady Rest, shown in Place in Fig. 1.

ting of spiral gears. It is difficult to escape the conclusion that there are great possibilities in store for the hobbing process of generating spur and spiral gears.

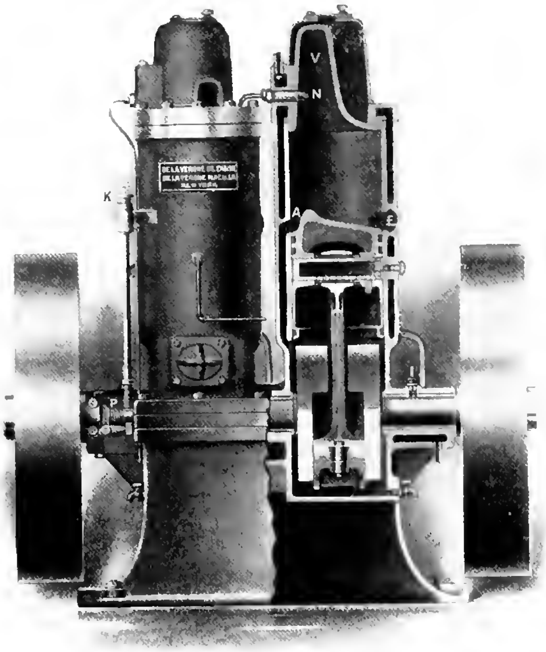
This machine is the result of the combined efforts of Mr. H. J. Lees and Mr. John J. Grant, the former well known as a pioneer in the development of the heavy multiple spindle milling machine, and the latter recognized as one of the most original and ingenious machine tool designers in the country. The Grant-Lees Machine Co. of Cleveland is building the machine and placing it on the market.

DE LA VERGNE TWO-CYCLE VERTICAL OIL ENGINE.

For the past twelve years, the De La Vergne Machine Co., New York, has built the Hornsby-Akroyd oil engine in sizes up to 250 H.P. With the valuable experience gained in the design and construction of this engine to guide it, the company has developed a two-cycle two-cylinder vertical oil engine designed for small powers. At present it is built in two sizes only—

7½ and 15 horse-power. The new engine uses ordinary kerosene or fuel oil. Kerosene is available everywhere, and in most sections can be purchased for about one-half the cost of gasoline. With kerosene at 10 cents a gallon and gasoline at 17 cents a gallon it is calculated that power developed from kerosene costs less than one-half as much as power developed by gasoline. The two-cycle engine has the advantage over the four-cycle type that the piston receives an impulse every revolution, and in a two-cylinder two-cycle engine the crankshaft receives two impulses every revolution the same as that of a single-cylinder double-acting steam engine.

Referring to the sectional part of the cut, air is admitted to the cylinder from the crank case through the port *A*, which is uncovered by the piston near the end of the downward stroke. The beginning of the upward stroke closes the fresh air port *A* and the exhaust port *E*. The air thus trapped is compressed into the vaporizer *V* at the head of the cylinder. A spray nozzle *N* projects into the vaporizer, and through



De La Vergne Two-cylinder Oil Engine.

this a charge of atomized oil is sprayed against the hot walls of the vaporizer. The spray is forced into the vaporizer by the plunger pump *P*, which is driven by a cam on the crankshaft.

The vaporizer is similar in construction to that used on the Hornsby-Akroyd oil engine, being a cast iron bulb on the cylinder head and forming an extension to same. No sparking device or hot tube is used. The walls of the vaporizer retain sufficient heat to vaporize each successive charge of oil, and ignition is effected by the heat of the vaporizer walls together with the heat of compression. Slightly before the end of the downward stroke the exhaust port *E* is uncovered, permitting the escape of burned gases, and on the upward stroke fresh air is drawn into the crank chamber through an automatic poppet valve. On the downward stroke this air is slightly compressed, and when the air port *A* is uncovered the fresh air rushes into the cylinder.

It is evident from the above that the construction is essentially that of the typical two-cycle engine; the design has been modified and improved with the view of obtaining all the advantages of the two-cycle type and of avoiding its defects. The fuel consumption is about one pint of kerosene or fuel oil per brake horse-power hour, and fuel consumption not to exceed one pound per brake horse-power hour is guaranteed when running at three-fourths to full load.

THE BURKE TAPPING MACHINE.

The half-tone shows a tapping machine made by the Burke Machinery Co. of Cleveland, Ohio. The spindle carries a chuck for holding the taps. Mounted on it are two pulleys, one of which is driven by a straight and the other by a cross belt. The spindle may be connected with the forward moving pulley by shoving it inward, or may be disconnected from this and connected with the reversing pulley by drawing it downward. These connections are effected by two expanding ring clutches, one in each pulley, operated by the end motion of the spindle. The work is held by the hand against the plate, shown attached to the bar passing through the base of the head-stock. This foot-stock bar slides freely in its bearings, and is provided with an adjustable stop for limiting its

Burke Horizontal Tapping Machine.

inward motion. When the work held against the plate by the hand is pressed against the tap, this pressure connects the spindle with the pulley which gives the forward movement. When the hole has been tapped to depth, as determined by the adjustable stop, the continued rotation of the tap draws out the spindle and so disconnects it from the forward motion, whereupon the withdrawal of the work puts the reversing pulley in connection with the spindle, and the tap is backed out.

The foot-stock bar has a movement of 3½ inches. The machine has a capacity for tapping holes up to ¾ inch in diameter. Unless otherwise ordered, it is furnished with a 5/16-inch chuck, without extra charge. The spindle will be tapered to fit a No. 2 Almond chuck, if the purchaser desires. The pulleys are 6½ inches in diameter for 1¾-inch belt, and are intended to run at about 100 revolutions per minute. The net weight of the machine is 40 pounds.

CHAPMAN DOUBLE BALL BEARING.

The ball bearing made by the Chapman Double Ball Bearing Co., 40 Bristol St., Boston, Mass., has, as the special feature of its design, an arrangement by which friction between neighboring balls is eliminated. A lot of balls running together in a bearing under pressure have a tendency to crowd together, and it is the belief of the makers of this bearing that a large

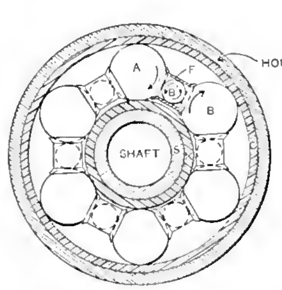


Fig. 1. Use of Intermediate Ball in the Chapman Bearings.

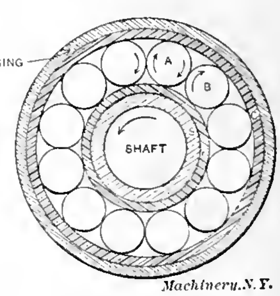


Fig. 2. The Cause of the Friction in Ordinary Bearings.

share of the loss of power, and the larger part of the wear to which the balls and races are subjected, can be traced to this crowding tendency, and the consequent friction of the balls on each other. The means taken to prevent this will be understood by referring to Figs. 1 and 2. In Fig. 2, which shows the ordinary bearing, balls *A* and *B* rotate in the same direction, as shown, when the bearing is in action. This, it will be seen, makes the two balls rub against each other at the point of contact, since the surfaces are moving in opposite directions at this point.

Fig. 1 shows the method of obviating this difficulty. A small ball *B'* is inserted between *A* and *B* on the line of cen-

ters between them, so there is no tendency for it to move out of position. It is held here by a light spool or bushing F, which is beveled at the ends to rest lightly against the large balls A and B, and has a central hole just large enough to allow the small ball B' to rotate freely. It will thus be seen that, barring the entirely negligible weight of the spool F, there is nothing except rolling friction to be considered in the whole bearing. The makers consider that this method of separating the balls is much preferable to the use of a cage, in which case the friction is merely transferred to the sides of the container instead of taking place between the balls themselves, as in the ordinary old-style bearing.

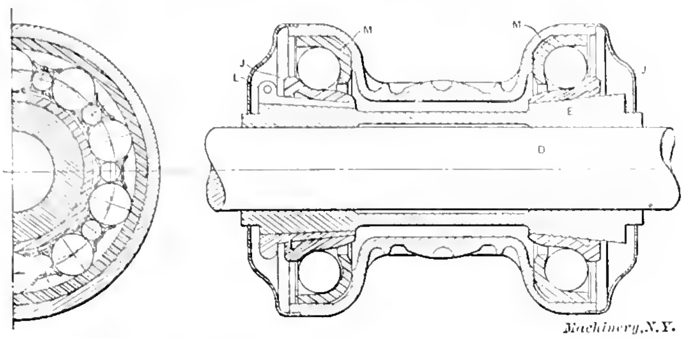


Fig. 3. The Chapman Ball Bearing for Shaft Hangers.

The application of this arrangement to hangers and other shafting bearings will be perhaps as interesting to the readers of MACHINERY as any of the numerous uses to which it has been put. A hanger equipped with a Chapman bearing is shown in Fig. 4, while Fig. 3 is a cross section explaining the construction followed. D is the shafting to be supported, and E is the sleeve on which the inner ball races are mounted. Races J and J are mounted on the sleeve, one at the right-hand, and the other at the left over an adjusting collar L. This may be moved in or out to adjust the bearing to the proper degree of play. It will be noted that the inner races J and the outer races M are both unsupported directly behind the line of thrust. A slight elasticity is thus allowed which permits the bearing to take care of minute irregularities due to temperature changes, etc., while still leaving the parts rigid enough to support any weight which may be put upon

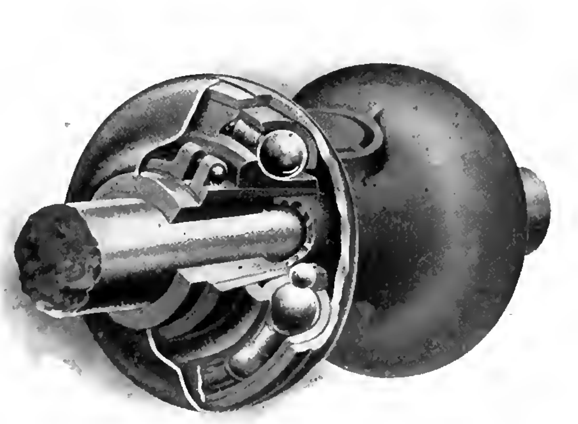


Fig. 4. Sectional View of the Hanger Bearing.

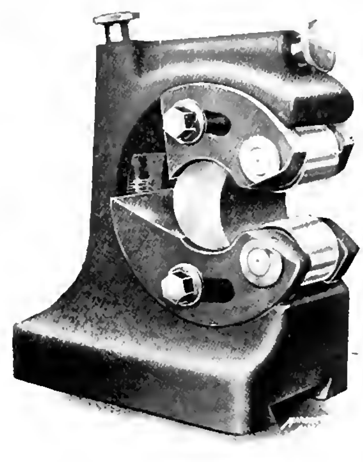
them. In addition to this, the complete bearing is free to swivel in the hanger to adjust itself to the axis of rotation of the shaft.

A number of tests have been made by a competent engineer comparing the efficiency of the Chapman bearing, the ordinary ball bearing, and the plain journal, the workmanship in each case being of the same quality. These tests were made in various ways. One of the simplest of them was carried out with an apparatus consisting of three exactly similar cast iron pulleys, perfectly balanced and weighing 105 pounds each, mounted on a central axle The first of these ran on a Chapman double ball bearing, the second on an ordinary three-point ball bearing of similar design, and the third on a plain journal of hardened and ground steel, running in a cast iron hub. A 7-pound weight was hung by a small cord from the periphery of each pulley in turn, at a height of 10 inches from the floor. Then the weight was released, and the number of revolutions that each pulley made before it came to a stop, as well as the duration of the spin, was noted. The Chapman bearing rotated for 16 minutes and 35 seconds, the ordinary ball bearing, 5 minutes 8 seconds, and the plain journal, 20 seconds.

LODGE & SHIPLEY ROLLER FOLLOWER REST.

The tendency of work carried on centers to spring away from the tool under the pressure of the cut is more pronounced with the high speed attainable with modern tool steels than was the case under former conditions. At the same time, the use of the follow rest to counteract this tendency has been made less satisfactory, owing to the coarser chip, higher speed and rougher surface left by the new steels. The jaws are rapidly worn away, and rubbing friction is a fruitful source of lost power. The half-tone shown herewith illustrates a follow rest in which these difficulties have been overcome.

The body of the follow rest is clamped to the dove-tail slide of the bridge of the carriage. The two jaws can be separated or brought together by a circular motion, effected by two screws meshing with teeth in these jaws; the screws are operated by the knobs shown at the top of the device. The jaws carry hardened steel rollers, and are so located as to give, with the point of the tool, a three-point support to the work. When once set, the device is adapted for a variety of diameters by simply moving the entire rest backward or forward by its connection with a screw which telescopes through the regular cross feed screw, and is operated by the hand-wheel controlling the tool rest. When approaching a shoulder, the position of the rolls is such that they support the shaft on the smaller diameter until the cutting tool has turned a portion of the larger diameter, when the rollers may be quickly brought to bear upon it. Ample provision is made for oiling. Sensitive adjustment is provided for, without the aid of the wrench, and the jaws, once set, can be locked in position.



Follower Rest for High-speed Turning.

This follow rest is made by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

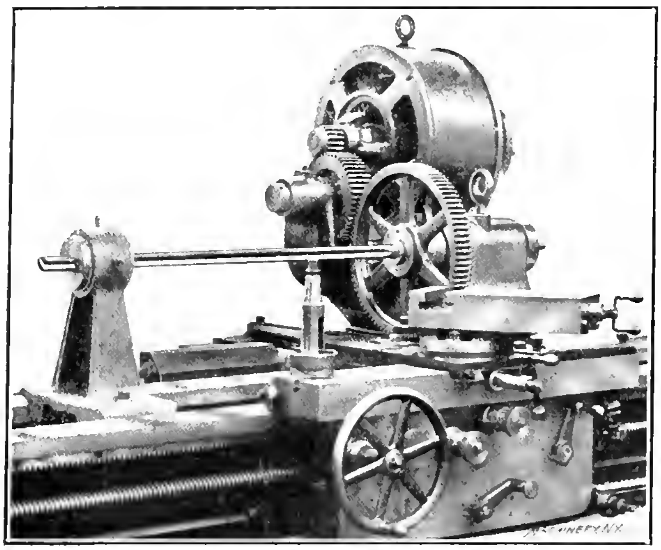
DEEP DRILLING ATTACHMENT FOR THE LATHE.

An attachment is shown in the accompanying half-tone for performing deep drilling rapidly and economically on the engine lathe. It consists essentially of a drill spindle, mounted on the cross slide in place of the usual tool-post, in combination with an electric motor and suitable gearing for rotating the spindle. A support is provided for holding the outer end of the work, the other end of which is clamped by the chuck or face-plate of the lathe. Provision is also made for forcing a copious supply of lubricant to the point of the drill used. The purpose of the attachment is to make it possible to drill a hole true with the center line by the usual method of rotating the work, and at the same time give the high cutting speed of which high-speed tools are capable, without necessitating a high rate of revolution for the heavy spindle and gearing of the lathe.

The drill spindle bearing, with the bracket on which the motor is mounted, is cast as one piece with the bed plate. This plate is bolted to the wings or arms of the carriage. The 3-horse-power 2 to 1 variable speed motor shown, is connected to the drill spindle through an intermediate raw-hide

gear. The spindle is bored to supply lubrication to the drill; it has a large bearing, and is ring oiled. The drill shank is fitted to the hole in the spindle by reducing bushings. The outer end of the drill is carried in a free bushing, revolving in a support bolted to the lathe bed. The drill used is of the special construction known as the "Chard" deep drill. A flat blade of high-speed steel is held in position at the end of a steel shank by a tapered pin; it is so ground as to break up the chips and thus facilitate their removal. Lubrication under pressure sufficient to clear the chips and cool the cutting edge is supplied by a pump, attached to the lathe at the rear of the head-stock, and driven from the lathe countershaft. Flexible tubing connects this pump with the hollow spindle through a nipple at the rear. Two copper tubes, flush with the surface of the drill, carry the lubricant to the cutting edge. This type of drill has been in use for some time on lathe spindles, back gear sleeves and pulley sleeves. Under favorable conditions a 2-inch drill has been advanced at the rate of 2¼ inches per minute. The drill in the cut is 1 inch in diameter.

This whole attachment may be easily removed from the carriage by the use of an over-head crane, suitable I-bolts



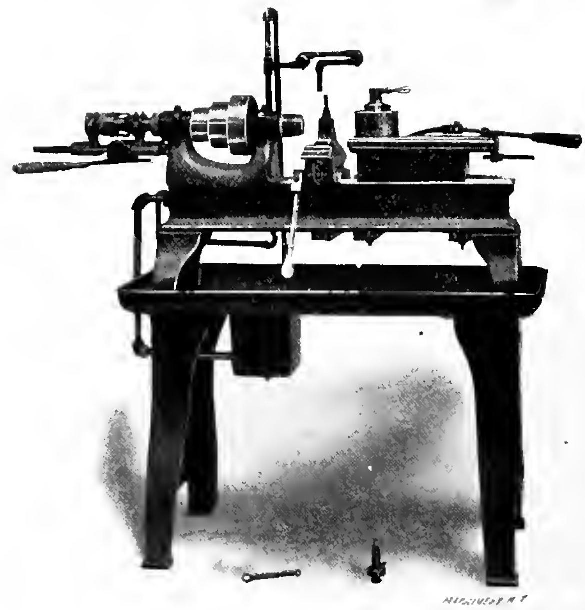
Motor-driven Attachment for Deep Drilling in the Lathe.

being provided for this purpose. Only a few minutes time is required to change the machine over to engine lathe work. The particular machine illustrated is used regularly for drilling central holes in locomotive driving axles, the hole being 1 inch in diameter and 44 inches deep. It was built by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

WELLS SCREW MACHINE.

This is a small machine of inexpensive design and construction, intended to be used for a large range of work originally done on more elaborate machinery. The machine is stiffly made, as may be seen from the cut, the head-stock being cast solid with the bed. The other parts, such as the turret slide, cross slide, etc., are provided with ample bearing surfaces and plenty of metal to resist the strains imposed on them when taking cuts with high speed tools. The spindle is fitted with an automatic chuck operated by a lever. The wire feed used is not of the ordinary chain actuated type, but instead follows the plan generally used in automatic machines, an inside tube and collet or finger being used to grip the stock, and feed it forward against the stop in the turret. This is operated by the same lever that works the chuck. This reduces the capacity of the wire feed, but has the advantage that the bar is under the control of the feed until it is entirely used up. For larger work the inside tube and collet can be taken out at any time, and hand feed used with the automatic chuck. The spindle is so designed that the cap may be taken off and any lathe chuck up to 8 inches in diameter used for holding large work, such as castings, etc.

This machine will be furnished with either a 4-hole hand operated turret, or a 4 or 6-hole automatic turret, with or without the wire feed just described. The equipment regularly furnished includes one automatic chuck and feeding collet for ½-inch wire, the turret slide and cross slide shown, oil pump and piping, and a friction clutch reversing counter-shaft. The machine swings 11 inches over the bed and has a 1⅛-inch hole through the spindle. The automatic chuck has a



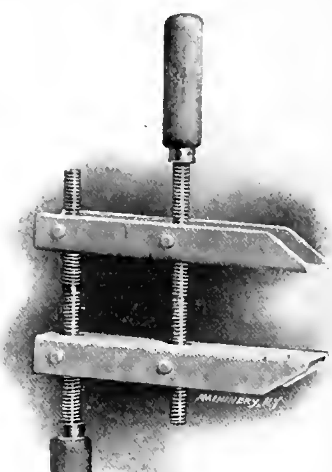
Wells Screw Machine.

capacity up to ⅞-inch and the wire feed up to ⅝-inch. Four and one-half inches is the greatest length that can be turned by the turret tools. The holes in the turret are 1-inch in diameter. The net weight of this machine is 675 pounds. F. E. Wells & Son Company of Greenfield, Mass., are the builders.

THOMPSON PATENT CLAMP.

The clamp shown in the accompanying half-tone is our old friend the wooden "hand screw" in a new guise. As shown, the jaws are made of steel in channel form, each of them carrying two swivel nuts, through which the wooden handled screws pass. Each of these screws is threaded right- and left-hand, the threads meeting at the center. Both screw spindles and swivel nuts are made of the best steel.

The clamp is opened and closed rapidly by grasping the handles in the two hands and rotating the clamp like a reel, the same as with its wooden progenitor. It has the added advantage, however, of allowing either screw to be adjusted without moving the other, so that the jaws may be set to incline toward each other, or away from each other, as well as in a parallel position. This is allowed by the use of the swivel nuts.



Metal Clamp on the Lines of the Wooden "Hand Screw."

The following advantages are claimed for the construction. The jaws being made in the form of a channel and of a good quality of steel, makes the clamp much stronger than any other. Owing to the rigidity of the design, this strength is obtained without sacrificing lightness. The jaws and screws being of metal, glue will not adhere to them. The jaws can be adjusted to any angle. It is twice as fast in operation as the old style, on account of the use of right and left thread

on the spindles. Owing to the use of metal screws and nuts, a stronger hold is obtained with less power. The jaws, which are polished, may be made to over-lap. The Erie Stamping and Mfg. Co., Erie, Pa., manufactures the clamp.

BULLARD RAPID PRODUCTION VERTICAL TURRET LATHE.

The Bullard rapid production vertical turret lathe is built by the Bullard Machine Tool Company, 531 Broad Street, Bridgeport, Conn. The steps by which this machine has arrived at its present form, as shown in the accompanying cuts, are typical of the process of development that machine tool design has gone through in the past few years, showing both the growth of the requirements which the builder has to meet, and the line of development which the machine has had to pass through to meet these requirements.

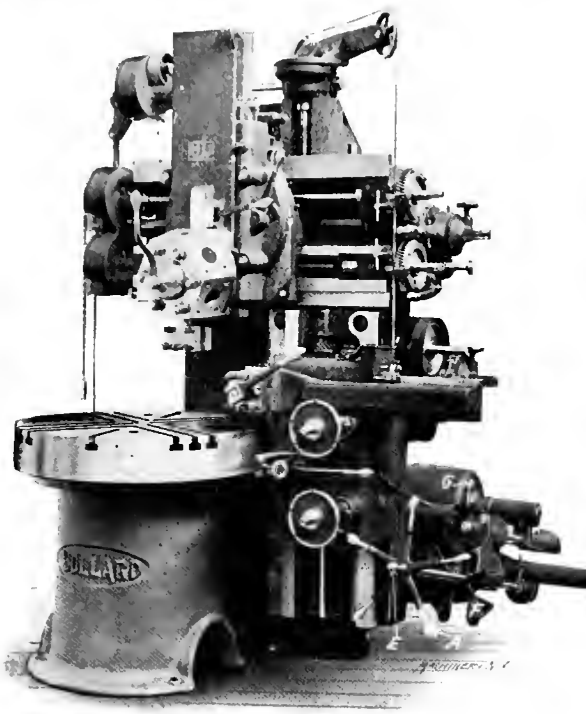


Fig. 1. Bullard Rapid Production Vertical Turret Lathe.

The boring mill is essentially a lathe, set on end for convenience in handling work of large diameter and comparatively short length. Being a lathe, the turret was naturally applied to it at about the time the turret lathe began to approach its present state of development. In larger mills, the use of two turrets was naturally suggested, owing to the room available on the cross rail, and the desirability of having as many tools cutting at once as possible. In the boring mills of smaller sizes, however, the carrying out of this idea was found to be impracticable, since in many cases the use of two heads required the second one to be swiveled to an excessive degree and extended from its supporting saddle to a point where the two tools could be used in close proximity. This extension of the tools beyond their supports resulted in a reduction in the feeds and speeds possible, owing to the lack of rigidity in the support, so that very little gain was found in the use of two turrets over that of the single tool.

A few years ago Mr. E. P. Bullard, Jr., of the Bullard Machine Tool Company, conceived the idea of placing one of the turrets on the vertical slide at the side of the column. This combination of vertical and horizontal rails and turret slides permitted the tools to be set for simultaneous cuts on any part of the work without interfering with each other. A machine was built to try out this idea, and later a number of them were installed in various plants, although they were not publicly put on sale. From time to time improvements and elaborations have been made until the machine has developed into its present form, which has been very properly called a "vertical turret lathe." It will be seen that the arrangement of the slides and tool-holders fits it for filling very nearly the field occupied by the heavy horizontal turret lathe, particularly in the matter of finishing castings and large diameter forgings.

The machine consists essentially of a rotating face-plate, mounted on a bed which has a vertical column carrying a horizontal turret slide at its right-hand side, and a cross rail with a vertical turret slide above the work. The ram or tool slide in the carriage on the vertical slide has a four-sided turret for holding turning and facing tools. The cross rail turret slide has a heavy hexagonal turret for boring, reaming, facing and turning tools. These two sets of tool-holders are provided with suitable feeds and handling devices as will be described.

The table is driven from an internal gear of nearly the outside diameter of the table. It is naturally self-centering, due to the large angular thrust bearing with which it is provided. The side strains are taken by straight vertical bearings of large proportions. The weight of the table spindle and work tends to preserve rather than destroy the alignment. The spindle journals are carefully scraped to fit, and are entirely immersed in oil.

A feature of the spindle drive mechanism is the fact that no step-up in the speeds is involved in the gearing, a constant reduction being maintained at all speeds, all the way from the driving pulley to the table.

The table has 15 changes of speed, obtained by a positive geared mechanism from a single speed pulley or electric motor. The controlling mechanism for these changes is planned on what the builders call the "automobile" principle, described in connection with their 56-inch "rapid production" boring mill in the December, 1905, issue of MACHINERY. The handle *G* may be given three positions corresponding to three changes of speed obtained by positive clutches in the headstock *B*. Pilot wheel *A* has five positions corresponding to

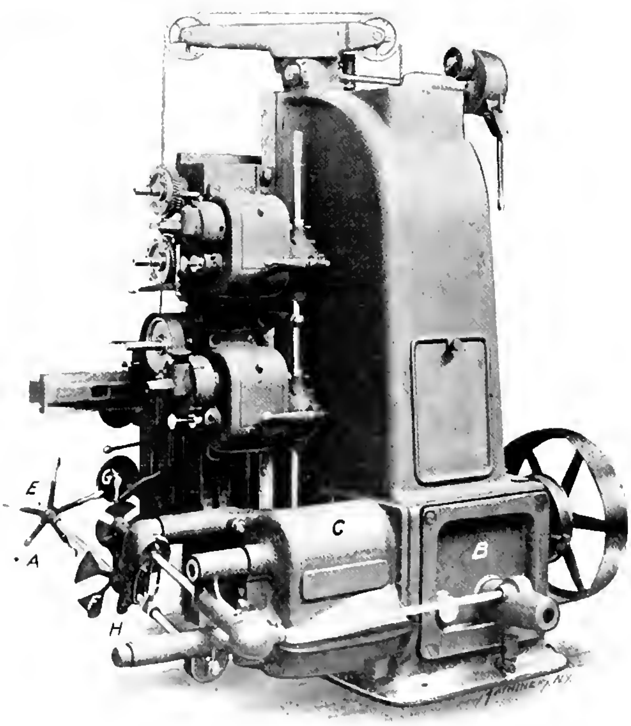


Fig. 2. Rear View of Vertical Turret Lathe, showing Spindle Speed Changing Device.

the five changes obtained in speed box *C* by a cone of gears and friction clutches. The raising of the shaft on which the pilot wheel is mounted, by handle *E*, throws a brake into action, for stopping the table at any desired point. The movements of *E*, *A* and *G* are interlocked by the locking disk *F*, the link *H* and the attached parts, in such a way that it is impossible for the workman to make an error in handling the controlling mechanism. The brake handle *E* cannot be raised until the pilot wheel *A* is placed in a neutral position, so that the power is cut off; and handle *G*, controlling the positive clutches, cannot be shifted until the mechanism is disconnected from the power and the brake applied. This

arrangment gives a "selective" control, making it possible to change from any speed to any other without going through the intermediate positions. The number of table revolutions per minute may be instantly ascertained from the direct reading indicator incorporated in the interlocking mechanism. The arrangement of the pilot wheel and its attached parts, the selective control, and the concentration of all operating levers within easy reach of the operator, account for the likeness to the mechanism of the automobile to which the builders refer.

The same facility for rapid changes is furnished for the various feeds, as has been described for the spindle speeds.

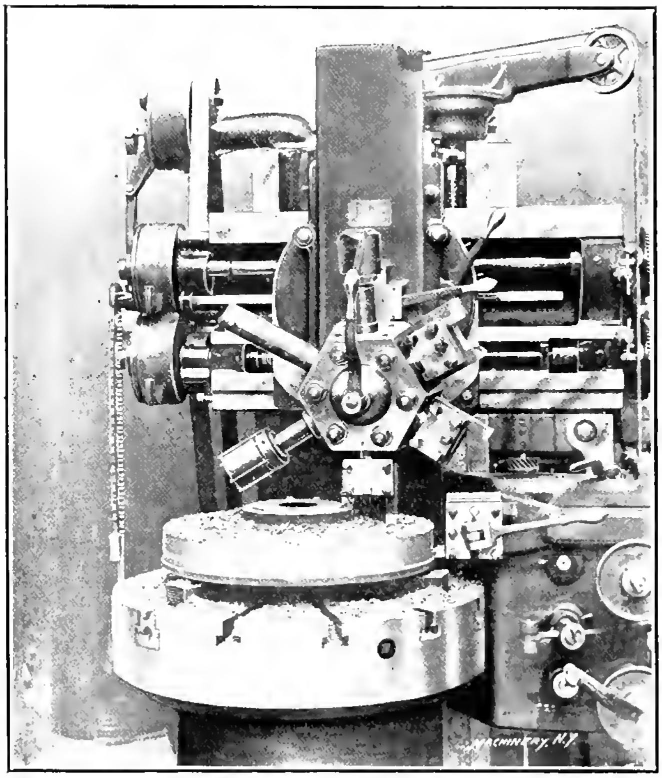


Fig. 3. Machine in Operation, Finishing Gear Blanks.

Each slide is provided with its own rapid feed change mechanism, handled by its own separate levers. The eight changes are obtained in two series of four by cones of gears constantly in mesh. Handles on each feed box are provided for shifting the position of the "diving" keys, to match the gears they are required to engage. It will be noted that there are no pull gears used in changing from cross to vertical feeds and vice versa. In the case of the cross rail, a drop worm is used which may be connected to the worm-wheel on either the cross feed or vertical feed shafts. In the case of the movements for the side head on the vertical slide, the change from cross to vertical feed is made by the lever shown between the two square-ended operating shafts. This lever controls friction clutches for throwing in either of the two feeds desired. The operating shafts on this side head are provided with disks having graduations for reading the movements in both directions, and similar graduations are provided on the worm-wheels operating the movements of the cross slide turret. Clips numbered to correspond with the holes in the two turrets are used at these two points. These clips may be set in any desired position, and used instead of stops for the various movements, obviating the necessity for all calipering and measuring except in the case of the first piece made. They have the advantage of greater accuracy, and are not subjected to some of the mechanical difficulties involved in the use of automatic throw-outs or positive stops.

Positive stops are provided for setting the turret slide accurately in a vertical position and for centering it for boring, drilling, reaming, etc.

A rapid power handling mechanism, operated from the driving shaft by a belt running to the small pulley and gearing shown at the extreme upper left hand corner of Fig. 1, may be used to operate all the movements of the main turret, or for raising and lowering the cross and vertical slides and all their attached mechanism. The cross and vertical slides move together as a unit. The two cross handles shown just at the left of the worm gears on the cross rail control the rapid power movements for that mechanism. A friction slip, set up strong enough to carry the heaviest feeds that are met with, but having the tension adjusted well within the limit of strength of the mechanism, is provided for each of the various feed movements, so that no damage to the machine will result from the attempt to run the slides beyond the limit of their travel, or from running them together so that they strike. The quick acting mechanism, being driven from the first speed shaft, has a constant rate, and has no relation to the speed of the table.

Fig. 4 shows the construction of the various friction clutches used throughout the machine. A bent lever, as shown, is arranged to expand an internal ring against the inner rim of the driving gear. The long end of this lever bears on the top of a plunger, which passes through the supporting sleeve to the hole in its center. Through this central hole passes a rod, flatted on one side, and carrying a wedge adapted to raise the plunger and throw in the clutch when it comes opposite to it. A series of clutches with their levers and plungers may be mounted on the sleeve, and this wedge brought to act on any one of them. Owing to the fact that the clutch lever has some degree of flexibility, the clutch is practically self-adjusting; but if, after long usage, it should be necessary to take up the friction on account of the wear it has suffered, the small wedge shown at the fulcrum point may be set up. Provision is made in the speed box construction whereby the adjusting points may be brought in line with a removable cap, so that it is unnecessary to take the machine apart for this purpose.

Fig. 3 shows the machine set up for a turning and facing operation on a gear blank. Its likeness to the horizontal turret lathe is at once evident, the shape of the tool-holders and the arrangement of the main turret being identical, although the vertical form of the machine renders necessary a general change in the outward appearance of the machine. This vertical turret lathe has, in fact, at least one advantage over its horizontal competitor, in the simplicity of the tool equipment required, owing to the fact that the main turret head on the cross rail has a full universal movement, both

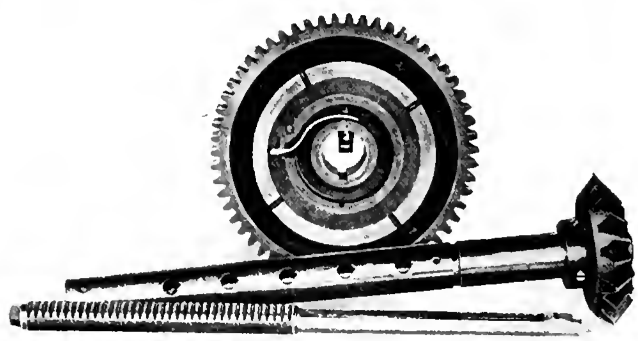


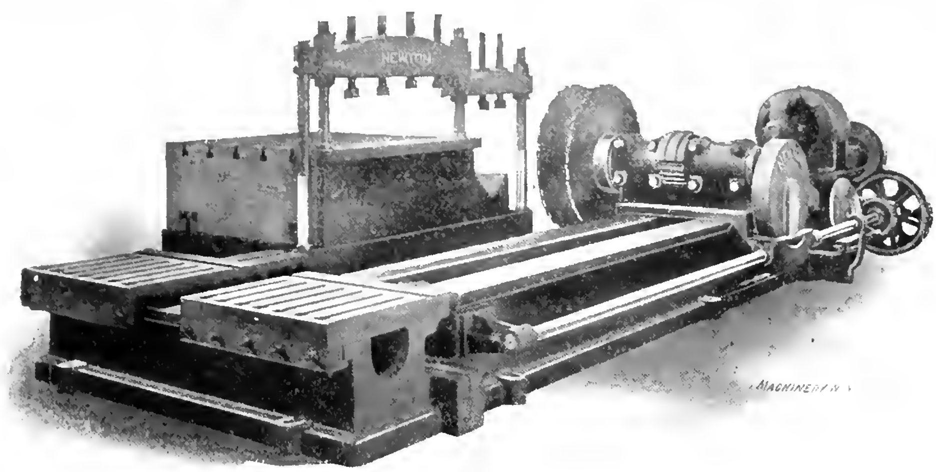
Fig. 4 Construction of Friction Clutch, generally used throughout the Machine.

vertical and horizontal, throughout the entire range of the machine, so that expensive overhanging cutters are unnecessary. This advantage is well illustrated in Fig. 3.

The machine has a capacity for work 36 inches in diameter and 24 inches in height. The face-plate, which is 34 inches in diameter, may be built plain with four independent jaws fitted to it; or, if desired, may be given the form of a three-jaw combination chuck or a four-jaw independent chuck. The main turret will face work 36 inches in diameter, and has a vertical movement of 26 inches. It may be swiveled to any angle up to 45 degrees, either side of the center. The turret is 12 inches in diameter, and bored for tool shanks $2\frac{1}{2}$ inches in diameter. The side head has a vertical movement of 28 inches, and a horizontal movement of 15 inches. $1 \times 1\frac{1}{4}$-inch tool steel may be used in the four-sided tool-holder. A thread cutting attachment for threads from 2 to 14 per inch may be furnished extra if desired, and can be applied at any time subsequent to the purchase of the machine. The net weight of the machine is about 11,300 pounds.

NEWTON DOUBLE COLD SAW CUTTING OFF MACHINE.

This tool, built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., is adapted to a wide range of work, owing to the construction of the work-holding tables and the provision made for carrying two saw blades when required. It was built for the Pennsylvania Railroad Co. for general locomotive work. In this service it may be used in cutting off round stock up to 11½ inches in diameter, for sawing off oblong sections up to 11½ x 38 inches long, or, with the double saws, for cutting out crank-shafts, connecting-rod ends, etc., to a depth of 11½ inches. Round stock is held in the V block shown at the further end of the work table. General cutting-off work may be done on the supplementary table, shown with the clamping device attached. When using the two saws for cutting out rectangular openings, the adjustable tables at the front end of the machine are used for holding the work. These may be set as close together as the width of the opening required will allow, so that the work is supported close up to the saws.



Cold Saw with Double Blades for Cutting Out Connecting-rod Ends, Etc.

The saw spindle is driven by spur gearing, from a phosphor bronze worm-wheel and a hardened steel worm of steep lead, enclosed and run in oil, and geared to a 15-horse-power motor mounted on the end of the base. The saw carriage has an automatic feed movement with power quick return, the feed variation being obtained from friction disks running at high speed.

In a test carried out in the shops of the builders, cuts to a depth of 12 inches were made in locomotive rod ends with the blades set 5¾ inches apart. The rods were 5 inches thick, and the time taken for each cut was 17 minutes. This record the customers have been able to maintain, resulting in a saving of about 50 per cent over the time required by former methods of working out the open ends.

DRILL SPEED AND FEED AND DECIMAL EQUIVALENT INDICATOR.

The Cleveland Twist Drill Co., Cleveland, Ohio, has designed the neat drill speed and feed, and decimal equivalent indicator

Fig. 1. Decimal Equivalent Indicator (one-half size).

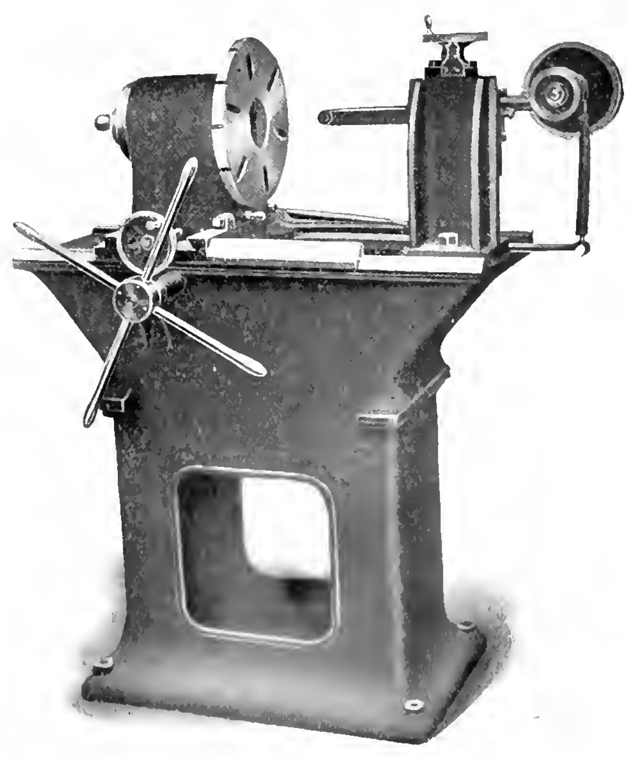
Fig. 2. Drill Speed and Feed Indicator (one-half size).

shown below. It consists of two celluloid disks pivoted on opposite sides of a third and larger celluloid disk. The outer disks are notched and the middle disk has concentric rows of numbers, as shown in the cuts. In the case of the drill speed and feed indicator, Fig. 2, the outer concentric row of numbers is the diameters of the drills. The second row, one number of which shows through the notch, is the proper speed in revolution per minute for carbon steel drills, and the inner row shows the revolutions per minute permissible with high-speed drills. Thus for a 2⅝-inch drill 43.7 revolutions per minute are indicated for carbon steel drills and 72.8 for high-speed steel drills. Good feed practice is stated in the paragraph on the face of the rotatable disk. The decimal equivalent indicator on the opposite side, Fig. 1, works on the same principle, the outer row of numbers being common fractions up to 1, varying by sixty-fourths, and the inner row the equivalents, to five places of decimals. The company will send these disks to all interested.

IMPROVED SQUARE HOLE GRINDING MACHINE.

In the February, 1907, issue of MACHINERY we published a description of a machine built by C. W. Burton, Griffiths & Co., Ludgate Square, Ludgate Hill, London, for grinding square, hexagonal and other flat-sided holes, such as are found in automobile work and other machinery. Ordinarily such holes are finished on the slotter or are broached. In automobile work, where parts subject to wear are generally hardened, the accuracy required necessitates finishing the surfaces of such small holes after hardening. The machine mentioned was designed to perform this difficult operation. The half-tone shows an improved design recently developed by the manufacturers, intended for general manufacturing.

The machine consists of a strong bed, provided with ways on which the work carrying carriage traverses by means of a rack and pinion operated by a hand-wheel. On cross ways on this carriage is mounted the work carrying head, which may thus be adjusted toward or



Machine for Grinding Internal Flat Surfaces

away from the center of the machine. The head is provided with a large hollow spindle for holding the work, and an index plate for setting the spindle for square, hexagonal and other shaped holes.

The grinding wheel is of the cup form, and is carried on a bar which projects from a vertically adjustable slide on the knee, shown at the right of the bed. It is driven by an endless round belt running along the bar, connecting the wheel with the small speed multiplying counter-shaft attached to the vertical slide. This counter-shaft is supported by a hinged arm with spring tension, so as to prevent the vibration in the driving belt from affecting the bar carrying the emery wheel —a condition which would impair the accuracy of the work if not allowed for. The vertical slide is elevated by a screw, having a hand-wheel graduated to read in thousandths of an inch. This movement provides for broad surfacing by raising and lowering the emery wheel, in addition to the traversing movement of the carriage, given by the pilot wheel. The feed movements are operated by hand.

WHITCOMB-BLAISDELL 20-INCH LATHE.

The Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., has recently placed on the market the 20-inch lathe shown in the accompanying half-tones. This lathe is intended to possess the required driving power at high speeds

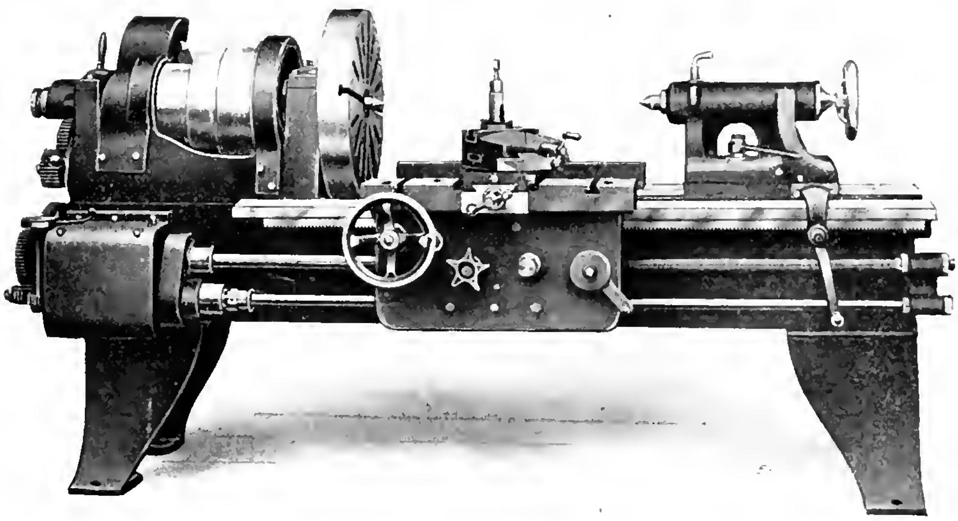


Fig. 1. Whitcomb-Blaisdell 20-inch Lathe.

for using modern tool steels, and at the same time to be easily handled in all its movements, so as to reduce to a minimum the time between cuts.

The bed of the lathe is substantial and well proportioned, being stiffly ribbed and of the box pattern type, with a broad top carrying ways of generous proportions. Fig. 3 shows the head-stock with the gear guards removed. A 3-step cone of large diameter and wide face is used. This, in conjunction with

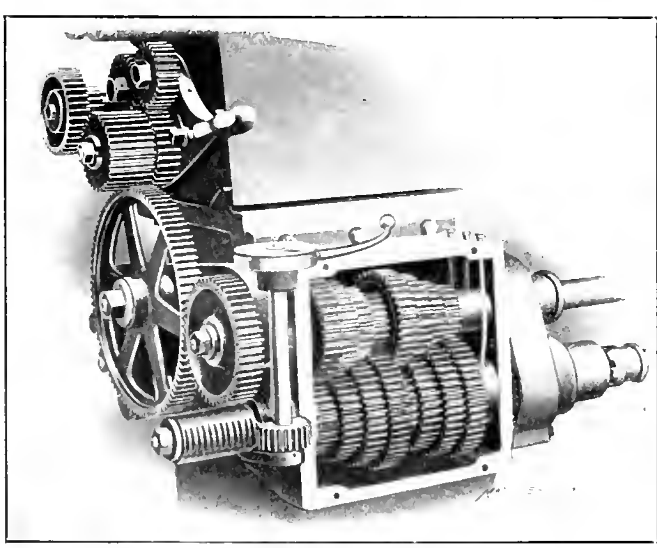


Fig. 2. Quick Change Gear Casing, with Mechanism Exposed, showing Pinion and Rack for Shifting the Key.

double back gearing, gives the lathe great power and wide range. Nine changes of speed are obtained, and the effective power developed at the different speeds is much more nearly equal than is the case when the same range is obtained with single back gearing and a cone having four or five steps.

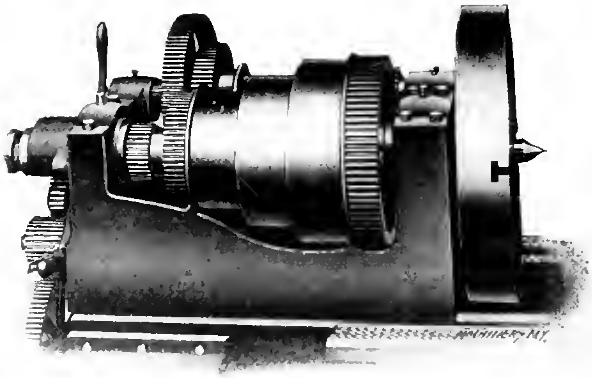


Fig. 3. Head-stock, with Guard Removed, showing Gearing.

The smallest diameter of the cone of this lathe is so proportioned as to give ample belt contact and speed. The spindle is of high carbon crucible steel with generous journals, running in bronze boxes.

A quick change device for feeds has been applied. This is best shown in Fig. 2. It is simple and durable in design, and well made. It consists, as shown, of two parallel shafts carrying eight gears each, meshing with each other. The gears on the lower shaft run freely on it, but may be connected to it by a sliding key, operated by the handle through the rack and pinion shown. This gives the operator command of eight geared feeds, or eight of the commonly used screw pitches. Then, by bringing into use a small compound gear permanently placed at the end of the head-stock, eight more feeds and screw pitches are obtained. All this is done without the removal of a gear. Three extra changes are provided, however, one of them solely for the purpose of permitting 11½ threads per inch to be cut, and the other two to double the range of both the feed and the screw pitch numbers.

The apron of this lathe is of substantial design and carries a feed mechanism of great strength and durability. The gears

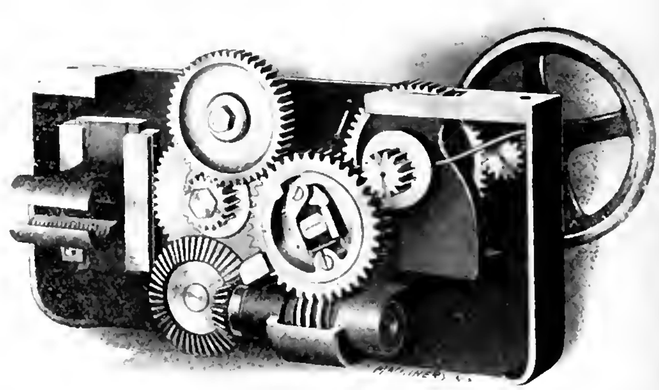


Fig. 4. Apron Mechanism of the Whitcomb-Blaisdell Lathe.

used have coarse pitch and wide face, and are strongly supported in the apron. The operating friction is powerful and simple, and may be adjusted from the outside of the apron to give a light or heavy carrying power, by simply turning a small exposed nut. Friction counter-shaft, large and small face-plates and the necessary wrenches are furnished with each lathe.

PEASE BLUE-PRINT CUTTING, TRIMMING AND SIZING TABLE.

The apparatus shown in the accompanying cut is made and sold by C. F. Pease Blue-print Machinery & Supply Company of 22 Fifth Avenue, Chicago. It is designed to facilitate the cutting to size of blue-prints, or of unexposed blue-print paper. The cutting or trimming table is constructed of hard wood with metal trimmings, and is so arranged as to be easily knocked down for shipment. The top of this table is covered with a sizing diagram, which gives at a glance the dimensions of the tracing or print being trimmed or cut, and the area in square feet, no calculation being necessary. The top of the table is 4 feet wide by 6 feet long. The cutting

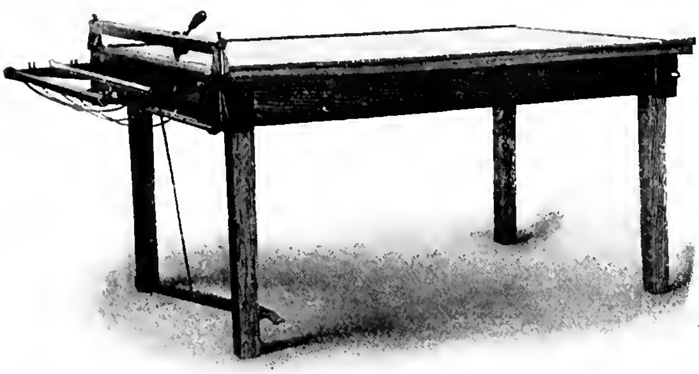


Table with Attachment for Sizing and Trimming Blue-prints.

and trimming device at the end is provided with a parallel clamp, operated by the treadle shown, which holds the paper or print securely while the knife is being used. The cutting knife is of the revolving type, rotating positively by mechanical means, not depending on the friction caused by the blade on the paper. Owing to this construction it will cut a narrow strip of the thinnest paper with rapidity and precision. The apparatus was designed especially for cutting up blue-prints exposed on the builders' continuous printing machine. It will cut accurately to a line, trimming the print perfectly at the same time it is cut from the roll.

* * *

It is reported that the White Star Line proposes to equip a passenger steamer on their Dominion Line with a combination of turbines and reciprocating engines. This steamer is to be built by Harland & Wolff. This combination has been advocated by Mr. Parsons for some time in the case of vessels of moderate or slow speed, from the point of fuel economy. It is proposed to use the turbines for the low-pressure expansion. A considerable gain in economy is expected with this arrangement, since the turbines are able to carry the expansion of steam economically to a degree far beyond that obtainable in the cylinder of the reciprocating engine. It will be necessary to provide for the use of condensers permitting a high vacuum. A gain of from 10 to 12 per cent is claimed in consequence. The proposal of Messrs. Harland & Wolff is to use two sets of quadruple expansion engines, each driving a screw propeller and placed in about the position they would occupy in a twin-screw steamer. Associated with them on a central shaft, a single turbine is to be used, driving a third propeller of a smaller diameter than the wing screws driven by reciprocating engines. This is only one of two or three arrangements which have been proposed, the problem being a more or less uncertain one as yet.

* * *

The machinists who hire out to go to the Panama Canal are required to provide the following extensive (?) list of tools: One pair each 8-inch inside and outside calipers; one 2-foot rule; 1 combination square; and one 4-inch or 6-inch steel scale. Car borers and axle turners are required to have one pair 8-inch inside calipers; one pair 8-inch outside calipers, and one 2-foot rule. Surely the eminent Isthmian Canal Commission should have included in the latter case that essential little tool required for making infallible press fits—the prick-punch.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE CONDITIONS.

Steady business seems to be the characteristic feature of British trade in general, the amounts and values dealt with in the returns tending to increase. For the month of July the value of British exports increased by $35,000,000 or 20 per cent as compared with the same period in 1906, and the imports increased by $16,500,000. For the seven months ending July, the increased value of exports was $163,665,000, and the imports $157,140,000. The total values of the exports and imports for the same period were $1,528,536,735 and $1,900,000,000, respectively. Simultaneously with these developments the prices obtainable for bonds and railway stocks of the best descriptions have steadily depreciated, a feature not confined to this country. The much better rate of interest now obtainable from many industrial investments is advanced as one reason for the decline, but the situation has not yet been convincingly accounted for.

Labor Conditions and Supply.

In labor matters a noticeable feature has been the number of minor strikes of comparatively isolated character and dealing with local issues. A local strike of shipbuilders at Newcastle, in which the men left work in an irregular manner, has resulted in the Employers' Federation taking advantage of the incident to threaten a lock-out on a large scale, until machinery has been set up to allow of negotiation proceeding in every case of dispute, without stoppages being occasioned. In Belfast, however, a strike of carters and dockyard laborers for an increase of wages with reduction of hours, and also for the recognition of the union officials as responsible negotiators on the men's behalf, developed in a serious manner. Disturbances and riots principally participated in, with no definite object, by outsiders, culminated in armed force having to be resorted to with some loss of life. Government action in the way of conciliation had to be undertaken and with the personal efforts of local priests and magistrates and prominent government officials, a provisional settlement was arrived at by which wages were increased and hours reduced but no present concessions granted as regards recognition of union officials. This latter point is, however, being brought into considerable prominence by railway employes who consider it of even more importance than immediate questions of wages and hours. Considerable pressure has recently been brought to bear, with some success, on non-unionists, particularly in the coal and cotton trades, to induce them to join the trade unions. Whether such action is inimical to general progress is open to discussion. In connection with the new Workmen's Compensation Act, recently brought into operation, which greatly increases the number of work people entitled to benefit in case of accident, the services of many elderly men have been dispensed with in view of their assumed greater liability to meet with accidents. It has been proposed to make the insuring of risks compulsory on the part of the employer, somewhat on lines now in vogue in Germany.

American concerns are often exercised as to the future supply of labor, but the offering of prizes at agricultural shows for the largest working families is a method most probably untried. Over here, in the almost purely agricultural county of Lincolnshire, the leading agricultural society annually offers prizes for the largest families who have been brought up and placed in agricultural service. The first prize this year was awarded for a family numbering nineteen children, of whom fourteen had been brought up and placed in work. The second prize went to a family which had numbered twenty-three, of whom seventeen had been brought up and twelve placed. President Roosevelt would scarcely recognize symptoms of race suicide in Lincolnshire.

New Discoveries of Coal and Iron.

Periodical scares arise as to the future supplies of coal and iron, pessimistic tendencies nearly always prevailing. However, at the present time new deposits of iron ore are reported in the north of Ireland, Staffordshire, Derbyshire, Cumberland, Lancashire, and Sussex. In the latter county

coal for smelting purposes is not at present available, the ore having to be shipped to the north for smelting, but boreholes are being sunk with some prospects of coal being found, and somewhat more optimistic views on the topic generally find expression.

Shipbuilding Developments.

Touching on shipbuilding matters, the trial performances of the *Lusitania* have evoked great interest, particularly the 48 hours run over a course of 300 miles under conditions representing average Atlantic conditions, when the contract speed of 24½ knots was exceeded by a margin of three-quarters of a knot. To the present time, its design, construction, launching and performances have been a continuous series of triumphs. In the naval section, the *Bellerophon*, recently launched at Portsmouth, less than eight mouths after the laying down of the keel, represents an increased displacement over the *Dreadnought* of about 700 tons. The length and beam of the new vessel are 496 feet and 82 feet, respectively. Turbine engines to develop 23,000 horse-power will be fitted, giving a speed of 20¾ knots. Her armament will include ten 12-inch guns, with four 7-inch guns for repelling torpedo attacks. The total cost will be about $10,000,000.

Harland & Wolff are understood to purpose utilizing a combination of reciprocating and turbine engines in a new Atlantic liner to be laid down, and the departure will be closely followed in view of the possibilities in the way of economies in steam consumption, increased maneuvering facilities and decreased first cost. In connection with the maintenance and deepening of the Mersey channel at Liverpool, three of the largest dredgers yet built are employed, but a still more powerful one is to be added, capable of lifting 1,000 tons of sand in 50 minutes from a maximum depth of 70 feet.

The proposal of the Canadian Government to construct a ship caual with a navigable depth of 24 feet, connecting the Great Lakes *via* the St. Lawrence and Montreal with Liverpool, and perhaps Manchester, by the establishment of a special line of steamers, will, if proceeded with, involve an expenditure of $100,000,000. The firm of C. H. Walker & Co., of London, who were the engineering contractors for the construction of the Manchester to Liverpool ship canal, is freely mentioned as likely to be instrumental in the carrying out of the work.

Olympia Machinery Exhibition.

The Engineering and Machine Tool Exhibition to be held at Olympia, London, during September and October is being participated in by a larger number of representative British tool makers than that of last year. One reason for the smaller representation then was the lack of tools to show, as deliveries were often many months behind. The leading tool merchants contrived to make a good show, Continental specialties being well in evidence, and generally the exhibition was so successful from a business standpoint that special efforts have this year been made to secure good locations and place the latest productions on view.

Machines for General Purposes in Demand.

Concurrently with the general appreciation and employment of special machine tools, particularly in the line of turret lathes and automatics, is to be noted a disposition to concede cheerful recognition of the possibilities of comparatively simple, but well made tools which combine ample power with some extra facilities for all-round work. This is particularly the case where, though a good aggregate of work is dealt with, the demand for any one article is somewhat irregular, and the ability to employ the machine regularly at a medium profit on any miscellaneous work is of greater importance than the possibilities of mass production, at very low labor costs, of an expensive machine which could only be intermittently employed. Of late years the Glasgow district has become more prominent in the line of machine tool manufacture.

For some time heavy machine tools have been produced in good quantity, chiefly in connection with shipbuilding and marine and locomotive engineering, but medium and light tools were not so systematically built and brought to the notice of users. The industry in these branches now seems likely to increase, the recent shortage of American tools having no doubt assisted in the upward movement.

Shanks & Co., Ltd., of Johnstone, in its more recent commercial literature enters more fully than is usually the case into the reasons for the distinctive features embodied in its designs.

Slotting and shaping machines appear to hold their own with increasing tenacity notwithstanding the competition of improved types of milling machines, and a statement of Messrs. Shanks on the rate of machining plane surfaces on a 20-inch stroke traverse head shaper is of interest, it being to the effect that 30 square inches per minute may be machined with heavy cuts.

New Grinding Machines.

Macdonald, Adamson, Swinburne & Co., Ltd., of Barrhead, near Glasgow, is one of the latest additions to British manufacturers of precision grinding machinery. Its universal machines are driven by motor or direct from the line shafts, no overhead gear being employed. The speeds of the headstocks, traverse, and emery wheel drives are all separately adjustable by the finest gradations, and controlled by individual lever in front of the machine. Another line taken up by the company is the manufacture of disk-grinding machines in a variety of designs and capacities. With regard to the employment of grinding machines in general, the necessity for frank collaboration between the builders and users of the machines and the makers of the abrading wheels, in the selection of suitable grades, etc., of wheels, and the methods adopted in their employment is much more generally assented to than formerly, an attitude conducive to even more striking and satisfactory results than has already attended this form of machining surfaces.

JAMES VOSE.

Manchester, England, August 24, 1907.

MISCELLANEOUS FOREIGN NOTES.

INTERNATIONAL EXHIBITION IN TOKIO.—The Japanese government has allowed $5,000,000 for an international exhibition to be held in Tokio next year. The total cost is estimated to be $10,000,000, half of which has already been subscribed for by private citizens. The exhibition will open on April 1 and will last until October 15, and it is intended to make it the greatest exhibit that has ever taken place outside of Europe and the United States.

ENCOURAGEMENT OF INDUSTRY IN MEXICO.—An agreement has been entered into between the Mexican government and some industrial promoters for the establishment within the territory of Mexico of a factory or factories for the manufacture of engines and motors. The capital invested in the business is to be exempt for a period of ten years from the date of the contract from all direct Federal taxes, with the exception of the stamp tax. All the necessary material and machinery may be imported free of duty.

SPECIALIZED GERMAN EXHIBITIONS.—We mentioned in our September issue the tendency in Germany to discourage world's fairs, and instead favor small exhibitions of certain branches of industries. A general exhibition of inventions for use in the minor industries has been in progress in Berlin this summer. It was held as a preliminary to a larger exhibition to be held later in the same city, and for the purpose of stimulating invention and "enlarging and multiplying the points of contact between inventor and capitalist, designer and manufacturer, producer and customer."

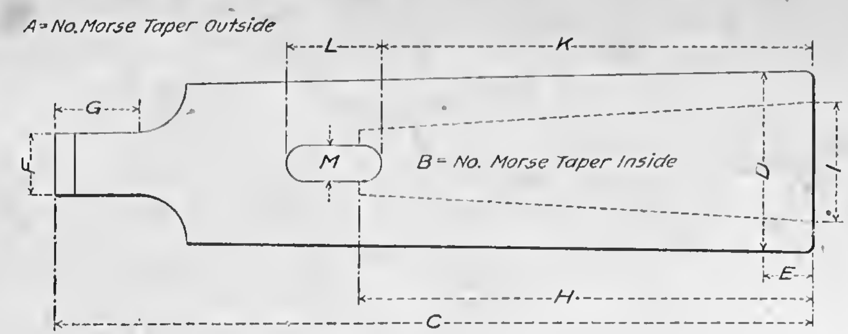
PROGRESS IN THE AUTOMOBILE BUSINESS IN GERMANY.—The automobile business in Germany seems to be not only in a flourishing state as far as production is concerned, but to be a well-paying business as well. The well-known German automobile firm, Benz & Co., reports for 1906 earnings amounting to nearly $300,000, and declares a dividend of 15 per cent. In 1905 the firm paid 7 per cent. In view of the recent failures of some American automobile concerns, these results are the more remarkable. It is likely, however, that the German firm has not capitalized "good will" at quite as high a figure as have some of our concerns.

Contributions and data suitable for publication in these Data Sheets

PUNCH

CREASE HERE

MORSE TAPER SOCKETS.



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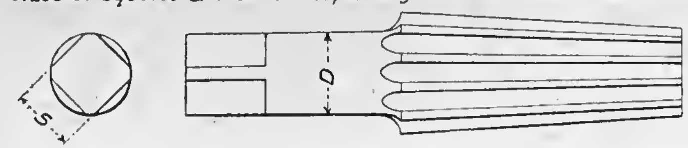
SQUARES ON SHANKS OF REAMERS AND TAPS.

Sizes of Squares of Tools Corresponding to certain Shank Diameters



Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square	Diam. of Shank	Square
D	S	D	S	D	S	D	S	D	S	D	S	D	S
1/16	3/64	27/64	5/16	25/32	19/32	1 9/64	55/64	1 1/2	1 1/8	2 7/32	1 43/64	2 15/16	2 13/64
5/64	1/16	7/16	21/64	51/64	19/32	1 5/32	7/8	1 17/32	1 5/32	2 1/4	1 11/16	2 31/32	2 15/64
3/32	5/64	29/64	11/32	13/16	39/64	1 11/64	7/8	1 9/16	1 11/64	2 9/32	1 23/32	3	2 1/4
7/64	5/64	15/32	23/64	53/64	5/8	1 3/16	57/64	1 19/32	1 13/64	2 5/16	1 47/64	3 1/32	2 9/32
1/8	3/32	31/64	23/64	27/32	41/64	1 13/64	29/32	1 5/8	1 7/32	2 11/32	1 49/64	3 1/16	2 19/64
9/64	7/64	1/2	3/8	55/64	41/64	1 7/32	59/64	1 21/32	1 1/4	2 3/8	1 25/32	3 3/32	2 21/64
5/32	1/8	33/64	25/64	7/8	21/32	1 15/64	59/64	1 11/16	1 17/64	2 13/32	1 13/16	3 1/8	2 11/32
11/64	1/8	17/32	13/32	57/64	43/64	1 1/4	15/16	1 23/32	1 19/64	2 7/16	1 53/64	3 5/32	2 3/8
3/16	9/64	35/64	13/32	29/32	11/16	1 17/64	61/64	1 3/4	1 5/16	2 15/32	1 55/64	3 3/16	2 25/64
13/64	5/32	9/16	27/64	59/64	11/16	1 9/32	31/32	1 25/32	1 11/32	2 1/2	1 7/8	3 7/32	2 27/64
7/32	11/64	37/64	7/16	15/16	45/64	1 19/64	31/32	1 13/16	1 23/64	2 17/32	1 29/32	3 1/4	2 7/16
15/64	11/64	19/32	29/64	61/64	23/32	1 5/16	63/64	1 27/32	1 25/64	2 9/16	1 59/64	3 5/16	2 31/64
1/4	3/16	39/64	29/64	31/32	47/64	1 21/64	1	1 7/8	1 13/32	2 19/32	1 61/64	3 3/8	2 17/32
17/64	13/64	5/8	15/32	63/64	47/64	1 11/32	1 1/64	1 29/32	1 7/16	2 5/8	1 31/32	3 7/16	2 37/64
9/32	7/32	41/64	31/64	1	3/4	1 23/64	1 1/64	1 15/16	1 29/64	2 21/32	2	3 1/2	2 5/8
19/64	7/32	21/32	1/2	1 1/64	49/64	1 3/8	1 1/32	1 31/32	1 31/64	2 11/16	2 1/64	3 9/16	2 43/64
5/16	15/64	43/64	1/2	1 1/32	25/32	1 25/64	1 3/64	2	1 1/2	2 23/32	2 3/64	3 5/8	2 23/32
21/64	1/4	11/16	33/64	1 3/64	25/32	1 13/32	1 1/16	2 1/32	1 17/32	2 3/4	2 1/16	3 11/16	2 49/64
11/32	17/64	45/64	17/32	1 1/16	51/64	1 27/64	1 1/16	2 1/16	1 35/64	2 25/32	2 3/32	3 3/4	2 13/16
23/64	17/64	23/32	35/64	1 5/64	13/16	1 7/16	1 5/64	2 3/32	1 37/64	2 13/16	2 7/64	3 13/16	2 55/64
3/8	9/32	47/64	35/64	1 3/32	53/64	1 29/64	1 3/32	2 1/8	1 19/32	2 27/32	2 9/64	3 7/8	2 29/32
25/64	19/64	3/4	9/16	1 7/64	53/64	1 15/32	1 7/64	2 5/32	1 5/8	2 7/8	2 5/32	3 15/16	2 61/64
13/32	5/16	49/64	37/64	1 1/8	27/32	1 31/64	1 7/64	2 3/16	1 41/64	2 29/32	2 3/16	4	3

ATA SHEET.

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This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

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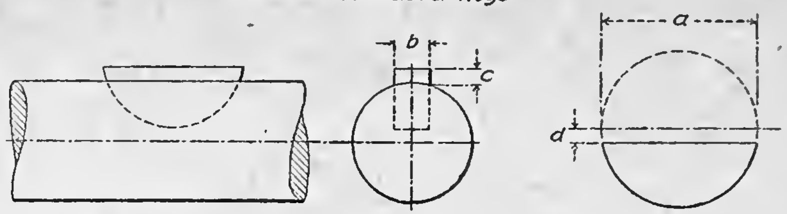
WOODRUFF KEYS.—I.

Woodruff Standard Keys



No. of Key	Diam. of Key	Thickness of Key	Depth of Keyway	Center of stock, from which key is made, to top of key	No of Key	Diam. of Key	Thickness of Key	Depth of Keyway	Center of stock, from which key is made, to top of key
	a	b	c	d		a	b	c	d
1	1/2	1/16	1/32	3/64	B	1	5/16	5/32	1/16
2	1/2	3/32	3/64	3/64	16	1 1/8	3/16	3/32	5/64
3	1/2	1/8	1/16	3/64	17	1 1/8	7/32	7/64	5/64
4	5/8	3/32	3/64	1/16	18	1 1/8	1/4	1/8	5/64
5	5/8	1/8	1/16	1/16	C	1 1/8	5/16	5/32	5/64
6	5/8	5/32	5/64	1/16	19	1 1/4	3/16	3/32	5/64
7	3/4	1/8	1/16	1/16	20	1 1/4	7/32	7/64	5/64
8	3/4	5/32	5/64	1/16	21	1 1/4	1/4	1/8	5/64
9	3/4	3/16	3/32	1/16	D	1 1/4	5/16	5/32	5/64
10	7/8	5/32	5/64	1/16	E	1 1/4	3/8	3/16	5/64
11	7/8	3/16	3/32	1/16	22	1 3/8	1/4	1/8	3/32
12	7/8	7/32	7/64	1/16	23	1 3/8	5/16	5/32	3/32
A	7/8	1/4	1/8	1/16	F	1 3/8	3/8	3/16	3/32
13	1	3/16	3/32	1/16	24	1 1/2	1/4	1/8	7/64
14	1	7/32	7/64	1/16	25	1 1/2	5/16	5/32	7/64
15	1	1/4	1/8	1/16	G	1 1/2	3/8	3/16	7/64

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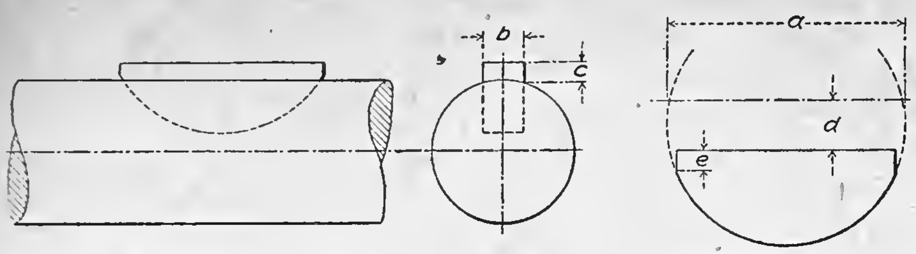
WOODRUFF KEYS.—II.

Woodruff Special Keys



No. of Key	Diam. of Key	Thickness of Key	Depth of Keyway	Center of stock, from which key is made to top of key	Width of Flat	No. of Key	Diam. of Key	Thickness of Key	Depth of Keyway	Center of stock, from which key is made, to top of key	Width of Flat
	a	b	c	d	e		a	b	c	d	e
26	2 1/8	3/16	3/32	17/32	3/32	31	3 1/2	7/16	7/32	13/16	3/16
27	2 1/8	1/4	1/8	17/32	3/32	32	3 1/2	1/2	1/4	13/16	3/16
28	2 1/8	5/16	5/32	17/32	3/32	33	3 1/2	9/16	9/32	13/16	3/16
29	2 1/8	3/8	3/16	17/32	3/32	34	3 1/2	5/8	5/16	13/16	3/16
30	3 1/2	3/8	3/16	13/16	3/16						

Standard Keys to use with various diameter shafts

Diameter of Shaft	Number of Keys	Diameter of Shaft	Number of Keys	Diameter of Shaft	Number of Keys
5/16 – 3/8	1	7/8 – 15/16	6, 8, 10	1 3/8 – 1 7/16	14, 17, 20
7/16 – 1/2	2, 4	1	9, 11, 13	1 1/2 – 1 5/8	15, 18, 21, 24
9/16 – 5/8	3, 5	1 1/16 – 1 1/8	9, 11, 13, 16	1 11/16 – 1 3/4	18, 21, 24
11/16 – 3/4	3, 5, 7	1 3/16	11, 13, 16	1 13/16 – 2	23, 25
13/16	6, 8	1 1/4 – 1 5/16	12, 14, 17, 20	2 1/16 – 2 1/2	25

MACHINERY.

November, 1907.

A RECORD-BREAKING ARMOR-PLATE VAULT.

PROBABLY most of our readers would be at a loss to guess, off hand, the purpose of the enormous steel plate structure shown in Fig. 1, were the caption of the cut not there to explain it. The building of armor-plate vaults is a comparatively new development, having sprung up in the past eight or nine years. The one whose making and construction we are to describe is so much larger than anything else of its kind, that an uninitiated mechanic would be justified in being perplexed to state the use to which it is to be put. This vault was built by the Bethlehem Steel Works, of Bethlehem, Pa., in whose shop the photographs from which the accompanying half-tones were made, were taken.

General Description of the Vault.

This armor-plate vault is a sort of glorified safe, to be filled with strong boxes which are to be rented to the customers of the Carnegie Safe Deposit Co., in the new United States Realty Building, corner of Cedar street and Broadway, New York City. The advantage claimed for the armor plate vault over all other types of construction is that it is fire, burglar, mob and earthquake proof. This one is built in two stories (as shown in the line cut Fig. 2), with a connecting passage between them carrying a stairway and a passenger elevator. The lower story is 9½ feet high, 106½ feet long, and 30½ feet wide. The whole structure weighs about 1,200 tons. It is provided with an "emergency door" in the right hand corner of the foreground of Fig. 1. The upper floor is 82 feet long, 9 feet high, and 19 feet wide, provided with two doors for regular service, one at either end.

The upper vault, in particular, is to be equipped on a scale of magnificence exceeding anything of the kind previously installed. The whole room is to be finished in solid bronze, with all the fittings of the same material. It will be seen in Figs. 1 and 2 that the vault is so large that it overflows the unobstructed floor of the sub-basement, and includes two rows of the columns of the building within its area. To take care of these, several openings, entirely cased in, are made through the vault from top to bottom.

Besides being remarkable in its general features, this vault is unusually interesting in its design and construction. As stated, it is intended to be fire, burglar, mob and earthquake proof. Danger from fire is obviated by the heavy 16-inch coating of concrete and fire-proofing material which surrounds the top, bottom and sides. The burglar's chances for success are small, as the walls of the vault are made of 4 inch Harveyized steel armor-plate, of the same kind as furnished the government for war vessels. Not only would the burglar have to perform the task of getting through this case-hardened surface, but to even reach the armor-plate he would have the reinforced concrete to reckon with. As may be seen from the cut, the vault is made of separate steel plates, with numerous joints; but these are all dove-tailed together and held in such a way as to make their separation impossible from the outside, and the fitting is so finely done that the joints are impervious to nitroglycerine.

Barring those for the doors, the armor plate walls are free from openings of any kind, which a burglar might use in be-

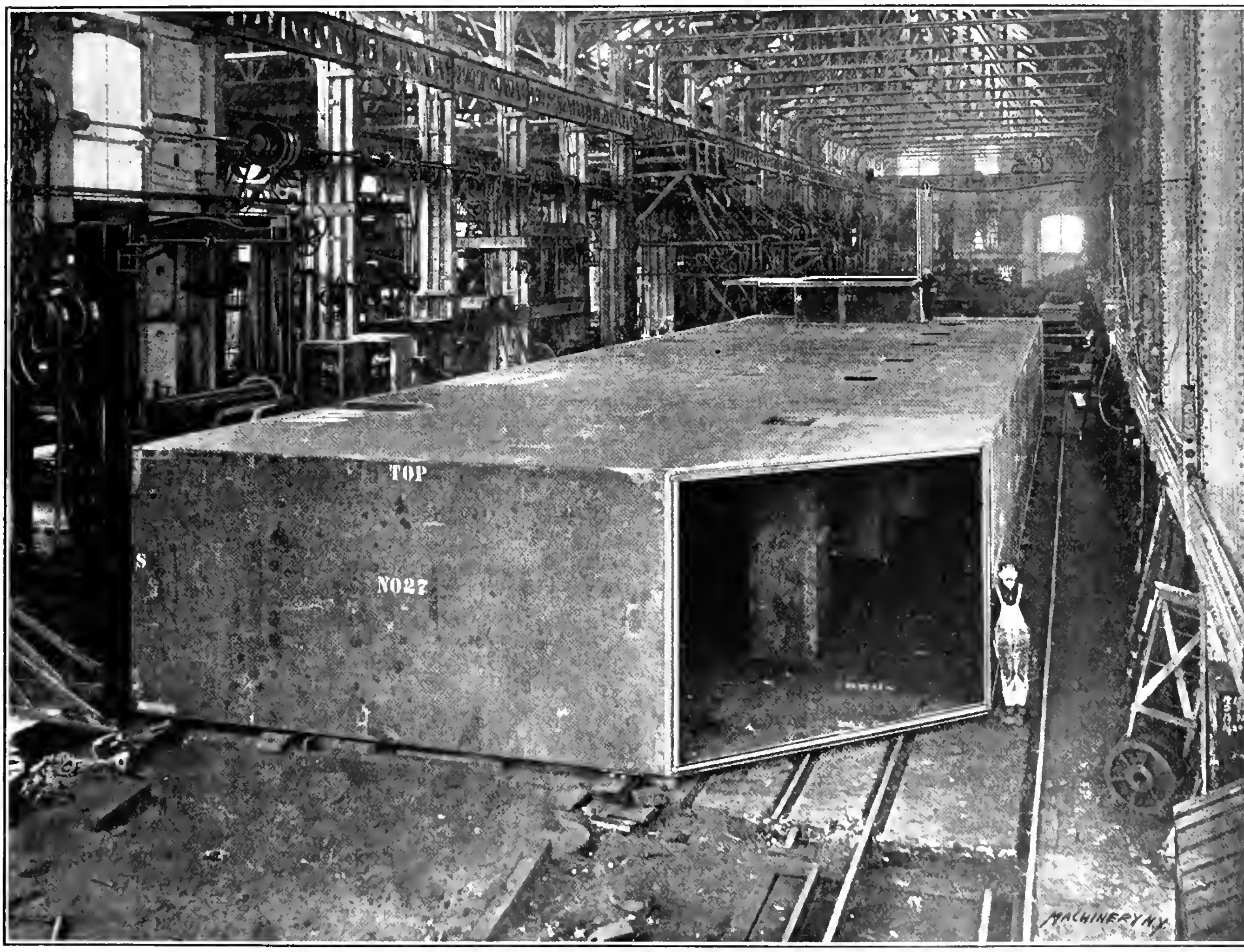


Fig. 1. Lower Story of Vault, on Erecting Floor of the Armor Plate Shop of the Bethlehem Steel Works

ginning his vault-breaking operation. There are no holes through the doors for the locking mechanism. The automatic time lock is the sole means of opening the vault, once it has been locked. For each of the three doors there are four clocks, making twelve in all. All twelve of these would have to fail simultaneously to make an accidental permanent locking possible. The clocks are set for the hour of opening on the next day, or any succeeding day, and the vault doors are closed. When the hour arrives, the clocks automatically throw the bolt-operating mechanism into action and the doors are released, so that they can be opened from the outside. No combination of any kind is used for these main doors.

As to the matter of protection against mobs (a contingency which seems almost too distant a thing to be reckoned with) the vault is safe from a 3-inch projectile, even without reckoning with the outer protection of reinforced concrete. It is not believed that a gun of a larger caliber than this could be handled by a mob. The vault is made strong and stiff enough to support the wreckage of the building, supposing the latter were thrown upon it by an earthquake or other disaster. In fact, it would seem as if valuables intrusted to this remarkable structure would be reasonably safe.

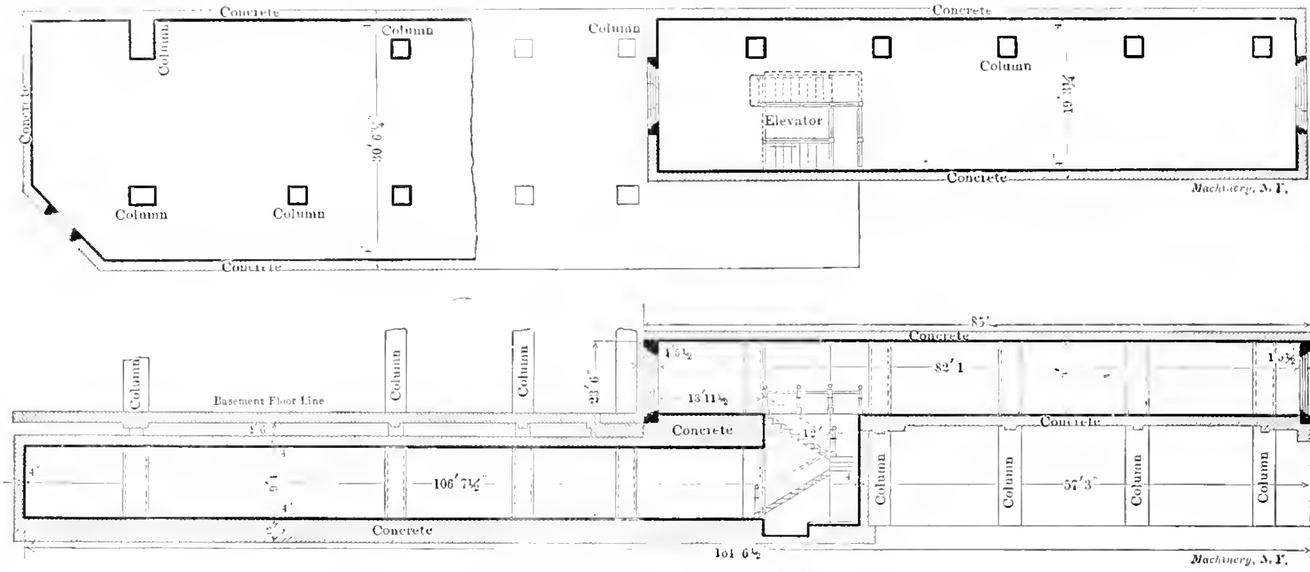


Fig. 2. Plan and Section of Vault, giving Dimensions.

Design and Construction.

It is in the mechanical design and construction of this vault, however, that we are principally interested. It is built in sections of Harveyized armor-plate, 4 inches thick, the sections being dove-tailed and wedged together from the inside in such a way as to be impregnable from the exterior. Details of the joints are shown in Fig. 3. As shown, the side plates have a dove-tail which fits into a groove in the edge of the bottom plates. A key, driven into this groove after the side plate is inserted, forces it tightly into position and makes its removal impossible without first removing the key. In a somewhat similar manner the side plates are dove-tailed and fitted into corresponding grooves in the top plate. Here, however, the keys are driven upward into the space made for them on the tapered side of the joint, and when in place are locked there by a filling piece, which is inserted and screwed into position. The top plates are joined to each other by rabbeted joints as shown, held together by bolts from the inside. These bolts are tapped into blind holes, so that there is comparatively little difficulty in doing the drilling and tapping needed for them from the inside, in the soft part of the metal. The side plates are similarly spliced together.

The fine work on this vault, so far as workmanship is concerned, is in the making of these numerous joints nitroglycerine tight. To accomplish this, the joints must fit within 0.001 inch or less. The vault must, of course, be erected on a firm foundation, allowing no deflection, to make this fine fitting possible. This was satisfactorily done on the erecting floor of the shop, and as that provided for it in its final resting place is of much more rigid and permanent construction, there will be no difficulty on this score. It is when one comes to think of the score of joints in the structure, and the large size of the parts of which it is built, that the problem of making these joints tight is seen to be a serious one. This is further complicated by the heat treatment of the plates by which their faces are hardened. This is essentially a case-hardening process, and being such, it involves the distortion consequent on all such operations. A few words explaining the procedure in machining and hardening these plates will serve to show how the difficulty is overcome.

Forging, Machining and Hardening the Plates.

As received from the forging department, the plates are formed to the desired thickness and area. Their edges are finished on heavy rotary planers to the required dimensions. The material is a nickel steel of great toughness and hardness, so that the cutting speeds by necessity must be very slow. The machinery used, however, is rugged enough so that heavy chips are taken. After the finishing of the edges, the plates have the dove-tail grooves and rabbets formed in them

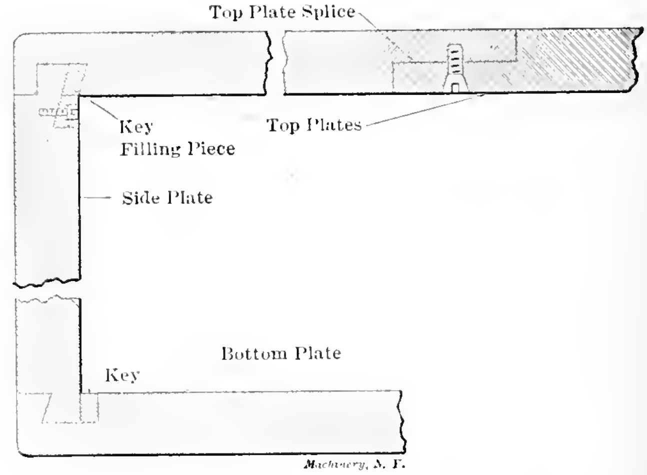


Fig. 3. Details of Joints used for Fastening the Sections Together.

on the planer. These surfaces forming the joints are not finished quite down to size, although every care is taken to have them square with each other, and of the proper dimensions. The plates are now taken to the hardening furnace. Owing to the great depth of hardening or "Harveyizing," the operation is a matter of many days, though it is very similar in principle to the shorter process used on small work.

After this heat treatment comes the straightening needed to return the finished surfaces to their original alignment. This is done under a heavy hydraulic press, the plate being slightly heated for this purpose, just enough to facilitate the bending without altering to the slightest degree the hardness

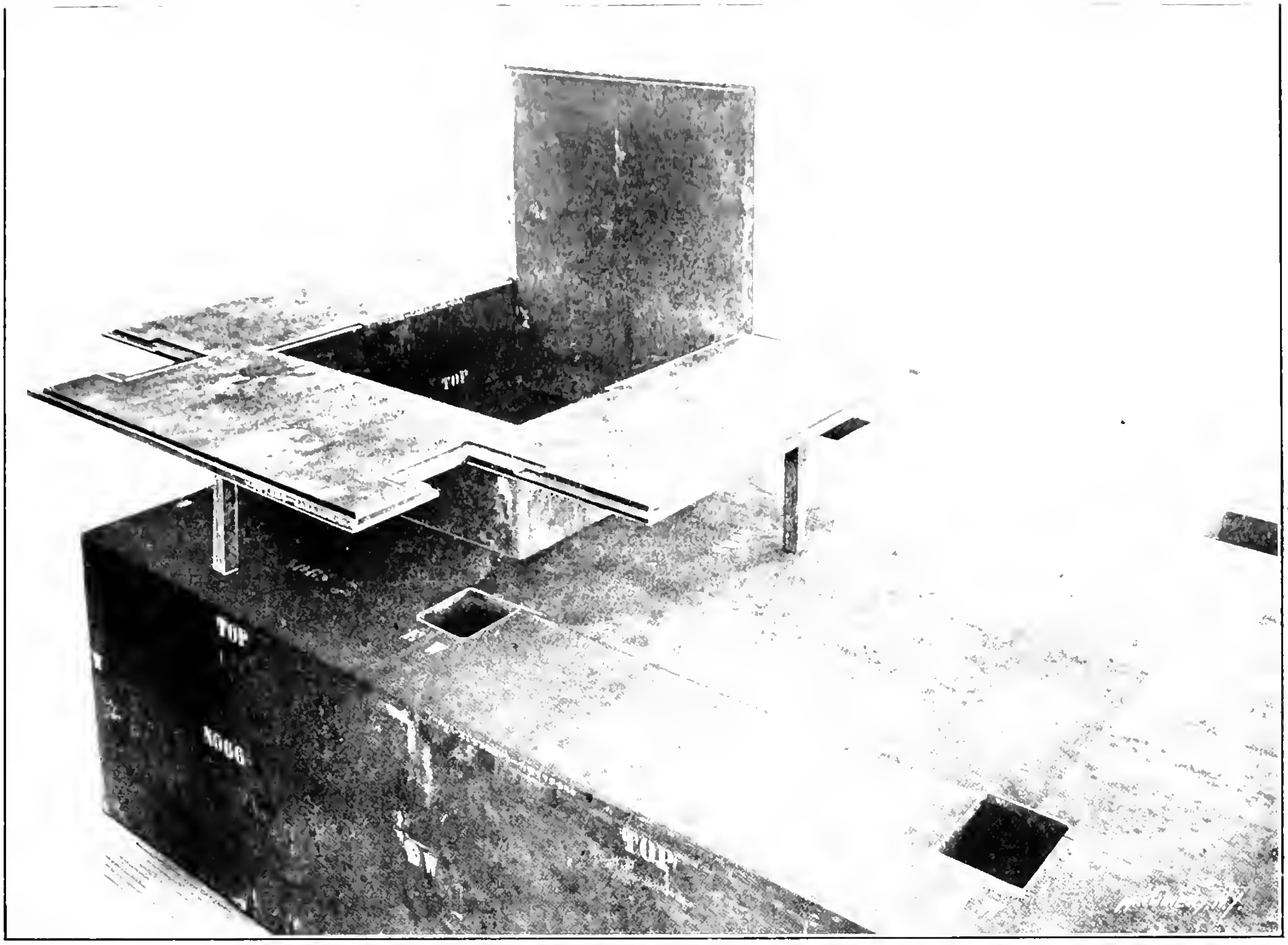


Fig. 4. Elevator and Stairway Well, Partly Assembled; note the Complicated Machine Work at the Joints.

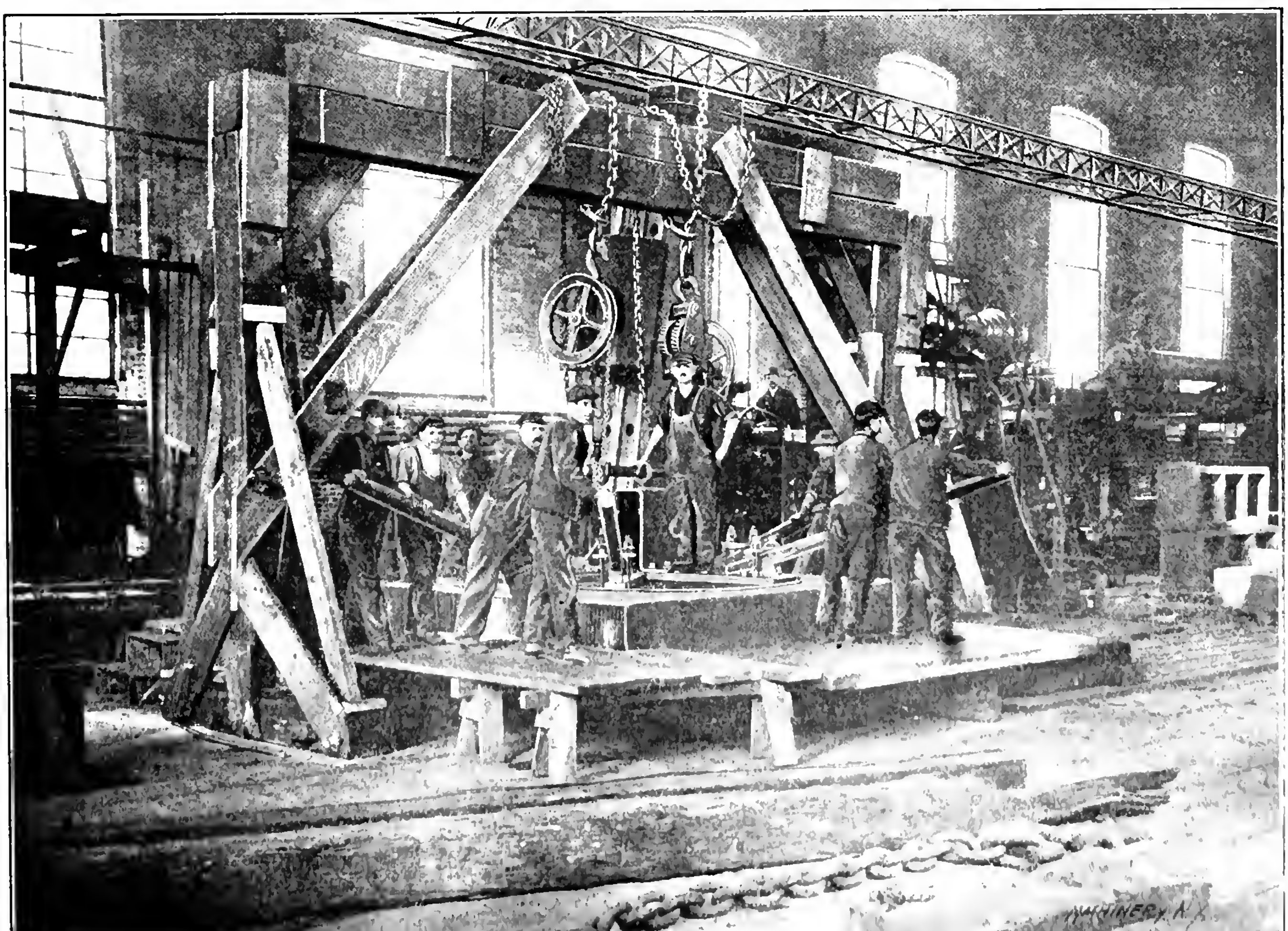


Fig. 5. Grinding in the Door into the Door Plate; a Case of Valve Grinding on a Large Scale.

which has been given to the face. The final operation on the finished surface is one of surface grinding, performed on the machine shown in Figs. 6 and 7. As shown, the spindle of this machine is carried by a traveling head and is driven by a flying belt arrangement. The plate is aligned on the supports provided for it, where it remains stationary, all the movements for traverse and feed required being given to the wheel. All of the surfaces forming the joint are thus finished. As to the matter of giving these joints the accurate

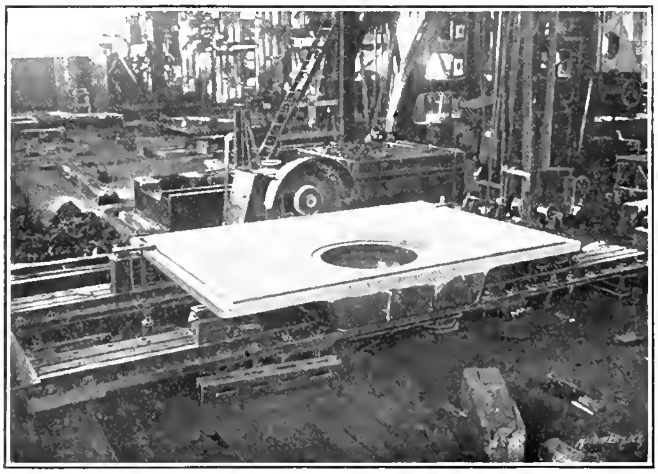


Fig. 6. Finishing Grinding the Joints after Hardening.

dimensions required for making the whole structure as tightly fitting as it has to be, no more can be said than that a high degree of skill is called for. The simplicity of this statement, however, does not detract from the unusualness of the feat. Nothing except the ordinary tools of the machinist for such work are needed or used.

Making the Door Plates and Doors.

The heaviest pieces in the vault are the sections in which the doors are formed. That for the emergency door, filling in the corner shown in Fig. 1, is in place on the grinding machine in Figs. 6 and 7. This small door is not used for regular service, but only in case the eight clocks of the two main doors fail to operate for some reason or other. The forgings of which these door plates are formed are unusual

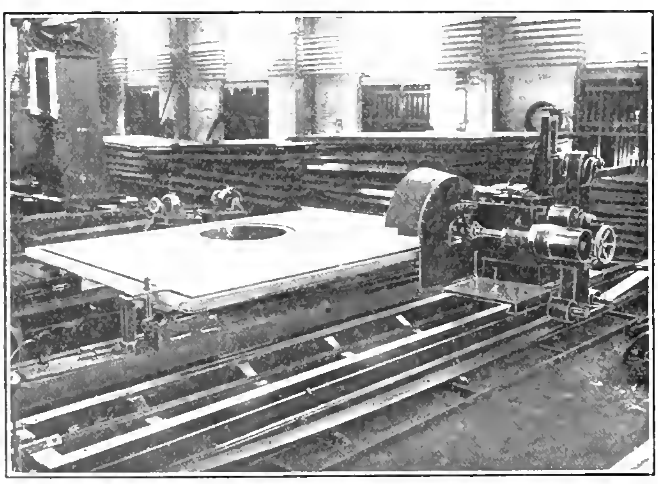


Fig. 7. Rear View of Grinder, showing Flying Belt Drive.

pieces of work, owing to their great size and somewhat complicated form. They are formed under the hydraulic press, no hammering operations being used. It might be mentioned that the joint by which this emergency door plate is fitted to the main structure is especially remarkable, being formed as it is of dove-tails on all four sides, and being on an angle cut out from the corner of the vault. Another splendid piece of dove-tailing was done in providing for one of the columns of the building which enters a recess in the further side of the vault near the front end, as shown in Figs. 1 and 2. This recess is seen directly over the word "Top" on the front plate, Fig. 1. This recess has all its joints dove-tailed, and it was something of a Chinese puzzle to design it so it could be removable at all, and still be secure from tampering from the outside.

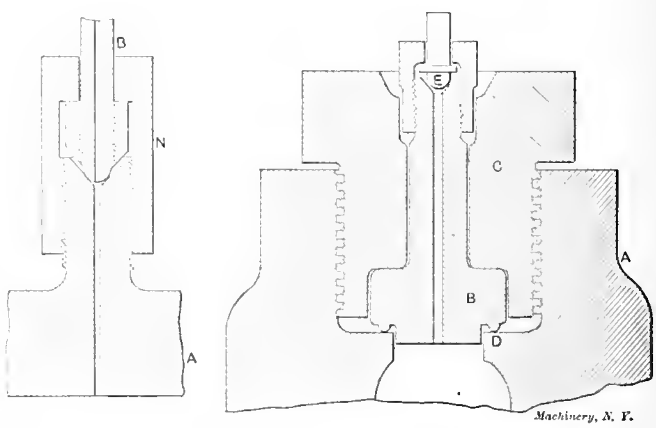
The forgings carrying the main doors are heavier than that of the emergency door. One of these is seen in Fig. 5, supported on blocking and having its door ground into it. This is a rather remarkable operation. It is essentially the operation of valve grinding, with which every automobile owner is familiar on a small scale. In this case, however, it requires twelve husky helpers to rotate the "valve," and even then it is only made possible by having the door suspended from the two chain blocks shown, so that only a portion of the weight bears on the seat. This work is done in the ordinary way with emery and water. The plate and its door were machined on the boring mill, then hardened, and finally finished by this grinding process. The door weighs about 18,000 pounds.

The operations involved in forming the armor-plate sections of which this vault is built, are interesting. They are essentially the same as those used in forming the plating used for warships. We hope to be able to describe something of this work in a forthcoming issue of MACHINERY.

* * *

CONNECTIONS FOR HIGH PRESSURES.

While the methods used in the design and construction of ordinary hydraulic machinery are well known to persons having to do with this kind of work, it may still be in place to refer to the common design used when encountering high pressures for relieving the threaded portions of a design from the direct pressure of the water. The cuts shown herewith are taken from an article in the July 26 issue of *Engineering*. These designs are particularly intended for pressures above 10,000 pounds per square inch. In Fig. 1 is shown a detail of a connection between a steel tube and



Figs. 1 and 2. Connections for High Pressures.

cylinder. The tube is solid drawn steel tubing, 1/16 inch bore and ½ inch outside diameter, and the actual joint is made directly between the tube and the fitting, as shown in the cut. In this cut *A* represents a portion of a high pressure cylinder, *B* is the steel tube mentioned, and *N* is the nut which presses down the spherical end of the steel tube against *A*, thus forming the joint. Steel tubes jointed in this way have been found to give satisfactory results at pressures up to 45,000 pounds per square inch. Small openings, say up to ¼ inch in diameter, may be closed up in the manner shown in Fig. 1, but for larger apertures, say up to 1½ inch in diameter, a steel plug of the form shown in Fig. 2 is used. This design is of a cover for closing up against pressures up to 40,000 pounds per square inch. In this *A* represents the body of the high pressure cylinder. The cover *B* carries a ring *D* which presses against the flat portion of *A*, thus making a tight joint. The central part of the cover *B* projects slightly beyond the ring *D*, thus protecting it from injury in handling. The screw *C* simply serves the purpose of holding down the cover *B* against the body *A*. At *E* is shown a joint of the same class as that shown in Fig. 1.

* * *

It is stated in *Revue Universelle des Mines* that in Germany 29 per cent of all the blast furnace gas is utilized for power purposes.

FAULTS OF IRON CASTINGS.—2.

POINTS FOR THE MACHINE DESIGNER.

FORREST E. CARDULLO.

Sponginess.

A second fault to which iron castings are subject is that of sponginess. Sponginess is due to the formation of gas bubbles in the iron, at the instant of solidification. In all ordinary cases this is due to an improper mixture of iron. However, if the casting is very thick at one place, and thin at most others, it will be impossible to obtain a mixture which will have satisfactory properties for general work, and not be spongy at points of extraordinary thickness. It is an excellent rule to allow no part of a casting to be at a greater distance from a sand surface than 2½ inches. In case this rule is strictly adhered to, and the castings are of fairly uniform thickness, no trouble will be experienced from sponginess, except from the use of poor iron. When, however, we are obliged to concentrate a considerable quantity of metal at one place, and give it a greater thickness than 5 or 6 inches, either we must take care that it will be at some point where the sponginess will do no harm, or else we must make provision to do away with it.

The only practical method for doing this is to place a riser immediately over the heavy spot. When the metal is poured, and the riser is full, a rod of wrought iron is inserted and worked up and down until the metal has almost solidified. By so doing, the bubbles have a better chance to escape, and the iron is left perfectly solid. Of course, it is not possible to use a riser effectively in this manner, unless it can be placed directly over the heavy spot. A riser at a point a few inches distant is useless. The use of a riser in this way, and for this purpose, is unnecessary when the part of the casting in which the heavy spot occurs is subject to no particular stress, or is not required to be tight under pressure, but nevertheless, a spongy spot is a defect in a casting, which should, if possible, be avoided.

Shrink-holes.

A third fault to which iron castings are subject is that of shrink-holes. A shrink-hole is a cavity in a casting, caused by the shrinking away of the metal in cooling. Like sponginess, this defect is especially likely to occur in those parts of a casting which are excessively thick. To avoid this fault, it is best to avoid sudden changes in the thickness of a section. If the part of a casting which is unusually thick does not have to be machined, the difficulty may be overcome by placing in the mold at that point a piece of iron, so that the casting will be caused to solidify at that point first, on account of the chilling effect of the cold iron. If, however, the heavy spot in the casting has to be machined, or if it is subject to heavy stress, this method of preventing shrink-holes is to be avoided, since the chilling of the iron makes it so hard as to be impossible to cut with a tool, and at the same time creates stresses within the metal which weaken it. In such a case, shrink-holes are best prevented in the same manner as has already been described for the prevention of sponginess, namely the use of a heavy riser, and the working of the iron with a rod when it is cooling.

The designer must therefore avoid heavy spots in castings, whenever possible, for the reason that they are likely to produce two serious faults, sponginess, and shrink-holes. He must avoid them especially in those parts of castings which are to be machined or which are subject to heavy stresses. If they cannot be avoided entirely, in such a case, they should be so arranged that risers may be placed immediately over them, so that a rod may be inserted into the riser, and into the heart of the spot where the metal is thickest.

Scabbiness.

A fourth fault often encountered in iron castings is that of scabbiness. Although iron in the molten condition does not permeate the sand of the mold, as water would if it were poured in, nevertheless, on account of the great weight of the fluid, it has a considerable erosive action on the materials of the mold. If, as it flows into the mold, the iron eats away fillets or partitions, or scours away patches of sand, it is obvious that the casting will not be of the proper form, but will have its angles partly filled up, and unsightly protuberances upon its surfaces. Such imperfections as these are known as scabs. The sand so washed from its proper place may float on the iron, and rise to the top of the mold, where it forms a dirty mixture, which, when cleaned away, leaves a rough depression in the surface of the casting, also known as a scab.

The remedy for this trouble is to avoid as far as possible sharp fillets, and thin tongues of sand, projecting into the mold, and to so gate the casting that the current of iron, as it enters the mold, will spread itself out, and not concentrate itself in any particular direction, for if it does, it will eat away the part against which it flows, just as quickly and surely as would a current of water. In general, proper gating is a

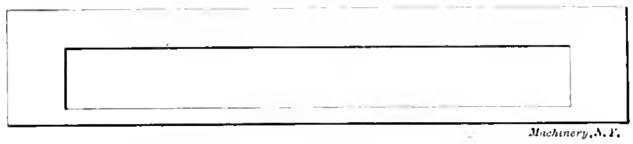


Fig. 1. Casting of such Shape as to be Subjected to Severe Internal Stresses.

matter which must be attended to by the molder, but if the designer has arranged things so that proper gating is inconvenient or impossible, the castings will almost surely be scabby.

Sand-holes.

The fifth fault to which iron castings are subject, namely sand-holes, is one which is almost invariably associated with that of scabbiness. If the sand which has been eroded by the entering current of iron does not rise immediately to the surface, the iron may partially solidify before it will float to the top. As a result, it will rise till it strikes a part of the iron which has so solidified, and will remain there, imprisoned within the body of the casting. Sand-holes generally occur in that part of a casting which lies near the top of the mold, and just a little ways under the skin. They may occasionally form large cavities which seriously impair the strength of the casting, but more often they form very small holes, which being full of sand, destroy the edge of any tool which may be used for the purpose of machining the casting, and leave the finished surface pitted and unsightly.

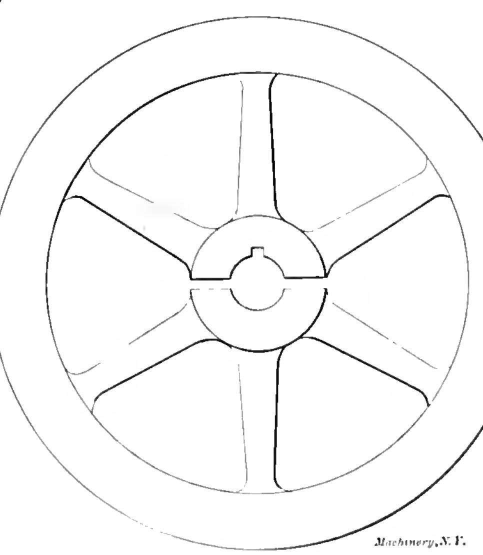


Fig. 2. Method of Obviating Shrinkage Strains in Large Wheels.

From this description of their origin, it must be apparent that the cure for sand-holes, as far as the designer's work is concerned, is the same as that for scabbiness. The fault may also be avoided by the use of a riser, so arranged that the current of iron will sweep the loose sand out of the mold and into the riser, where it will do no harm; but while this remedy avoids sand-holes, it does nothing to remedy scabbiness, which is generally the cause of sand-holes.

Floating Cores.

A sixth difficulty often encountered in the production of sound iron castings, is caused by floating cores. The buoyant

effect of the molten iron on a core is equal to about three times the weight of the core, if it is solid, and very much more than that in case the core is hollow. Large cores are generally built up about cast-iron skeletons known as core frames. These core frames are roughly of the same shape as the core, and serve to support it, and to bind it together. Were it not for these frames, heavy cores would fall to pieces by their own weight, and would be broken up in the process of casting, owing to the buoyant effect of the iron. A projecting piece of core having a volume of four cubic feet, for instance, will weigh approximately 500 pounds, and have a buoyant force of about 1,500 pounds thrusting it upward when the mold is poured. If the core frame is not amply strong and stiff, this force will bend the projection upward, or even break it off entirely. Hence the necessity of making large cored cavities of such form that the cores may be rigidly anchored and thoroughly secured. Nor is it sufficient that provision be made for securing the cores, but they must be of such shape, and so reinforced by the frames, that they will be stiff and strong, and not bend appreciably under the tremendous forces which will act on them when they are surrounded by the molten iron.

One of the most difficult things to cast properly is a long iron pipe having a small diameter and thin walls. If such a pipe be cast in the usual position, that is lying, horizontally, there will be an upward thrust along the whole length of the core, tending to bend it. On account of its slenderness, the central portions will be deflected upward, making the walls of the pipe thinner on one side, and thicker on the other. Often the deflection proves sufficient to thrust the core against the side of the mold, if it is long, or, in case the

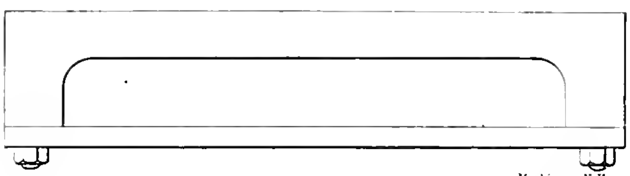


Fig. 3. Piece shown in Fig. 1, made in Two Parts.

thickness of the wall is great in proportion to the length of the core, to break it off entirely. On this account, pipes and hollow columns of cast iron are often cast on end, thus avoiding any deflection of the core. The same principle may be applied to many other pieces, by taking care to so design them that long and slender cores shall have a vertical position when the mold is poured. If they have such a vertical position, and are supported at both ends, they will have no tendency to deflect one way or another, and this source of trouble may be completely avoided.

Cold Shuts.

The seventh fault is known as a cold shut. A cold shut is caused by the imperfect uniting of two or more streams of molten iron, flowing together, which are too cold to coalesce. Such a fault often occurs on the upper side of a thin cylinder cast horizontally, when the iron is not sufficiently hot at the instant of pouring It there appears as a seam in the side of the cylinder, where it is very apparent that the metal has united imperfectly. It is not only a weak spot in the casting, along which it will readily split if called upon to sustain any great stress, but it is a spot which will surely leak under pressure, and which it is impossible to calk. The cause of the imperfection is generally improper gating, or else too great thinness of metal. If the iron is obliged to flow in thin streams for long distances, it will be cooled very much, and probably the advancing face will be partially solidified. Consequently, when it meets a similar advancing face of metal, which has been similarly cooled, there is small likelihood of their uniting properly.

The remedy is obviously to so design the casting that the metal will not have to flow in thin streams for long distances. The arrangement of gates and risers is often of great importance in minimizing cold shuts, and if the casting is large, and at the same time has thin walls, the designer must see that the gates may be so arranged that the iron may quickly fill up the mold. While the arrangement of the gating generally depends on the molder's fancy, he may often be limited by the shape of the casting, and obliged to place the gate at some point where the iron, in flowing in, must spread itself into a thin sheet, or pass for a considerable distance through a narrow passage. Under such circumstances, a cold shut is hardly to be avoided.

Shrinkage Strains.

The eighth and last fault to which I shall call attention is that of shrinkage strain. If we have two pieces of iron fastened end to end, as shown in Fig. 1, one piece being notably thinner than the other, the thinner piece will solidify first in the mold, and cool some hundreds of degrees below its freezing point, before the thicker part solidifies. As a result, the thicker part, when cooled to air temperature, will have, or rather tend to have, a less length than the thinner part, the reason being that at the instant of solidification of the thicker part, both pieces had the same length, although the thinner part was much the cooler. The thin part will then be in compression, while the thick part is in tension, and severe stresses will exist within the piece, which make it weaker than it would otherwise be in most cases.

Sometimes, however, we are enabled to utilize the shrinkage stresses to advantage. For instance when cast iron was the standard material for the manufacture of ordnance, guns were cast with cores through which water was circulated, so as to cool the surface of the bore before the outer parts solidified. When a gun is fired, it is known that the inner layers of metal are stretched more than the outer ones. By cooling the inner layers of metal first, shrinkage strains are produced in the walls of the gun, causing the outer layers of metal to compress the inner ones. The combined effect of the shrinkage stresses and the stresses produced by the explosion is to produce a uniform stress throughout the walls of the gun, and so reduce the chance of rupture.

It is not often, however, that we are able to take advantage of shrinkage strains in this way. More often they are troublesome, causing work to warp in the process of machining, or causing mysterious cracks to develop without apparent cause. Since these strains are due to unequal rates of cooling in the different parts of the casting, the best way to eliminate them is to so arrange the thickness of the various parts, that the entire casting shall solidify at the same time. The second best way is to so arrange the parts of the casting that the unequal contraction shall not produce dangerous stresses at any point. In order that the entire casting shall cool at a uniform rate, it is necessary that all parts of it shall be of approximately uniform thickness, and that there shall be no sudden changes of section. In order that unequal contraction shall not produce dangerous stresses in the metal, it is necessary that there shall be no sharp corners, and that the various parts shall be free to expand when necessary. For instance, a wheel or pulley with a solid rim is likely to have severe stresses set up within the arms by unequal cooling, but if the hub be divided as shown in Fig. 2, by means of a thin core, and then bolted subsequently, no shrinkage strains will occur, since the arms are free to expand or contract, independently of the rim.

Shrinkage strains often become so serious that it becomes necessary to make pieces in two or more parts, which it would be perfectly possible to make, at much less expense, in one piece. Large jacketed cylinders, for steam and gas engines, are good examples of this. When cast in one piece, the shrinkage stresses, together with the stresses set up by the varying temperatures incident to service, are often sufficient to crack them. Were the piece shown in Fig. 1 made in two parts, as shown in Fig. 3, there would be no shrinkage strains in either part, although the cost of machining the surfaces which are fitted together, and of putting in the bolts, would not always warrant the construction.

Relative Economy of Simple and Complicated Castings.

In conclusion, it may be well to state that the most of the faults enumerated will be more likely to occur in a part of a complicated casting, than in a similar part of a simpler casting. For instance, the cylinder of a gas engine will be more likely to have some imperfection if it is cast integral with the frame, than if it is cast separately. In the same

way, the frame will be more likely to have an imperfection of some kind, than if it were cast separately. Assuming that ten per cent of the cylinders or frames would be lost if they were cast separately, it is more than likely that fifteen per cent of the castings, having cylinder and frame cast together, would be rejected for faults in the frame, and fifteen per cent of the remainder would be rejected for faults in the cylinder. In other words twenty-eight per cent of these castings would be rejected, against ten per cent of the simpler forms. If more than eighteen per cent of the cost of the castings is saved in machining, or in other ways, by casting cylinder and frame together, it is well to do so, but if the saving is not more than sufficient to balance the loss, it is well to make several simple forms, instead of one complicated one.

* * *

COLLEGE AND APPRENTICE TRAINING.

The subject of the monthly meeting of the American Society of Mechanical Engineers, held October 8, was "College and Apprentice Training." A paper having this title was read by Prof. John P. Jackson of the State College of Pennsylvania, in which he pleaded for more co-operation between the present collegiate institutions and manufacturing industries. He was of the opinion that a great lack at the present time is a connecting link which will make the collegiate work of technical schools more practical and that will enable students to realize more quickly the benefits they should accrue from their technical work. The discussion was animated, and about as many diverse opinions were expressed as there were individuals taking part. One speaker (Mr. C. W. Cross, of the New York Central) intimated that a great fault with higher education is that in too many cases the wrong men were educated. He epigramatically remarked "there are no text-books on horse sense," the idea being, of course, that a man to be successful in engineering work must first of all have good common sense and an instinctive knowledge of the proper course to pursue without regard to what he has learned in schools. If he does not possess this natural instinct, no amount of education will make up for it. Mr. F. W. Taylor is a firm believer in the refining effect of work. He believes that the great need of the college graduate is to learn how to do dull, monotonous tasks day after day without feeling that he must be learning something. He said that a graduate is purely in an absorptive frame of mind; for four years he has been learning things without giving out ideas. When he comes into the shop he finds that his employers look to him to produce, and they are more interested in the ideas and suggestions that he can or will make, and in the work he can do, than in teaching him new things. Until he learns to do his work simply as a cog in the wheel of production he will not be a valuable man to his employers. He must become a trained and disciplined producer before he is really fitted to direct the production of others. It can hardly be said that anything startlingly new was contributed to the discussion, but it nevertheless may be profitable. The meeting betrays the deepest interest of educators and manufacturers in what is doubtless one of the most vital subjects affecting our manufacturing industries.

* * *

The curious fact that the useful life of frosted incandescent lamps is only a little more than half the life of the corresponding plain bulb lamp has long been recognized. One explanation advanced is that the temperature of the frosted lamp is higher, due to the increased absorption by the bulb. Mr. Edward P. Hyde of the Bureau of Standards, Washington, D. C., claims, however, that this explanation is not correct, but that the decreased efficiency of the frosted lamp depends upon the fact that although the filament in the frosted bulb emits the same total flux of light as that emitted by the filament in the plain bulb, the light is reflected through the glass of the frosted lamp several times, and the absorption of light by the carbon filament itself becomes so great in that case that the apparent intensity of the frosted lamp at any time during its life is less than that of the plain lamp, and the difference in intensity increases with the length of time a frosted lamp is used.

ECONOMY TESTS OF 7,500 K.W. WESTINGHOUSE-PARSONS STEAM TURBINE.

The following data comprises the principal results obtained during the eight-hour economy test on September 1, 1907, upon turbine No. 253 installed earlier in the year at Waterside Station No. 2 of the New York Edison Company. This test was conducted entirely by the New York Edison Company, under the direction of Mr. J. P. Sparrow, chief engineer.

The turbine unit tested is of standard Westinghouse construction throughout. [See MACHINERY, February, 1904, engineering edition.] It has a maximum rated capacity of 11,250 kilowatts, and was built to operate on 175 pounds steam pressure, 28 inches vacuum, and 100 degrees superheat. Under these conditions, the turbine unit was guaranteed to have a minimum steam consumption of 15.9 pounds per kilowatt hour at the generator terminals with a normal speed of 750 R.P.M. Incidentally, the electrical efficiency of the generator was guaranteed to be 97.8 per cent exclusive of friction and windage, at a load corresponding to that sustained during the test. The results of the tests, detailed below, show an economy about 7.5 per cent better than the guarantee.

Methods of Conducting the Tests.

Load.—During the test period, No. 2 Waterside Station sustained practically all of the 25-cycle load on the system, of which the unit under test carried practically 70 per cent, the remainder being carried by other turbine units. This load was maintained as constant as possible by remote control of the turbine governor by the switchboard operator. Between the first and the last hours of the test, the maximum variation in load was held within 4 per cent above and below mean. During the last hour, however, the load decreased somewhat. Previous to the test, this turbine unit had been running on a load of 7,000 kilowatts, which was increased to its test load ten minutes before the start.

Calibration.—Three-phase electrical load was measured by the two-wattmeter method, using two Weston indicating wattmeters of the standard laboratory type. These instruments were calibrated at the New York Electrical Testing Laboratories immediately before and after the test. The power factor was maintained substantially at unity, and all electrical readings were taken at one minute intervals.

Steam Consumption.—As a surface condenser was used in connection with this turbine unit, the water rate was determined by weighing the condensed steam delivered from the condenser hot well. This condensation was weighed in a tank mounted upon platform scales, with a reservoir above large enough to hold the condensation accumulating between each weighing. (See the accompanying cut, Fig. 2.) These weighings of 12,000 to 13,000 pounds each were made at intervals of five minutes.

Gland Leakage.—By the loop method of connecting the gland water supply, shown in the accompanying cut, the necessity for correcting condensation by an amount equivalent to the weight of the gland water used is avoided. It will be noted that a continuous gland water circuit is used entirely outside of the weighing apparatus, and that all overflow from the standpipe returns to the hot-well delivery.

Condenser Leakage.—As the circulating water is quite salt, any condenser leakage may immediately be detected by the salinity of the condensed steam, which should be pure distilled water. On this account, condenser leakage was determined entirely by chemical analysis, employing the silver-nitrate test with a suitable color indicator. This method proved extremely sensitive, and possessed a decided advantage over the ordinary method of weighing the leakage accumulating during a definite period when the condenser is idle and under full vacuum. As samples of circulating water and condensed steam could be taken at the same time, this method made it possible to discover any change in the rate of condenser leakage taking place during the test, while the method of weighing, above described, provides only an average result during the period.

Hot-Well Correction. In this condensing plant, the delivery of the hot-well pump is automatically controlled by a float valve in the interior of the hot-well. This maintains the

water level therein at a practically constant point, and hence no correction had to be made for difference in level of water in the hot-well before and after the test.

Steam Supply.—Steam pressures and temperatures were determined close to the turbine throttle. As usual, the degree of superheat was obtained by subtracting from the actual steam temperature the temperature of saturated steam at the corresponding pressure carried at the time. All gages and thermometers were calibrated previous to the test at the U. S. Testing Bureau. It will be noted that both pressure and superheat were somewhat below the guarantee.

Vacuum.—Vacuum was measured directly at the turbine exhaust by means of a mercury column with a barometer alongside for reducing to standard barometer—30 inches. This also obviated the necessity for temperature correction between the two mercury columns. During the test the vacuum was not maintained quite up to normal.

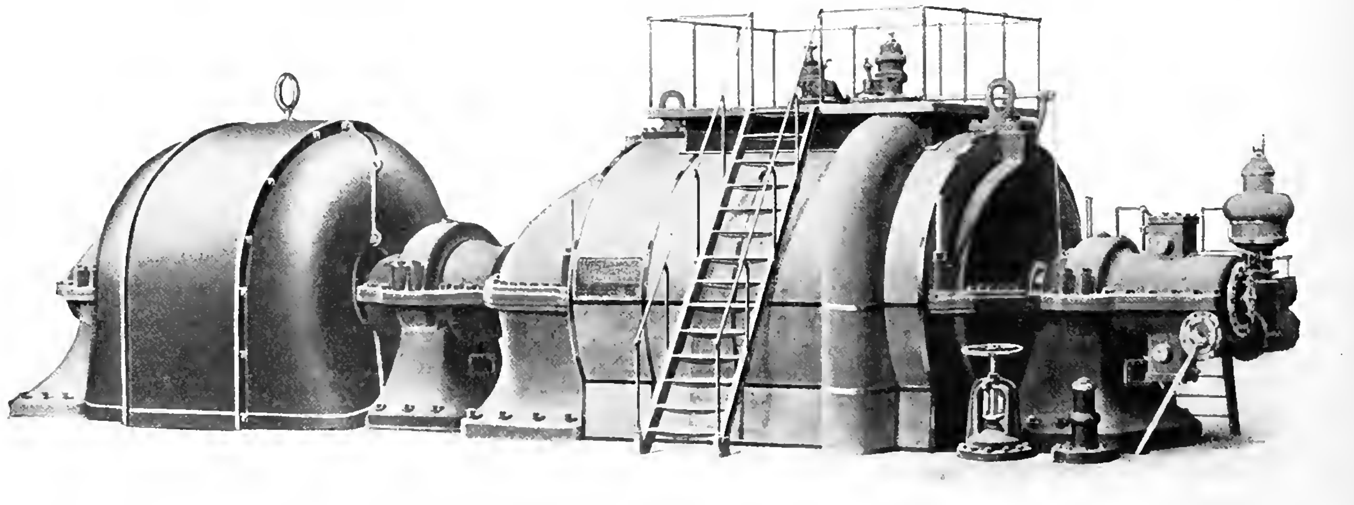


Fig. 1. Westinghouse-Parsons 7,500 K.W. Steam Turbine, Waterside Station No. 2, New York Edison Co.

Results of Tests.

The following data represents the results of the tests, calculated for the conditions as actually run, *i. e.*, for instrumental errors only:

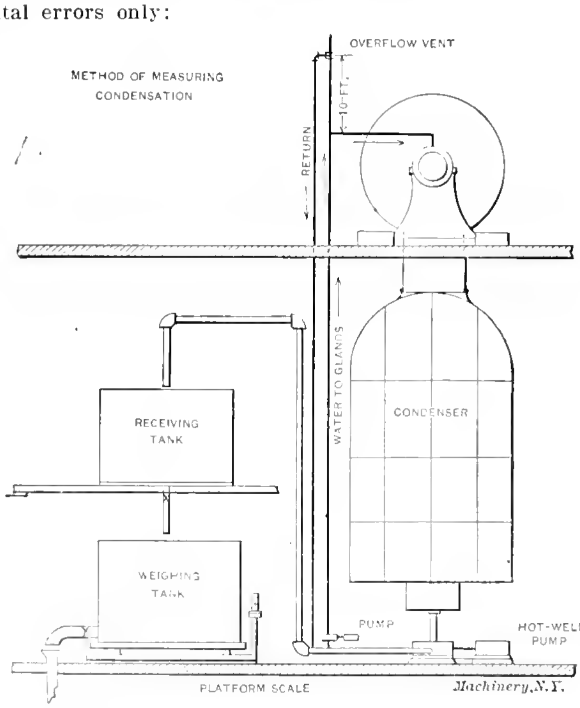


Fig. 2. Diagram of Water-weighing Apparatus, Etc.

Duration of test	9:30 a. m. to 5:30 p. m.
Average steam pressure at throttle, lbs. per sq. in. gage	177.5
Average superheat at throttle, degrees F.	95.74
Average vacuum (referred to 30-inch barom.) in. Hg.	27.31
Average load on generator, K. W.	9,830.48
Average steam consumption, as tested, lbs. per K.W. hr.	15.15

Test Correction.—Owing to the departure, during the test, from specific operating conditions upon which guarantees were based, it was necessary to correct the observed results by the following amounts:

Pressure (2.5 pounds high) correction, 0.25 per cent; vacuum (0.69-inch low) correction, 1.84 per cent; superheat (4.26 degrees low) correction, 0.29 per cent.

These corrections were mutually agreed upon previous to the test as representative of this type of turbine. When applied to the observed steam consumption given above, the following results, representing contract conditions, are obtained:

Average corrected water rate during 8-hour test	14.85 lbs. per K. W. hour
Guaranteed water rate	15.9 lbs. per K. W. hour

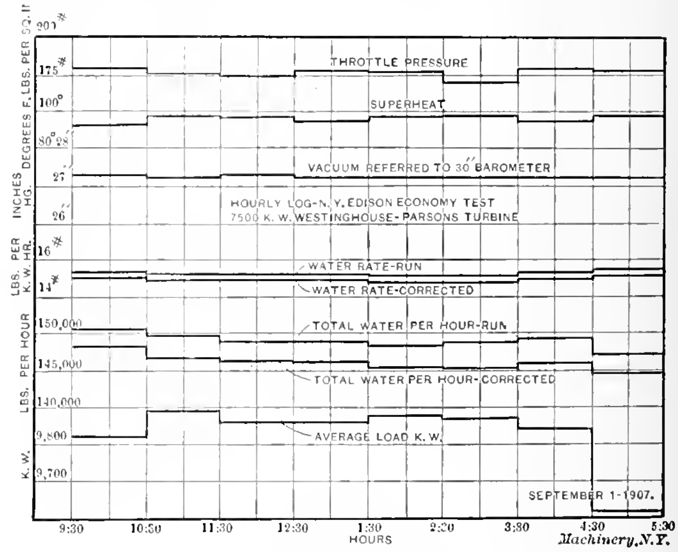


Fig. 3. Log of Test.

Log.—Referring now to the accompanying log, Fig. 3, it is interesting, as a check upon the average figures above presented, to observe the results segregated into hourly periods, as shown. Here it will be noted that the load was considerably lower during the first and last hour than during the main part of the test. Neglecting, therefore, these two hours and considering only the six-hour period from 10:30 a. m. to 4:30 p. m., the results are as follows:

Average corrected water rate, six hours	14.8 lbs. per K. W. hour
Equivalent water rate	10.65 lbs. per B.H.P. hour
Equivalent water rate	9.8 lbs. per I.H.P. hour

The two latter quantities are determined by applying conversion factors for generator efficiency and for internal losses.

A noteworthy agreement exists between the results here noted and those previously obtained from tests of machines similar in design installed in the Manhattan Station of the Interborough Rapid Transit Co., New York, and the Long Island City Station of the Pennsylvania R. R. At the same loads and with equivalent operating conditions, the performance of the machines is almost identical.

LAPPING FLAT WORK AND GAGE JAWS.*

F. E. SHAILOR†

The main essential points of the art of lapping can be described in an article, but, the same as with any other line of mechanical work, it is necessary that the workman shall do considerable lapping before he can become proficient. There are certain motions, touches, sounds, refinements, etc., which the skilled workman acquires by practice, that are impossible of enumeration and description, or of enumeration and description that would be intelligible to an inexperienced man. For instance, ask a carpenter how he knows that he is sawing a board straight, and he will be unable to tell you. Nevertheless, he has acquired a peculiar sense of touch, or such general acuteness of the senses, that he knows instantly when the saw starts to "run out." His mind and arm automatically, as it were, return the saw to a straight line without missing a stroke. It is the same way with a die-maker. He can file a die, looking only at the surface line, and can detect the instant when his file "rocks" from a straight line. He will tell you that he "feels" it, but is unable to define what the sensation is. Likewise I am unable to explain some of the finer points in the art of lapping, and I will simply point out those which are fundamental, and which must be acquired first by the workman unaccustomed to such operations. He must acquire the refinements by practice and experience.

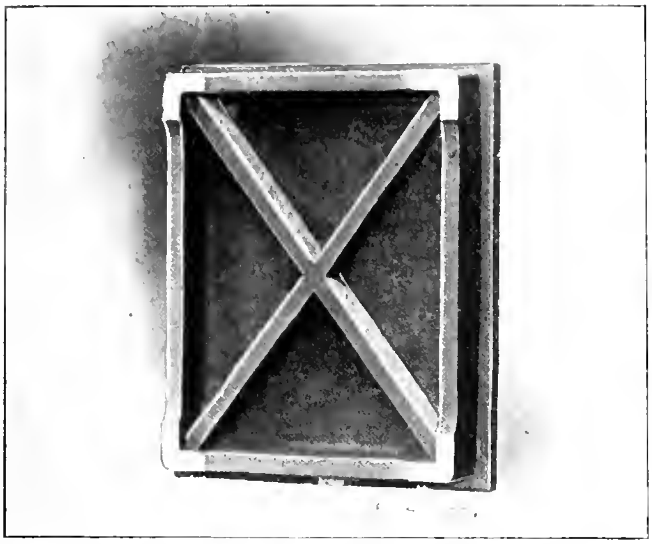


Fig. 1. Back of Standard Flat Lap, showing Ribbed Construction.

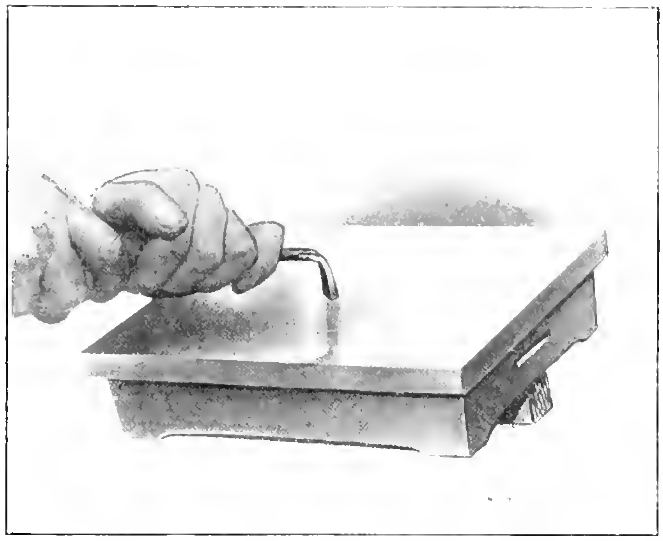


Fig. 2. Scraping Down the High Spots.

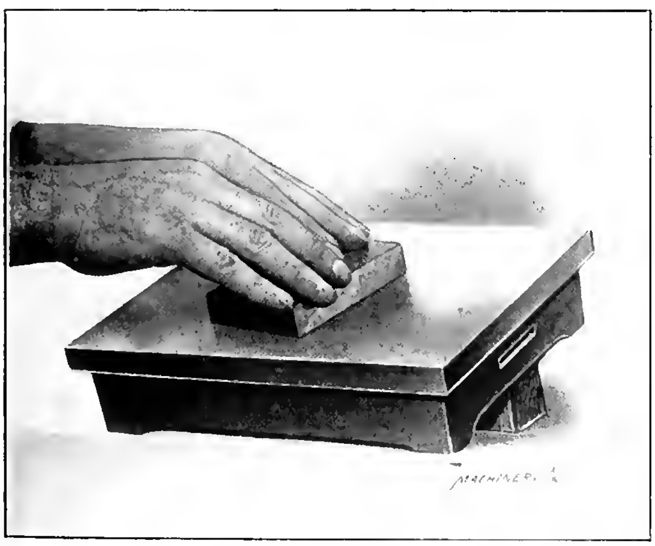


Fig. 3. Charging the Lap, using a Hardened Steel Block.

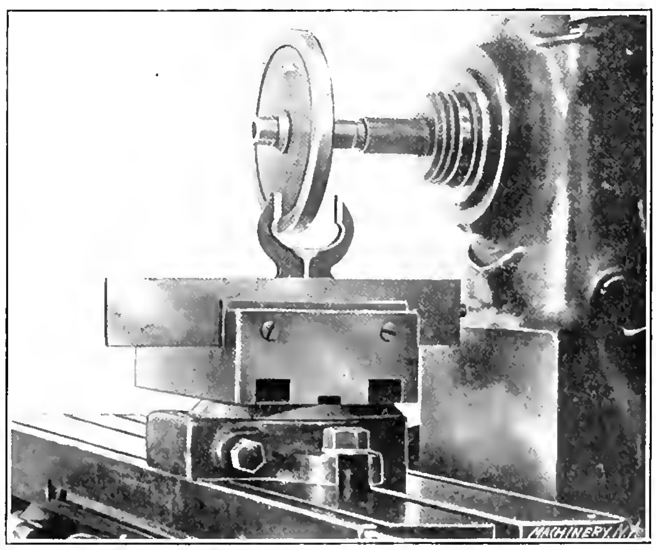


Fig. 4. Lapping a Gage.

A Perfect Lap Required for Perfect Lapping.

The first requisite of perfect lapping is a perfect lap, and right here is where the novice will make his first mistake, that is, in the preparation of the lap. To make a surface lap, it should be carefully planed, strains due to clamps being avoided, and then it should be carefully scraped to a standard surface plate. This is done by rubbing the face of the lap on the standard surface plate and scraping down the high spots until a perfect plane surface is obtained. If a standard surface plate is not at hand, a lap can be made level by using three laps that are nicely planed and used alternately as follows. We will number the laps Nos. 1, 2, and 3. Now, rub No. 1 and No. 2 together, and scrape the high spots until they fit. Then introduce No. 3 and scrape it down to fit No. 2, and then to fit No. 1, and so on. The third lap eliminates the error that might follow if only two laps were used. For example, it is possible to fit two plates accurately together without making them plane surfaces, one becoming concave and the other convex. The third lap absolutely prevents this and produces a perfect plane surface if time and patience hold out. It is a slow operation, but not so slow as trying to lap a piece true with a lap that is not true.

The Objection to Ground Laps.

The laps may be ground together instead of scraping, but the writer prefers the scraping process, as it is easy to see when the job is done. It is also better to scrape them, because it is quicker than attempting to grind them level with the fine grade of emery that is required for nice lapping, and it must be remembered that when ground together the laps *are already charged*. Hence, the necessity of using a fine grade of emery if they are ground together.

Using a Hand Surface Lap.

The writer prefers a cast iron lap, Fig. 1, thoroughly charged, and having all loose emery washed off with gasoline. When lapping, the surface is preferably kept moist with kerosene, although gasoline causes the lap to cut a trifle faster. It evaporates so rapidly, however, that the lap soon becomes

* See MACHINERY, May, 1904: A Few Suggestions in Tool-making.
† Address: Great Barrington, Mass.

dry, and the surface caked and glossy in spots. When in this condition, a lap will not produce true work. The lap should be employed so as to utilize every available part of its surface. Gently push the work all around on its surface, and try not to make two consecutive trips over the same place on the lap.

Do not add a fresh supply of loose emery to a lap, as is frequently done, because the work will roll around on these

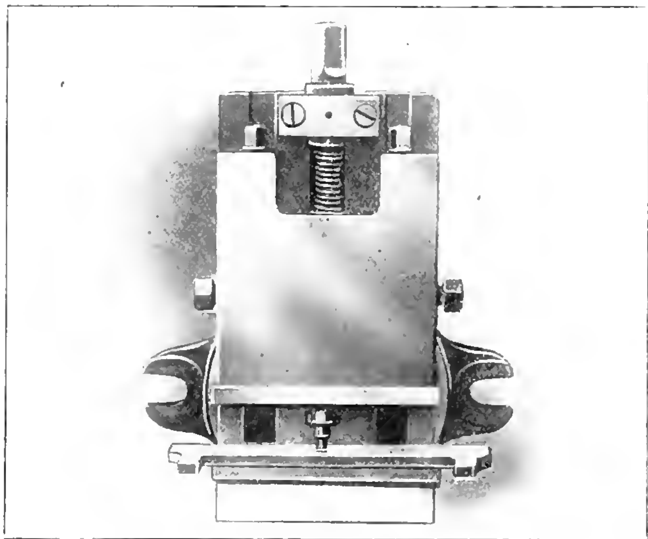


Fig. 5. View of Machine Vise, showing how a Gage is Clamped without Springing it.

small particles, which will keep it from good contact with the lap, causing poor results to follow. If a lap is thoroughly charged at the beginning, and is not crowded too hard, and is kept well moistened, it will carry all the abrasive that is required for a long time. This is evident, upon reflection, for if a lap is completely charged to begin with, no more emery can be forced into it. The pressure on the work should only be sufficient to insure constant contact. The lap can be made to cut only so fast, and if excessive pressure is applied, it will become "stripped" in places, which means that the emery which was imbedded in the lap has become dislodged, thus making an uneven surface on the lap.

Causes of Scratches—Grading Emery.

The causes for scratches are as follows: Loose emery on the lap; too much pressure on the work which dislodges the charged emery; and what is, perhaps, the greatest cause, poorly

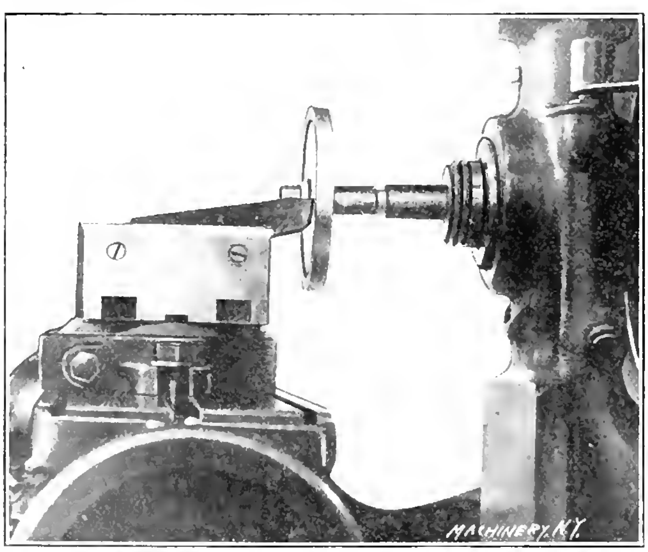


Fig. 6. Truing the Lap with a Tool held in the Vise.

graded emery. To produce a surface having a high polish free from scratches, the lap should be charged with emery or other abrasive that is very fine. The so-called "wash flour emery," sold commercially, is generally too uneven in grade. I would advise all those who have considerable high class lapping to do to grade their own emery in the following manner: A quantity of flour emery is placed in a heavy cloth bag, and the bag gently tapped. The finest emery will work through first, and should be caught on a piece of paper. When sufficient emery is thus obtained it is placed in a dish of lard or sperm oil. The largest particles of emery will rapidly sink to the bottom, and in about one hour the oil should be poured into another dish, care being exercised that the sediment at the bottom of the dish is not disturbed. The oil is now allowed to stand for several hours, say over night, and then is decanted again, and so on, until the desired grade of abrasive is obtained.

For the information of those not well acquainted with grading abrasives, it may be said that the grade of diamond dust known as "ungraded" is obtained in about five minutes, while it requires about three weeks to obtain the grade known as No. 5, which is very fine. But, even at the end of three weeks there still will be small particles in the oil that have not settled, due to the viscosity of the oil.

To lap true and free from scratches, one must have skill and be thoroughly conversant with the peculiar sounds, touches, and motions spoken of above. For a high polish on work, a rapid motion and slight pressure are necessary for success. It is also necessary that the lap is properly charged with properly graded abrasive.

Lapping Gage Jaws.

Fig. 4 shows the best method that has come to the writer's notice for lapping the jaws of gages. The lap is made of cast iron and is relieved as shown, leaving only a thin edge or

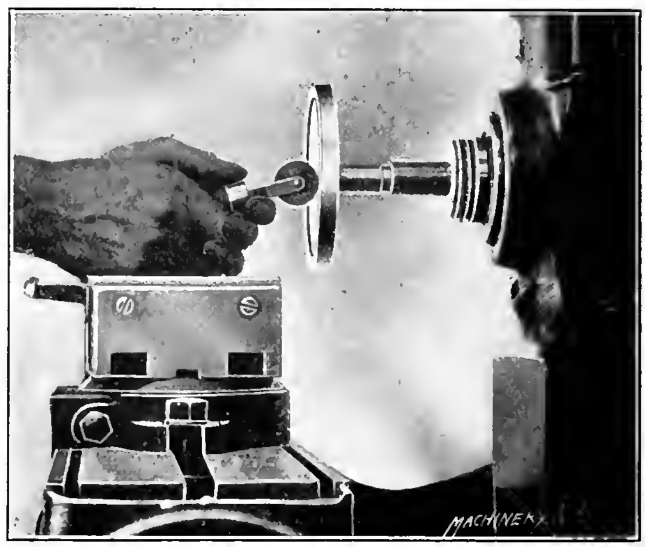


Fig. 7. Charging the Lap with a Roller.

flange on each side to bear against the jaws. As the machine table is worked back and forth, the lap passes over the entire surface of the jaw, grinding it down in the same manner as would be done with a cup emery wheel. Care must be taken to clamp the gage in the vise so as not to spring it. Fig. 5 illustrates an approved method for holding a gage so that the vise jaws will not deflect it. Should the gage be sprung, it is clamped at the center only, leaving the ends free. Snap gages are now mostly made of machinery steel and pack-hardened. Made in this way they do not change much, as the interior of the gage is left soft, and whatever change occurs can be easily remedied, but in any case the method illustrated is the safest one to follow, for it leaves no doubt as to the gage being held free from spring during the lapping operation.

A lap should be turned on the arbor on which it is to be used, for it is almost impossible to put a lap back on an arbor after it has been removed, and have it run true. Therefore, the lap should be recessed quite deeply, as shown, to allow for truing up each time the lap is placed on the arbor. Perhaps when the lap is mounted on an arbor in the milling machine, it will be found to run out not more than 0.001 inch, but that means that it is touching the work in only one spot, and the result can be hardly better than if a fly-cutter was used for a lap. Fig. 6 shows the operation of truing the lap. A keen cutting tool is clamped in the vise and in this way the lap can be trued as nicely as though it were done in the lathe. In fact, it is superior, for there is absolutely no change

in the alignment of the lap with the work spindle after it is turned, which might easily happen should it be turned in the lathe and then mounted in the milling machine spindle. With a perfectly true lap a perfect contact between the lap and gage is insured for its entire circumference. Both sides of the lap should be turned at the same setting on the arbor.

Fig. 7 shows the operation of charging a circular lap, using a roller mounted in a suitable handle for the purpose. The emery is rolled in under moderate pressure. It is good practice to make the roller of hardened steel, and after charging the lap, all the surface emery should be thoroughly washed off.

The next step is to square up the jaws of the gage. Do not depend on the zero marks of the vise. The jaws of the gage may have sprung a little in hardening, and if the zero marks of the vise are depended upon to square the work, there possibly will not be sufficient stock on the jaws to clean up. Be very careful to set the gage by the surface of the jaws and to clamp it in the vise as previously noted, so that it is under no pressure tending to spring it out of shape.

Importance of the Sound Magnifier in Machine Lapping.

When employing a power-actuated lap, the little instrument shown in Fig. 8 is useful in determining the instant when the lap touches the work. By placing the forked end on the work and the wooden part to the ear, the sound is greatly magnified, and it makes it much easier to determine the precise point of initial contact. If one depends upon the naked ear to tell when the lap touches the work, he is liable to crowd the lap too much, and scratch the work or strip the lap. With this instrument the mechanic will know the instant the lap just touches the work, and this is the position where its work should be done. In short, the lap should not work under any appreciable pressure, but should simply touch the work. Hence the desirability of some means of magnifying the sound and not depending on the naked ear.

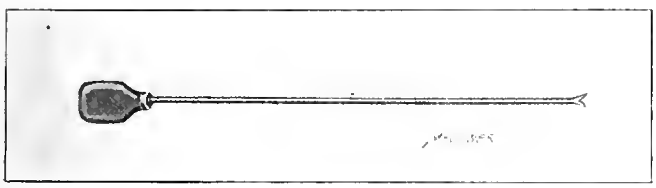


Fig. 8. Sound Magnifier.

The workman should avoid the custom of adding a fresh supply of abrasive to the lap, as it is not only injurious to the character of the product, but it naturally increases the time required for lapping. To illustrate the action, suppose that an arbor is to be ground in a grinding machine, and that it is belted so that it runs with a wheel at the same speed. The consequence will be that no grinding action could take place, as there would be no difference in motion. The condition is very similar when loose emery is placed on a surface lap. The emery simply rolls around between the work and the wheel, and occasionally a piece of emery is imbedded in the lap long enough to scratch the work. While it may look as though the lap was cutting much faster, the truth is that it cuts slower and produces poor work.

In lapping jaws, some workmen rough lap, and then finish by hand, but a better job will result when finished in the machine. I consider that it is poor practice to rough lap a gage, using a coarse grade of emery, and then wash the lap and smear it with fine emery. Of course the lap is already charged with a grade of emery last used, and the act of putting on a supply of fine emery on the lap will not produce as good a surface as if the gage were finished without the fresh supply of emery, though the latter is of a finer grade.

In the above remarks I have attempted to give some idea of the precautions that should be observed in lapping accurate work, but any practical tool-maker will know that I have left out many of the minor points which are necessary for the best work and which are properly regarded as refinements of the art. It is impracticable, however, to explain them in an article for the reasons enumerated in the beginning. Experience alone will give the workman the fine touches that are necessary for producing the highest grade of work.

HOT BEARINGS.*

THEIR CAUSES AND THE MEANS OF AVOIDING THEM.

E. KISTINGER.†

In our modern high speed steam and gas engines, turbines and the like, hot bearings are of more frequent occurrence than is generally supposed. Very often a new plant, just put into service, has to be shut down on this account. It not infrequently happens that the engine which has run "hot" is one of several, identical in design and construction, the bearings in the others having operated without trouble. Appar-

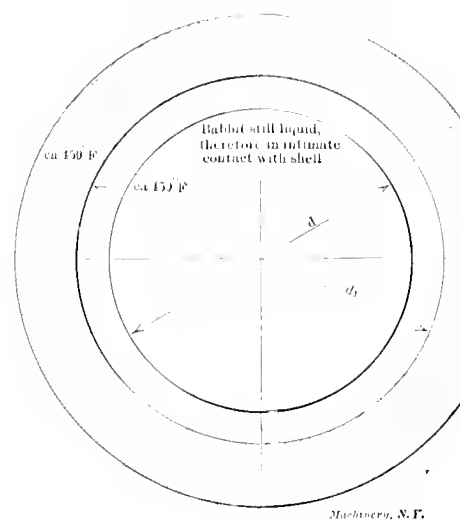


Fig. 1. One-piece Bearing; Babbitt just Poured. Both Shell and Babbitt at the Solidifying Temperature.

ently there is no cause for this particular engine to give trouble, but in order to remove the difficulty, various makes of babbitt metals and bronzes are tried, sometimes with good results, sometimes without. Again, it occurs that a machine or engine operates at the beginning with perfect satisfaction, but after a time one or more of the bearings begin to run "warm," and finally "hot," so that relining becomes necessary. As a general rule it is then simply accepted as a fact that the bearings "ran hot"; seldom does any one think it worth while

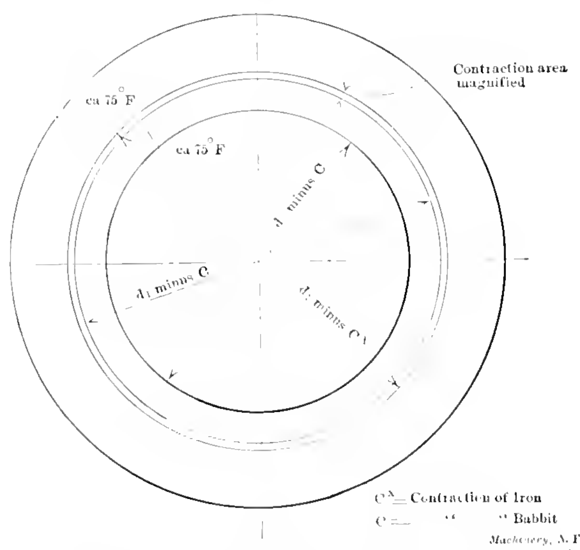


Fig. 2 Same Bearing as shown in Fig. 1 Cooled Down to Normal Temperature.

to seek out the fundamental causes for the trouble. That there is always the element of doubt, in regard to bearings, is evidenced by the fact that our modern engine builders usually deliver an extra set of bearings with the engine, so that, in the event of trouble, a new set is at hand. The following may be of some assistance towards discovering and eliminating, in a scientific manner, and along technical and metallurgical lines, the real causes of hot bearings.

*See MACHINERY, May, 1905, Oil Grooves and Bearings; December, 1906, January and February, 1907, The Design of Bearings.

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investigation will show that the main reasons for hot bearings are:

1.—Shrinkage or contraction of the babbitt.

2.—Shrinkage strains set up in the babbitt metal liner by the unequal distribution of the babbitt metal over the shell.

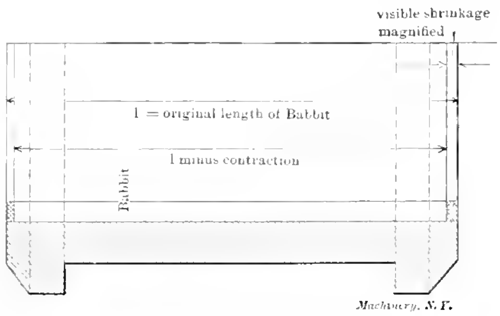


Fig. 3. Babbitt Bearing without Dove-tailed Grooves or other Retaining Device.

3.—A lack of contact between the babbitt metal liner and the cast iron or cast steel shell.

4.—The lubricant becomes partially deflected into the wrong place.

Shrinkage or Contraction of the Babbitt.

a. Shrinkage in a diametral direction As an illustration of this point, one may take the simple example of an iron ball and ring. If this ball, when cold, will just pass through an iron ring, it will not do so when somewhat heated and expanded. After cooling down, however, it will again pass through the ring. A similar action takes place in a bearing.

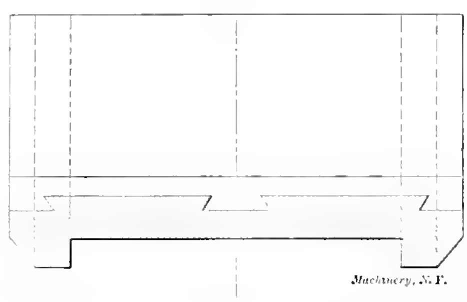


Fig. 4. Same Bearing as shown in Fig. 3, but with Dove-tailed Grooves. Visible Shrinkage Prevented, but Shrinkage Strains Produced

In Fig. 1, of the accompanying illustrations, the babbitt liner may be considered to have been jnst poured in, and the metal to be still liquid. At the exact solidifying point the babbitt will have filled all the interstices and be in good contact with the cast iron or cast steel shell, provided the babbitt itself has sufficient fluidity to enable it to penetrate the smallest spaces. From this solidifying point on, the babbitt will contract according to its coefficient of contraction. Now, if the coefficient of contraction of the babbitt were the same as that of the material out of which the shell is made (usually

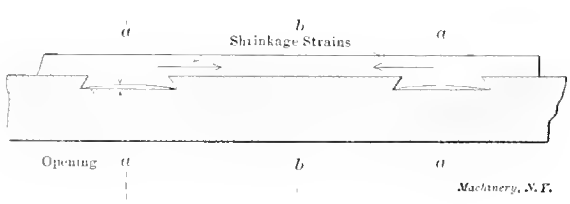


Fig. 5. Illustration of Shrinkage Strains produced by Unequal Distribution of Babbitt Metal.

cast iron or cast steel), and provided that the shell had acquired the same temperature as the babbitt, the shell and the babbitt liner would then contract equally, and a fairly good contact would result, and there would be nothing to set up counter strains during shrinkage. But, as the coefficient of contraction of almost all babbitt metals is approximately two to three times higher than that of cast iron or cast steel, a shrinkage or loosening of the babbitt liner from the shell must absolutely take place after the solidifying point of the babbitt is reached. Fig. 2 shows this contraction as it would appear if magnified. The fact that most bearings are "split" does not, of course, change this result. If the babbitt is secured in the shell by means of dove-tailed grooves, or other anchoring devices, so that the actnal visible contraction from the shell is lessened or minimized, then an unavoidable consequence of these grooves or other devices is *shrinkage strains*, set up while the babbitt cools down, as explained further on.

b. Shrinkage in an axial direction. With regard to shrinkage in the axial direction, it may be observed that the same results take place. Fig. 3 illustrates how the babbitt metal shrinks in a cast iron or cast steel shell in the axial direction, when there is no anchoring device employed. In Fig. 4 may

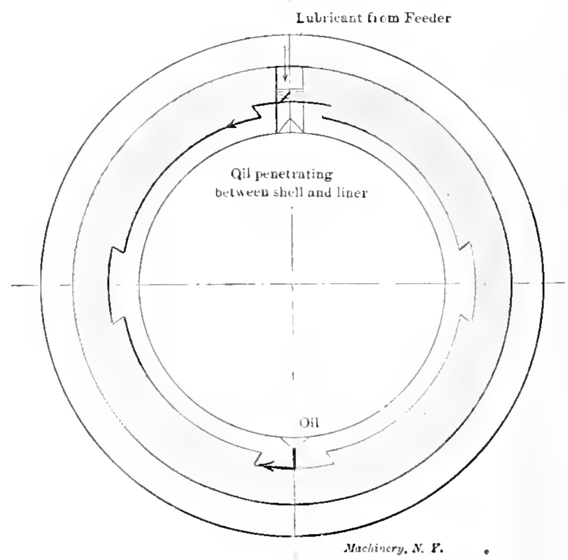


Fig. 6. Penetration of Oil between Shell and Liner.

be seen the old-fashioned dove-tailed groove construction, prohibiting an actual visible shrinkage, but causing shrinkage strains.

Shrinkage Strains Produced by an Unequal Distribution of Babbitt Metal Liner.

By referring to Fig. 5 it will be observed that the babbitt metal at *aa* is about twice as thick as at *bb*. The consequence is that, as the solidifying time of the greater mass *aa* is longer than that of the smaller mass *bb*, shrinkage strains are set up throughout the babbitt liner, which loosen it from the

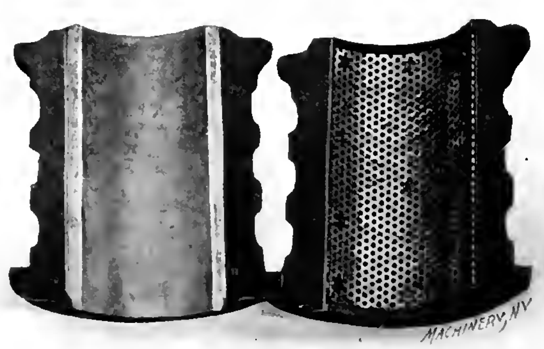


Fig. 7. Main Shaft Glyco Bearing for Large Gas Engine, Before and After Babbitting.

shell and have the tendency, in combination with the regular working pressures and shocks, to produce minute cracks in the liner.

Lack of Contact between Liner and Shell.

In a bearing shell, some parts of the liner are in close contact with the shell, as a result of careful pouring and the use of a properly-made babbitt metal, while other parts of the liner will not be in good contact with the shell, by reason of shrinkage and the formation of air bubbles and oxide gases, which latter are especially liable to be formed in babbitts containing copper. With the idea of filling up the hollow spaces between liner and shell, it is a quite general American practice, and an English one also, to peen or hammer the babbitt liner. The advisability of this treatment is, however, very qnestionable. By the peening process the air will simply

be driven from one point to another, and be forced into places where at first a good contact existed, thus destroying it. To secure a permanent and intimate contact between liner and shell by peening is impossible, on account of the elasticity of the liner material. When the hammer strikes the metal, a contact may be formed, but as soon as the force of the blow is gone, the metal will spring away more or less by reason of its elasticity. Furthermore, the babbitt metal becomes

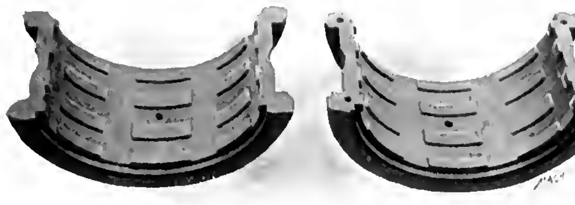


Fig. 8. Ordinary Babbitt Bearing Shell, showing Dove-tailed Anchoring Grooves

more brittle by peening, and its strength diminished; this has been proved by a number of tests made by the writer. Peening, unless performed with the utmost precaution, also produces minute cracks in the structure of the babbitt, which will constantly be enlarged by the regular working pressures. For these reasons, European continental practice has now practically abandoned the peening of babbitt metal liners. Therefore, in spite of good pouring, or peening, or dove-tailed grooves and other similar anchoring devices, the liners are in a greater or less degree loose in the shells.

The Lubricant Penetrating the Hollow Spaces.

When these bearings go into service, the hollow spaces between the liner and shell will gradually become impregnated with an oil film, from the lubricant employed, as shown in Fig. 6. Now, the coefficient of heat-conductivity of oil is only about 1/200th of that of an ordinary babbitt metal, or of cast iron. Therefore the warmth created in the liner by the working friction will not be conducted away to the shell, and thence to the engine frame, as quickly as though an intimate contact existed between shell and liner. The result is that the bearing readily becomes hot, because the babbitt metal liner retains, instead of throwing off, the heat. The regular working pressure also sets up an hydraulic pressure in the oil film, between the shell and the liner, which tends to produce breakages and cracks in the liner, as may sometimes be observed when removing bearings from gas engines, pumping engines and the like, subject to high pressures and shocks. A consequence of shocks is also that a liner which is somewhat loose will become distorted and "work"; this "working" produces additional friction and increased temperatures. All the facts mentioned above tend toward the one result, *viz:* the increasing of temperature in the bearings, even to the extent of melting down the babbitt liner.

From various tests made by the writer, the results of one may be given here. A bearing with a perfect contact between liner and shell was tested under a constant load of 400 pounds per square inch and a constant sliding speed of 480 feet per minute. The same bearing was again tested under the same conditions, but with the liner not in intimate contact with the shell. As the tests were necessarily made under a slightly varying atmospheric temperature, the difference between the actual bearing temperature and the room temperature was taken as the basis of each, and in the former case, the result was 60 degrees F while in the latter 85 degrees F. When such differences are obtained in a testing machine, under the best operating conditions, how much worse must be the influence of the slightest lack of contact under usual working conditions, such as we have them in steam engines, air compressors, pumps, gas engines, etc.!

Summing up the foregoing we may say that in most cases the direct causes of hot bearings are: A lack of contact between liner and shell caused, first, by shrinkage and careless treatment of the babbitt, and second, by shrinkage strains produced by an unequal distribution of the liner masses over the shell; the formation of an isolating oil film, together with its consequences; cracks or breakages in the liner produced as explained. The means of avoiding these troubles, and the principles of a good and safe bearing construction, must consequently be an absolutely intimate and homogeneous contact between liner and shell; an equal distribution of the liner over the shell; and a strengthening of the liner against the shocks and workiog pressures. If these conditions are faithfully carried out, many troubles and much expense may be avoided.

Skeleton Bearings.

The employment of the skeleton-bearing construction is a means for overcoming the foregoing difficulties. This is a

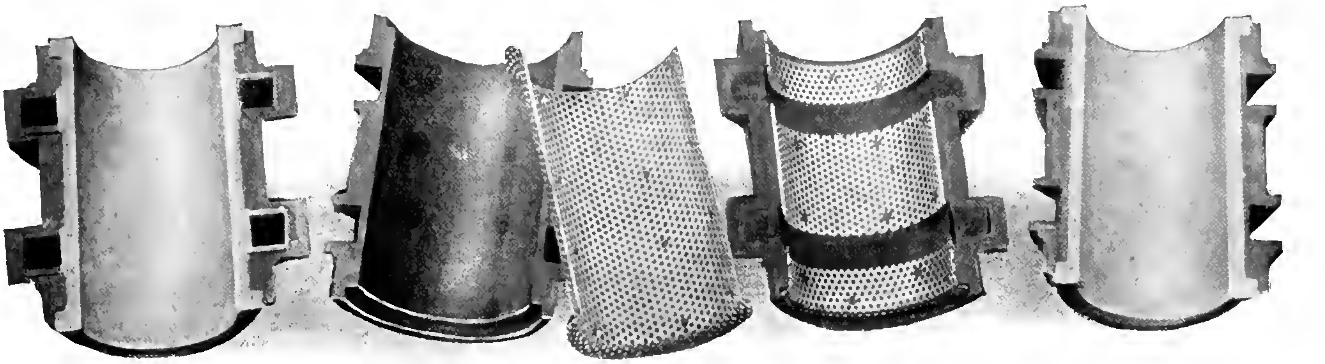


Fig. 9. Glyco Bearings of the Plain and Oil Ring Type, Before and After Babbitting.

bearing construction which has been used, and favorably commented upon, by European engineers, for several years past, and which is now being widely adopted by leading manufacturers of high speed and high pressure engines. In Fig. 7 is reproduced a main-shaft bearing of a large gas engine, constructed by a leading American manufacturer. The bearing is lined with Glyco bearing metal and the skeleton construction mentioned. The dimensions of the bearings are 8$\frac{1}{2}$ x 15$\frac{5}{8}$ inches. The skeleton consists of a No. 10 gage, soft steel perforated plate, thoroughly cleansed and tinned. The skeleton

Fig. 10. Large Bearing Shell and Glyco Liner.

is then fastened to the cast iron bearing shell by means of 5/16 inch countersunk screws. Glyco metal is then cast in and around it and fuses or solders together with the tinned skeleton. The skeleton being tightly pressed against, and fastened to, the shell by the countersunk screws, the whole forms one solid and homogeneous mass, consisting of shell, skeleton and babbitt, all in intimate contact. On account of the large number of small perforations in the skeleton, the Glyco metal is distributed uniformly over the whole surface

of the bearing shell, and shrinkage strains and hollow spaces are thus avoided. Peening is done away with, and furthermore, the strong, soft steel skeleton strengthens and supports the Glyco liner, just as iron does concrete, in our modern building construction, so that even the heaviest shocks will not break the Glyco liner. The skeleton thus not only prevents, in general, the breakage mentioned above, but also gives

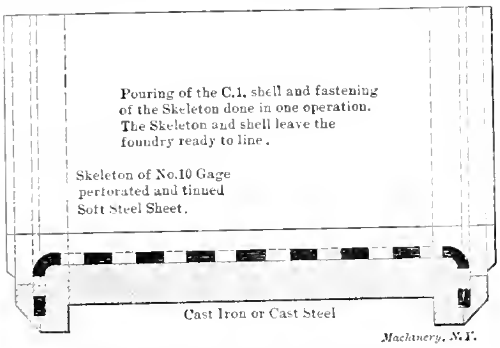


Fig. 11. Glyco Skeleton Cast Integrally with the Shell.

such strength to the babbitt liner that its thickness may be reduced, and economies as high as 50 per cent and more are reported.

On first sight the employment of a perforated skeleton sheet might seem to be a complication of construction, entailing additional expense, but quite apart from the saving by a reduction in thickness of the liner, the economies graphically illustrated in Figs. 8, 9 and 10 would offset any such expense, and may be explained as follows. Fig. 8 shows a bearing shell with dovetailed anchoring grooves; Figs. 9 and 10 show bearing shells, as designed for skeleton construction. The simplicity of the casting in the latter case, as compared with the former, is readily observed. The pattern for the former necessitates coreprints and the employment of core boxes. The pattern for the latter is perfectly plain, not requiring core-prints or core boxes, and the molding may be accomplished quickly. When the casting is made, the time-consuming process of cleaning or chiselling out dove-tailed grooves is also eliminated.

Another Simple Method of Fastening in the Skeletons.

Another method of securing the skeleton to the shell, as shown in Fig. 11, is employed with much success. Here the skeleton is integrally cast with the cast iron or cast steel shell, the skeleton having flanges which are cast into the flanges of the shell. In molding, the skeleton is put in the sand with the pattern. The perforations of the face of the skeleton are of course filled with sand, so that they may be left free. The skeleton cast integrally in this manner then fulfills its purpose, the same as when screwed in, and obviates the use of screws. The skeleton construction has been on the market in Europe for several years, and is patented in all countries.

* * *

In a consular report we find a note which throws some light upon the fact that it is not always the best business principle to appoint general agents in Europe, and then refuse to do business directly. The consul in question received a letter from a French dealer who stated, in substance: "I want ———'s goods, but they have a general agent at London, who has appointed Mr. ——— his general agent in Paris, who in turn has appointed Mr. ——— his agent in Lyon, and I have to pay all these people their commissions before I can commence to think of my own."

CRANE SIXTEEN-SPINDLE DRILL.

The multiple-spindle drill shown in Fig. 1 is an interesting special machine designed and built by the Crane Co., Chicago, Ill., for use in its manufacturing plant. It has 16 spindles, each driven by an independent motor; and still another independent motor is provided for the feed motion, thus giving the machine the unique distinction of having seventeen motors in all. But this is not, by any means, the only radical departure from the conventional forms of multiple-spindle drills. The machine was designed with the view of making each spindle produce to the full capacity possible with high-speed drills, and to be readily changed to any possible grouping of holes within its range. To facilitate changes, each motor and its drill spindle mechanism is mounted on an independent frame or base, which is not clamped down at all, but which depends on its weight and an over-hanging circular plate (for taking the upward thrust) to keep it in any set position.

The frames carrying the motors and drills rest upon a large circular plate *A*, Fig. 2, about 11 feet diameter. This plate is supported by two columns or uprights forming the frame of the machine. The raising of the motor and drill spindle frames by the upward thrust of the drills is prevented by the top plate *B*, which covers the range of lateral movement of

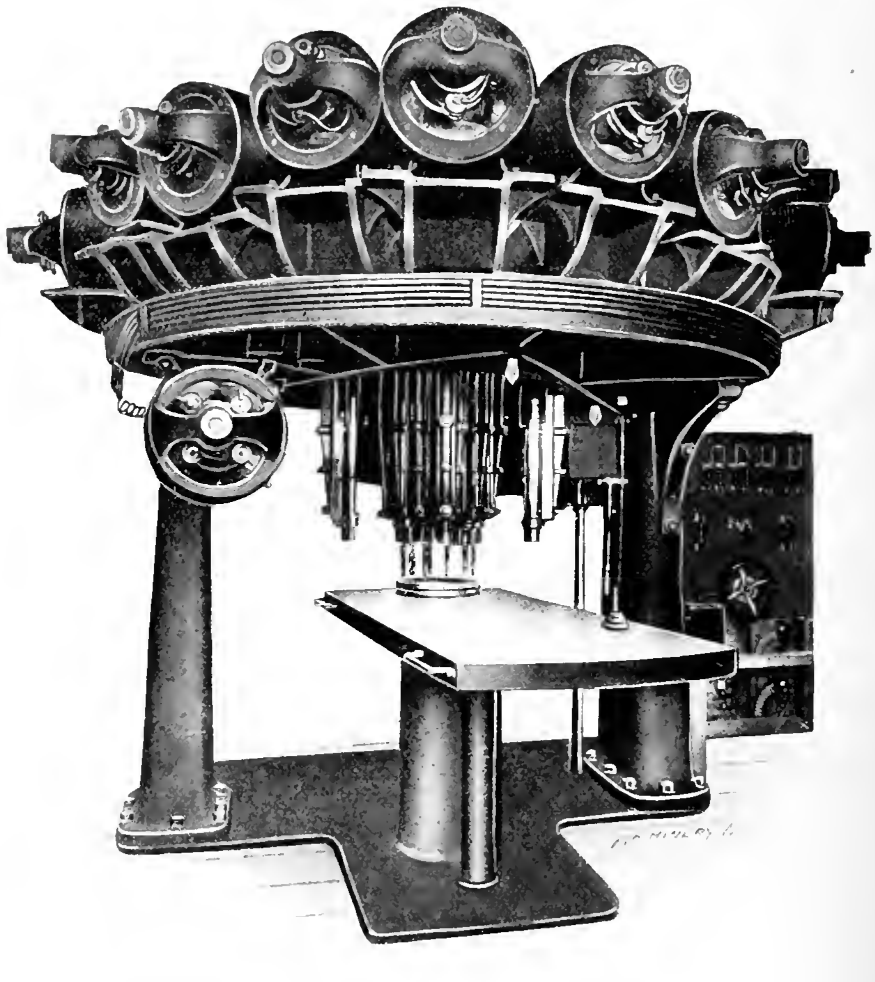


Fig. 1. Crane 16-spindle Drill, driven by Seventeen Variable Speed Motors.

the drills. It is suggested by the designing engineer that the plate *B* might be magnetized to hold the drills more firmly in place, but it has not been necessary to resort to any such expedient with the machine now in use in the Crane Co.'s shops. Thus it is apparent that all adjustments of this machine necessary to change for different classes of work are made without the use of wrenches, drifts or any sort of tool whatever. Only the hands of the operator are necessary. The motor bases are provided with small bearing wheels to facilitate these changes.

The drills may be set all to the same level in a few seconds simply by loosening the clamping nuts (see Fig. 1), holding the drill spindle guides. The drill spindles can be adjusted

to the minimum distance of 3⅛ inches between centers and to a circle of 36 inches maximum diameter. The maximum size drill that can be used is 1⅝ inch diameter.

Each drill spindle is driven through a sleeve coupling connecting the motor shaft and spindle through a pair of special bevel gears and a universal joint. There is no feed rigging attached to the drill spindle, the work table being fed up to the drills from beneath. The table upon which the work rests may be set from 2½ to 50 inches from the floor and the automatic feed covers the entire range of movement. The feed is driven by a variable-speed motor, and quick traversing

bottom of the spindle. This driver is inserted with the drill, and a slight backward turn prevents it from falling out, and brings it up against the feathers in the sleeve. A spiral spring is provided to hold the driver securely in place. The upward movement of the drill, due to thrust, is checked by a threaded nut fastened adjustably to the top of the drill. The thread on this nut and the internal thread of the sleeve are interrupted as is indicated in the cross-section views, this being done, of course, to save time when removing the drills for grinding and when adjusting them downward to compensate for the shortening due to wear.

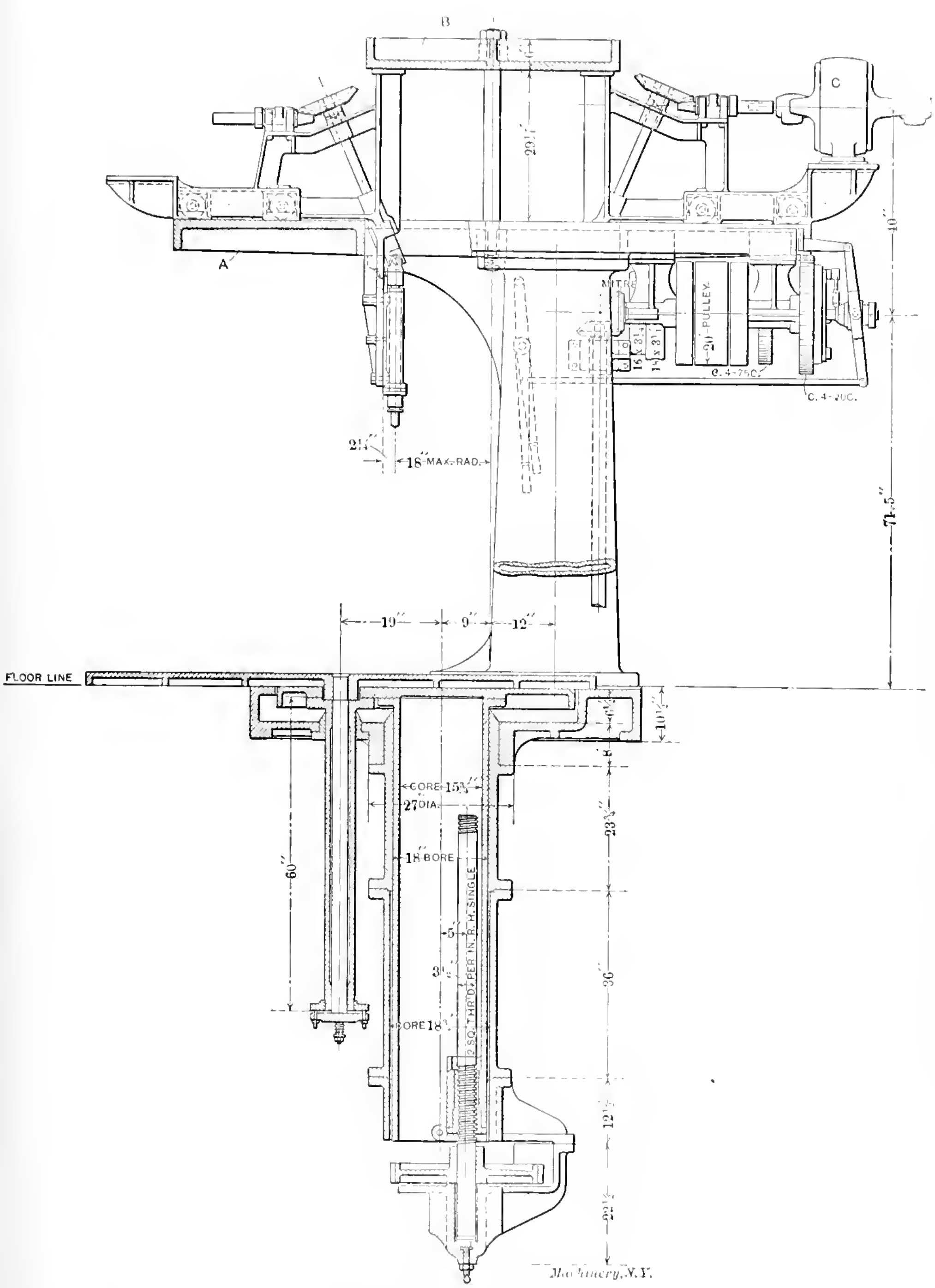


Fig. 2. Vertical Section of Crane 16-spindle Drill, showing Bearing and Thrust Plates, and Motor and Drill Spindle Connection.

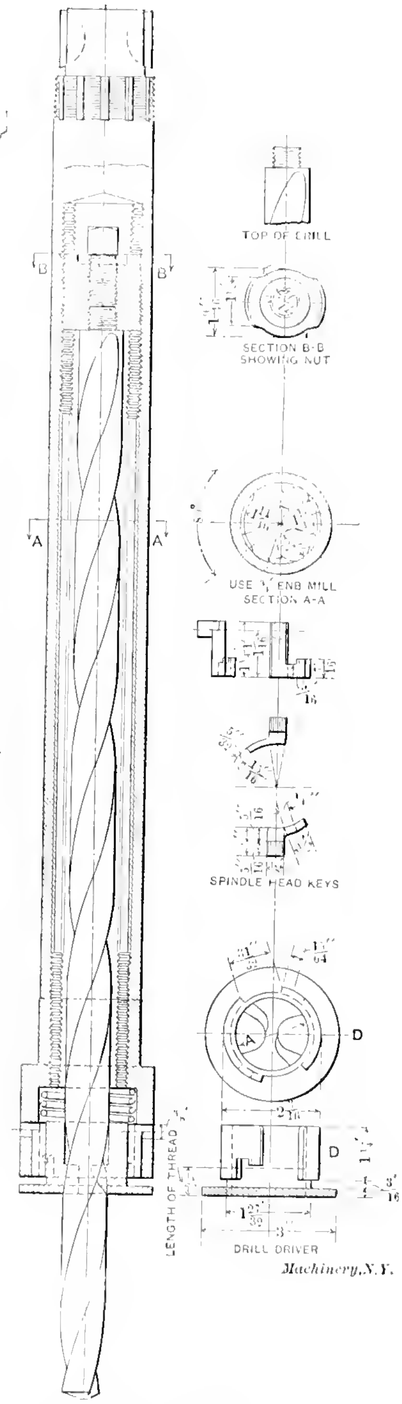


Fig. 3. Details of the Construction of Drill Spindle Sleeve.

movement is provided in both directions for adjusting the table to height. The table is pivoted at its center for facilitating changing the work. While a piece is being drilled upon one end, the other end projects beyond the upright frames where it is convenient for the operator to remove one just drilled and to replace it with another.

The twist drills used are without the usual shank, a short threaded end being provided instead. They are made 24 inches long and are used until there is only 2½ inches remaining in the socket. The drills are not driven from the shank end, but by a driver *D*, Fig. 3, fitting in the flutes at the

The flexibility of the arrangement is quite apparent. Any desired groupings within the capacity of the machine may be obtained, and spindles that are not required may remain idle, thereby avoiding needless consumption of power. Power is required only for the number of drills in use, whether it be one, two, or sixteen.

* * *

A Chicago company lately made for a large sawmill a leather belt which is supposed to be the largest ever manufactured. It is 7 feet wide, three ply in thickness, 114 feet long, and weighs 2,300 pounds.

REAMERS.—4.

ERIK OBERG.

Taper Reamers.

Taper reamers are used for reaming holes for standard taper pins, holes in taper sockets, and, of course, for all other cases where a correct tapered hole is required. In some cases roughing taper reamers are intended merely for removing metal, and the final finish of the work is of minor consideration. The reamers for standard taper pin holes are almost always finishing reamers, whereas for reaming taper sockets, and other work with large tapered holes, usually both roughing and finishing reamers are employed. The roughing reamer is simply intended to remove enough stock so that the finishing reamer can produce a smooth hole, true to size, without being exposed to excessive wear, and thus retain its correct size so much the longer.

Fig. 15. Roughing Taper Reamer.

Fig. 16. Finishing Taper Reamer.

Roughing Taper Reamers.

Roughing taper reamers, such as used for reaming Morse and Brown & Sharpe standard taper sockets are made exactly like the finishing reamers, except that they are made about 0.010 inch smaller in diameter, and are provided with a special groove cut like a thread all around the cutting edges, as shown in Fig. 15. This thread or groove breaks up the chip in the same manner as the nicks in the cutting edges of plain milling cutters. The thread is cut left-hand, with a tool similar to a square thread tool, but with the corners slightly rounded. The width of the tool should vary from about 1/32 inch for the smallest size reamer for Morse taper sockets, to 3/32 inch for the largest sizes. The depth of the groove should be slightly more than one-half of the width of the tool. After being hardened and drawn to a temperature of 370 degrees F., the roughing reamer should be ground with a somewhat greater clearance than the finishing reamer.

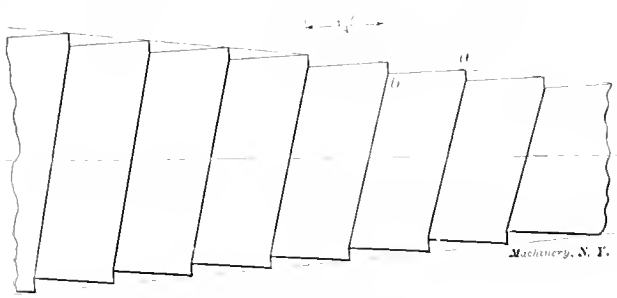


Fig. 17. Method of Making Steep Taper Roughing Reamer.

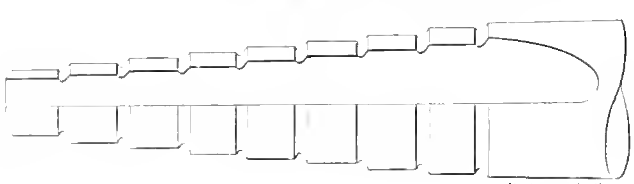


Fig. 18. Step Reamer.

The pitch of the thread should be from one-fifth inch for the smallest sizes of roughing taper reamers up to one-third inch for the largest sizes, that is, there will be from three to five threads per inch, according to size, along the cutting edge.

The cutting edges of roughing taper reamers are sometimes cut spiral. The spiral, or properly helix, may be a right-hand one in this case (on hand reamers, as mentioned in the August issue, the spiral must be left-hand), as there is no danger of the reamer drawing into the work too suddenly, on account of the taper. However, most manufacturers make both roughing and finishing reamers with straight flutes whenever there is not an exceptionally steep taper or a long tapered hole to be reamed. In such a case the roughing reamers are constructed on a different principle from the one just described. The reamer is turned somewhat over-size, and ground to the correct diameter desired before being fluted. It is then returned to the lathe, and a thread cut on the surface with a square-nosed tool, ¼ inch wide. The pitch of this thread is ¼ inch, and the depth such that the ground surface at the end of the cut nearest the end of the reamer is barely touched, as shown in Fig. 17. In this cut, the dash-dotted lines indicate the ground tool blank before the thread is cut, and the full lines the appearance of the blank with its thread. The thread itself is left-handed, and each step is slightly back-tapered, say 0.002 inch in the distance of ¼ inch, that is, the point *a* of each step is 0.002 inch further away from the axis of the reamer than the point *b*. After threading, the reamer is fluted with left-hand spiral flutes, the spiral being so selected that the angle which the cutting edges make with a plane through the axis of the reamer is 15 degrees. Some tool-makers also advocate an odd number of flutes for this class of reamers, but as long as the reamer is provided with spiral flutes, there seems to be no valid reason why an odd number of flutes would add any advantages.

TABLE XIII. STANDARD TAPER PINS.

No. of Taper Pin.	Diameter at Large End of Pin	Approximate Fractional Size at Large End of Pin.	Length of Longest Pin of this Size.	No. of Taper Pin.	Diameter at Large End of Pin.	Approximate Fractional Size at Large End of Pin.	Length of Longest Pin of this Size.
000000	0.0715	5/64	5/8	3	0.219	7/32	1¾
00000	0.092	3/32	5/8	4	0.250	¼	2
0000	0.108	7/64	¾	5	0.289	19/64	2¼
000	0.125	⅛	¾	6	0.341	11/32	3¼
00	0.147	9/64	1	7	0.409	13/32	3¾
0	0.156	5/32	1	8	0.492	½	4½
1	0.172	11/64	1¼	9	0.591	19/32	5¼
2	0.193	3/16	1½	10	0.706	23/32	6

TABLE XIV. DIMENSIONS OF TAPER PIN REAMERS.

No. of Taper Pin Reamer.	Total Length of Reamer.	Length of Cutting Edges.	Length of Shank.	Diameter at Small End of Reamer.
000000	1½	1	½	0.057
00000	1½	1	½	0.078
0000	1¾	1⅛	5/8	0.091
000	1¾	1⅛	5/8	0.108
00	2¼	1 7/16	13/16	0.125
0	2⅜	1½	⅞	0.134
1	2¾	1¾	1	0.145
2	3	2	1	0.161
3	3⅜	2¼	1⅛	0.182
4	3⅞	2⅝	1¼	0.205
5	4⅜	3	1⅜	0.239
6	5½	4	1½	0.270
7	6¼	4½	1¾	0.328
8	7¼	5¼	2	0.395
9	8⅜	6⅛	2¼	0.479
10	9½	7	2½	0.578

Fig. 18 shows another form of roughing taper reamers for steep tapers. This form is known as a step reamer. As a matter of fact, this tool is a kind of multiple counterbore; each step together with the previous one forms a complete counterbore, the smaller step being the guide and the larger the body. All the cutting is done at the front end of each step. The cylindrical portion of the step should not be relieved, but it is preferable to slightly back-taper these portions the same as in the case of the threaded taper reamer. The flutes may be straight or spiral; if the latter, the same angle of spiral as mentioned previously should be selected. The number of the flutes for this kind of reamer is usually four.

Finishing Taper Reamers.

Finishing taper reamers, as shown in Fig. 16, are similar to ordinary hand reamers, except that the cutting edges taper. The flutes are almost always cut straight, but spiral flutes are

of advantage in porous metal or in work pierced crosswise by other holes or openings. The spiral should be right-handed, there being no tendency to draw the reamer into the hole on account of the taper of the hole.

Taper Pin Reamers.

Taper pin reamers, as mentioned, are intended for reaming holes for standard taper pins. The taper is ¼ inch per foot. The diameter of the small end of the reamer should be such that the reamer will project at least 1/16 inch, or, on larger sizes, ⅛ inch, through the hole reamed for the longest standard taper pin of the size in question. The length of the cutting edges should be enough longer than the longest pin to permit the reamer to be ground a number of times without being too small in diameter at the upper end of the flutes for the size pin for which it is intended.

In Table XIII are given the standard dimensions for taper pins as adopted by the Pratt & Whitney Co., and in Table XIV the dimensions for corresponding sizes of taper pin reamers. These reamers are provided with a square on the end of a shank for a tap wrench. The length of the square should be about one and one-half times the diameter of the shank. The size of the square should be three-fourths the diameter of the shank.

TABLE XV. DIMENSIONS OF REAMERS FOR MORSE STANDARD TAPERS.

No. of Morse Standard Taper.	Total Length of Reamer.	Length of Cutting Edges.	Length of Shank.	Diameter at Small End, Finishing Reamer.	Diameter at Small End, Roughing Reamer.	Taper per foot.
0	4	2½	1½	0.252	0.242	0.625
1	4⅝	2¾	1⅞	0.369	0.359	0.600
2	5½	3¼	2¼	0.572	0.562	0.602
3	6⅝	4	2⅝	0.778	0.768	0.602
4	8	5	3	1.020	1.010	0.623
5	9½	6¼	3⅞	1.475	1.465	0.630
6	12	8¼	3¾	2.116	2.106	0.626
7	15	11	4	2.750	2.740	0.625

TABLE XVI. DIMENSIONS OF REAMERS FOR BROWN & SHARPE STANDARD TAPERS.

No. of Taper.	Total Length of Reamer.	Length of Cutting Edges.	Length of Shank.	Diameter at Small End. Finishing Reamer.	Diameter at Small End. Roughing Reamer.	Taper per foot.
1	2	1¼	¾	0.197	0.187	0.500
2	2¾	1⅝	1⅛	0.247	0.237	0.500
3	4	2½	1½	0.309	0.299	0.500
4	4	2½	1½	0.347	0.337	0.500
5	4¾	2⅞	1⅞	0.447	0.437	0.500
6	6¼	4	2¼	0.497	0.487	0.500
7	7¼	4¾	2½	0.597	0.587	0.500
8	7½	4¾	2½	0.747	0.737	0.500
9	7¾	5	2¾	0.897	0.887	0.500
10	10¼	7⅛	3⅛	1.042	1.032	0.516
11	11	7¾	3¼	1.247	1.237	0.500
12	11½	8⅛	3⅜	1.497	1.487	0.500
13	12¼	8¾	3½	1.747	1.737	0.500
14	13	9¼	3¾	1.997	1.987	0.500
15	13½	9¾	3¾	2.247	2.237	0.500
16	14	10¼	3¾	2.497	2.487	0.500
17	15	11	4	2.747	2.737	0.500
18	15½	11½	4	2.997	2.987	0.500

The number of flutes in taper pin reamers should be chosen as follows:

Number of Taper Pin Reamer.	Number of Flutes.
000000 — 00	4
0 — 7	6
8 — 10	8

Taper Reamers for Morse Standard Taper Sockets.

For reaming Morse standard taper sockets, two reamers are used, one for roughing and one for finishing, the construction of the former having already been described. The finishing reamer is made like the taper pin reamer, with the exception, of course, that the taper is made according to the Morse standard taper gages. This taper, as is well known, is different for the different sizes or numbers of Morse tapers, but is approximately ⅝ inch per foot. The square of these reamers should have a length equal to about the diameter of shank; the size of the square should be three-fourths the diameter of the shank. This leaves a small round on the corners of the square, which is desirable for the appearance of the tool as well as for the convenience of handling a tool without sharp corners. In Table XV are given the essential dimensions for these reamers. Morse tapers are the most extensively used of all standard tapers, and for twist drills this taper is used almost exclusively.

The number of flutes in roughing as well as finishing reamers should be as follows:

Reamer for Morse Taper Socket No.	No. of Flutes.	Reamer for Morse Taper Socket No.	No. of Flutes.
0—1	6	6	14
2—4	8	7	16
5	10		

Taper Reamers for Brown & Sharpe Standard Taper Sockets.

Roughing and finishing reamers are used in this case, the same as for Morse taper sockets. The taper is ½ inch per foot, except of taper No. 10, which is 0.5161 inch per foot. In Table XVI are given all the essential dimensions for these reamers. In the system of Brown & Sharpe taper shanks there are in certain cases a number of different lengths of taper sockets corresponding to the same number of taper, all, however, being of the same diameter at the small end. While the lengths of the sockets are different, the reamers can, of course, all be made the same for the same number of taper, inasmuch as the diameter at the small end is the same, and the only thing to consider is to make the length of the cutting edges of the reamer long enough for the longest or deepest taper socket of a particular size. In this case they will, of course, also answer the requirements for the shorter lengths. The Brown & Sharpe taper shanks are used mostly on shank end mills and T-slot cutters.

TABLE XVII. REAMERS FOR JARNO TAPERS.

No. of Jarno Taper.	Total Length of Reamer.	Length of Cutting Edge.	Length of Shank.	Diameter at Small End, Finishing Reamer.	Diameter at Small End, Roughing Reamer.
2	2⅝	1⅜	1¼	0.200	0.190
3	3½	2	1½	0.300	0.290
4	4⅜	2⅝	1¾	0.400	0.390
5	5¼	3¼	2	0.500	0.490
6	5⅞	3¾	2⅛	0.600	0.590
7	6½	4¼	2¼	0.700	0.690
8	7⅜	4⅞	2½	0.800	0.790
9	8¼	5⅜	2¾	0.900	0.890
10	8⅞	6	2⅞	1.000	0.990
11	9½	6½	3	1.100	1.090
12	10⅛	7	3⅛	1.200	1.190
13	10¾	7½	3¼	1.300	1.290
14	11⅜	8	3⅜	1.400	1.390
15	12	8½	3½	1.500	1.490
16	12⅝	9	3⅝	1.600	1.590
17	13⅜	9⅝	3¾	1.700	1.690
18	14	10⅛	3⅞	1.800	1.790
19	14⅝	10⅝	4	1.900	1.890
20	15¼	11⅛	4⅛	2.000	1.990

The number of flutes in roughing as well as finishing reamers should be as follows

Reamer for Brown & Sharpe Taper Socket No.	No. of Flutes.	Reamer for Brown & Sharpe Taper Socket No.	No. of Flutes.
1—5	6	13	12
6—10	8	14—15	14
11—12	10	16—18	16

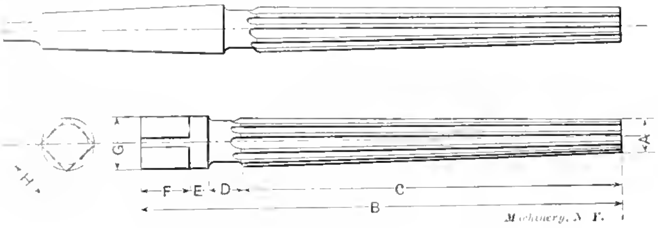
Jarno Taper Reamers.

The general characteristics of the Jarno taper reamers have been referred to in MACHINERY in the "How and Why" section of the April issue, and also in a short article entitled "Table of Jarno Tapers" in the June issue. In Table XVII are given the principal dimensions for reamers used to ream out Jarno taper sockets. The number of flutes in Jarno taper reamers should be as follows:

No. of Jarno Taper.	No. of Flutes.	No. of Jarno Taper.	No. of Flutes.
2	4	11—15	10
3—4	6	16—18	12
5—10	8	19—20	14

Locomotive Taper Reamers.

Taper reamers for locomotive work are generally made in two styles, with squared and tapered shanks, as shown in Figs. 19 and 20. While there are a great many different standards in use in locomotive railroad shops, the commonly accepted standard of taper for locomotive taper reamers is 1/16 inch per foot. In Table XVIII the principal dimensions for locomotive taper reamers with squared shanks, as commonly made, are given. The dimensions for the fluted part of those with taper shank, generally Morse taper, are exactly the same, the only difference being the over-all length, which, of course, is dependent upon the number of Morse taper shank used. The common practice is to use the following number of Morse taper shanks for the sizes given below:



Figs. 19 and 20. Locomotive Taper Reamers.

Sizes of Reamers	Number of Morse Taper Shank
From 1/4 to 9/16 inch	1
From 5/8 to 7/8 inch	2
From 15/16 to 1 3/16 inch	3
From 1 1/4 to 1 11/16 inch	4
From 1 3/4 to 2 inches	5

The number of flutes should be as follows:

Sizes of Reamers.	Number of Flutes.
From 1/4 to 1/2 inch	6
From 9/16 to 1⅛ inch	8
From 1 5/16 to 1¾ inch	10
From 1 13/16 to 2 inches	12

The length of the neck between the taper shank and the cutting portion of a reamer should be from ⅜ inch on the ¼-inch size to 1 inch on a 2-inch reamer. The size of these reamers is measured at the extreme small end of the fluted portion.

TABLE XVIII. DIMENSIONS OF LOCOMOTIVE TAPER REAMERS WITH SQUARED SHANK.

Diameter at Small End of Reamer.	Total Length.	Length of Flutes.	Length of Neck.	Length of Collar.	Length of Square.	Diameter of Collars	Size of Square.
A	B	C	D	E	F	G	H
1/4	5	4	3/8	1/4	3/8	5/16	1/4
5/16	5 3/4	4 1/2	7/16	5/16	1/2	3/8	9/32
3/8	6 1/2	5	9/16	3/8	9/16	7/16	5/16
7/16	7 1/4	5 1/2	5/8	3/8	5/8	1/2	3/8
1/2	8	6	11/16	1/2	3/4	9/16	7/16
9/16	8 3/4	6 1/2	3/4	9/16	13/16	11/16	1/2
5/8	9 5/8	7	3/4	11/16	7/8	3/4	9/16
11/16	10	7 1/2	3/4	3/4	15/16	13/16	5/8
3/4	10 5/8	8	13/16	13/16	1	7/8	11/16
7/8	11 3/4	9	13/16	13/16	1 1/16	1	3/4
1	12 7/8	10	7/8	7/8	1 1/8	1 1/8	13/16
1 1/8	14	11	15/16	7/8	1 3/16	1 1/4	15/16
1 1/4	15 1/8	12	1	7/8	1 1/4	1 3/8	1
1 3/8	16 1/4	13	1 1/16	7/8	1 5/16	1 1/2	1 1/8
1 1/2	17 3/8	14	1 1/8	7/8	1 3/8	1 5/8	1 3/16
1 5/8	18 1/2	15	1 1/8	7/8	1 7/16	1 3/4	1 5/16
1 3/4	19 5/8	16	1 1/8	7/8	1 1/2	1 7/8	1 3/8
1 7/8	20 3/4	17	1 1/4	7/8	1 9/16	2	1 1/2
2	21 3/4	18	1 1/4	1	1 5/8	2 1/8	1 9/16

* * *

The steam rock drill is a machine that is applied to a wide variety of uses. Not only is it very effective for its designed purposes—the drilling of blasting holes in rock and channeling—but not infrequently in some western mining camps it is mounted on a frame over an anvil and made to do duty as a steam hammer. Again, in building operations it is frequently put to other than its prime purpose. Not long ago we saw one being used on Broadway, New York, to drive sheet piling, which it did very effectively.

SOME BRITISH MACHINE TOOLS.*

JAMES VOSE.†

The firm of George Richards & Co., Ltd., Broadheath, Manchester, has for a number of years been prominent in several lines of machine tools, and the illustrations and particulars here presented will give a good idea of some of the leading specialties of the company. "Side" planers are built in a range of sizes dealing with work from 12 to 48 inches, and from 2 to 30 feet long. The advantages of this type include, of course, the comparatively small floor space occupied—the tool moving over the work, which is fixed—and facilities for handling awkward shaped pieces by the utilization of a pit in conjunction with the separately adjustable or removable tables. With the tables removed, and work fastened to the vertical platens, or apron plates, pieces up to 10 tons weight may be dealt with on a machine which planes 30 inches wide. The saddles are directly driven by screw, no gearing being used, the thrust of the screws being taken by roller bearings. The traversing arm may be fitted with one or more tool boxes, and if desired double arms may be fitted, each driven by separate screw, so that two distinct jobs may be dealt with at once, or one job set while the other is being tooled. The back shear of the bed is now made the guiding surface for the saddle, with distinct advantage in the reduction of friction, the ratio of length of saddle to width of guiding surface now being about 11 to 1. When both front and back surfaces acted as guides the ratio was about 2½ to 1. A modification of the machine for planing turbine frames consists of two beds with sliding saddles and cross head, the beds supported on legs, the whole mounted on a base-plate 15 inches deep. The cross-head is driven by two sets of driving pulleys through bevel gears, and carries two tool rams which may be swiveled to any angle, and have an automatic down feed of 30 inches. Work 10 feet wide may be planed across the top, or work 8 feet wide planed down the sides. Fig. 1 shows the 30-inch wide size machine, arranged with special swiveling slide for planing the angular bearings of engine beds, etc., no packing of the beds being required, they being placed flat on the machine tables or on the floor. As ordinarily arranged, the weight of such a machine to plane 15 feet long is 15 tons.

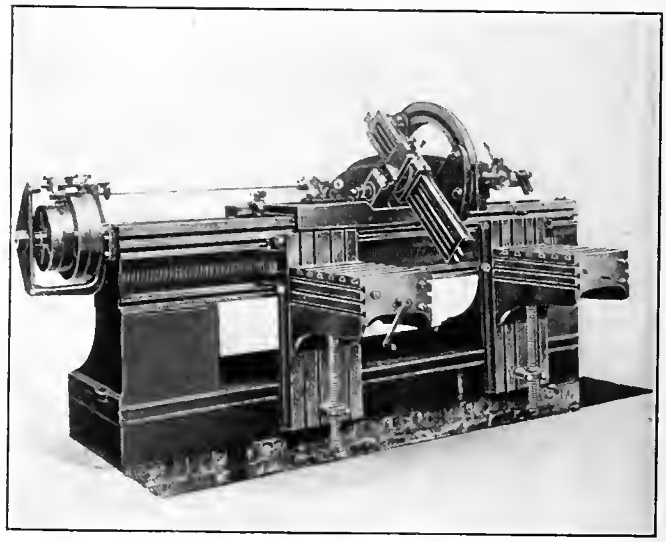


Fig. 1. Thirty-inch Richards Side Planer, with Special Swiveling Cross Rail.

Forty-inch Side Planer.

Fig. 2 represents the 40-inch wide size, to plane 12 feet long, but fitted with a special arm for deep vertical planing. The machine will plane 4 feet deep, the tool having a cross traverse of 3 inches only. The standard arm seen on the floor is interchangeable with the special one. Two tables, not shown, are provided for ordinary work, the users themselves providing a suitable bed plate in front of the machine to suit their own work. The vertical arm is supported at the

* The following articles dealing with machine tools of English design have previously been published in MACHINERY: Some Notes from an English Shop, September, 1897; Some English Lathes, September, 1904; A Vertical Miller and a Turret Lathe of English Design, March, 1907; Recent Development of British Machine Tool Industry, July, 1907.

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bottom by a slide formed on the cross girth of the machine, and is fitted with a taper strip for adjustment.

Forty-eight-inch Boring and Turning Mill.

Fig. 3 illustrates the 48-inch special type of boring and turning mill for machining steel tires, or for heavy cutting generally, in hard material. It takes in 36 inches under the cross-slide and tool-holders, which have a down feed of 20 inches. The spur gear driving the table is 40 inches pitch diameter by 5 inches wide and 2 inches circular pitch. The spindle is 10 inches diameter, with a bearing 23 inches long. The section, Fig. 4, shows the special annular thrust bearing which runs in an oil bath, a gage fixed to the side of the machine indicating the amount of oil in the reservoir. A fixed stop in the cross-slide facilitates the setting of the square steel tool-bars when using double-sided boring cutters. One of the tool-bars is usually arranged to swivel. A patent spring balance (see MACHINERY, March and December, 1904, for description) dispenses with weight and chains and generally conduces to easy setting of work. The drive may either be by belt, gear box and friction back gear, or direct-connected variable speed motor and spur gearing. A positive feed gear box, placed on one side of the machine, gives 10 changes or rates of feed. The line of boring and turning mills built for general use under modern conditions ranges from 3 feet to 10 feet swing.

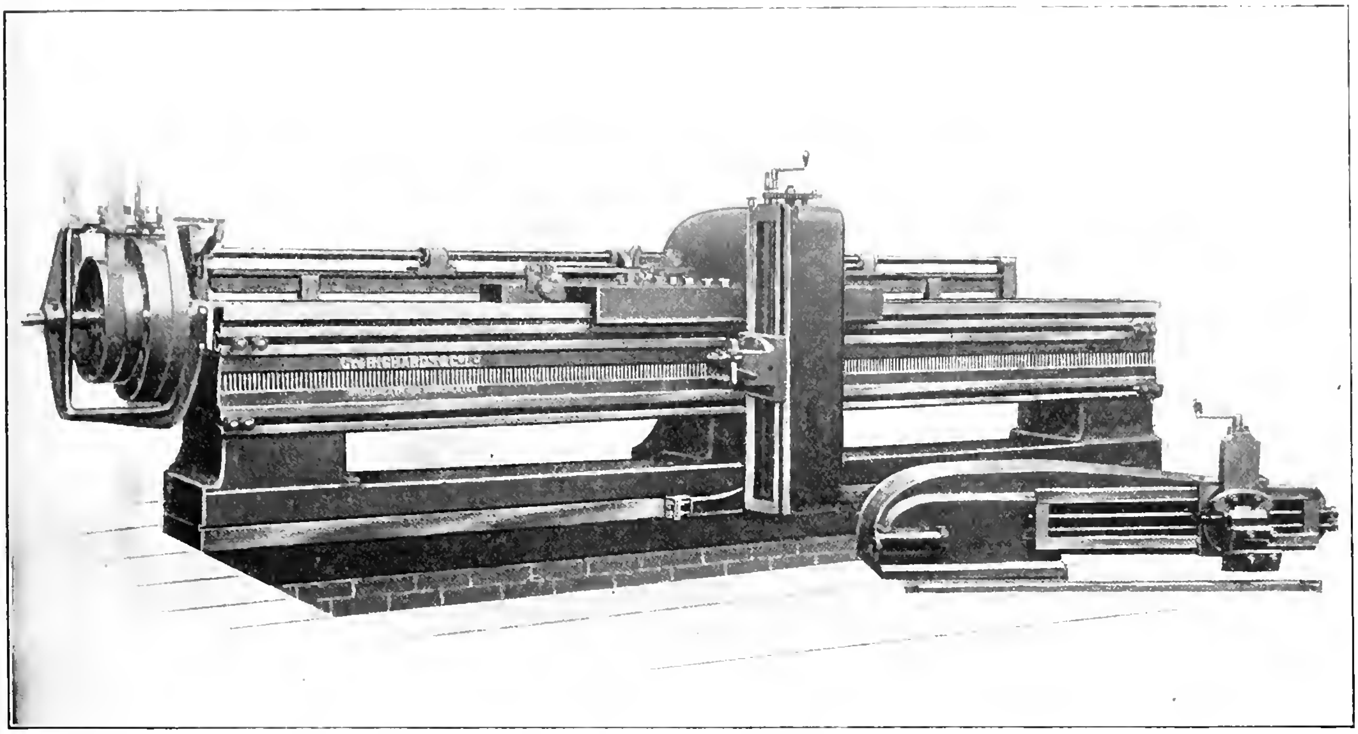

Fig. 2. Forty-inch Richards Side Planer, with Standard and Special Rails for Vertical and Horizontal Cuts.

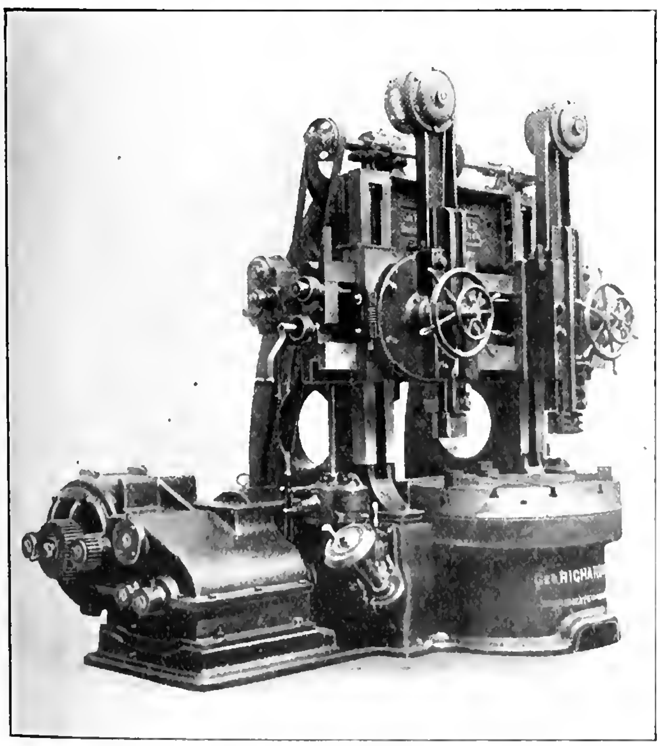

Fig. 3. Richards Forty-eight-inch Boring and Turning Mill.

Duplex Boring and Turning Mill.

Duplex boring and turning mills for work of small and medium diameter find an increasing field in British practice, and Fig. 5 illustrates a range of machines varying from 14 to 30 inches swing. Two machines are arranged right and left-hand and have their bases cast together. As regards their motions, they are entirely independent of each other, being driven by separate countershafts, the tables being started and stopped by individual levers in front. In the case of the 26 and 30-inch machines, the turret slides are arranged to swivel for turning or boring tapers. Four-jaw chuck tables with independent and reversible jaws are fitted on the 14- and 30-inch machines. The 26-inch machine is fitted optionally with plain or chuck tables.

General Line of Machine Tools Built.

Though the machines mentioned, in their ordinary and special forms, represent the types most prominently in demand, several other types of machine tools are also in regular call, amongst which may be mentioned direct belt driven radial drills in which bevel gears are dispensed with, the back gears being mounted on the spindle. These are made with arms from 3 feet to 6 feet radius, and are made with gear-box speed changes if desired, in place of cone drive. Completely automatic slot-drilling and keyway-cutting machines, producing keyways from the smallest sizes up to 3 feet 6 inches long and 2½ inches wide, are a well-established specialty. Horizontal boring machines with spindles from 2 to 4 inches diameter, and, generally, embodying approved modern conveniences in the way of wide range of speeds and feeds and easy handling of work, are another line in constant demand. A machine manufactured for many years, but recently also specially adapted for motor car work, is a vertical milling machine. For general work the tool is supplied with a plain rectangular table, or one with circular feed motion. It is built somewhat on the lines of a planing machine as regards the standards and cross rail; in one size the standards are 4 feet 4 inches apart, and in the other 6 feet apart, the table movements being 36 x 20 inches and 48 x 36 inches, respectively. Eight positive feed changes are provided. The spindle, with six speeds, is driven by worm and wheel sub-

merged in oil. For machining aluminum, and motor car details generally, duplex drive to the machine spindle is provided, the spindle at choice being driven by worm and wheel for the slower speeds, or by spiral gears for the higher ones, when using small cutters. The weights of the two sizes are $2\frac{1}{2}$ and $3\frac{1}{2}$ tons, respectively.

Band sawing machines, with unusually light 30 to 42-inch wheels, and "dimension" circular sawing machines, for patternmakers' use, in which smoothness of finish and accuracy to dimensions of the finished work have received special attention, are also manufactured.

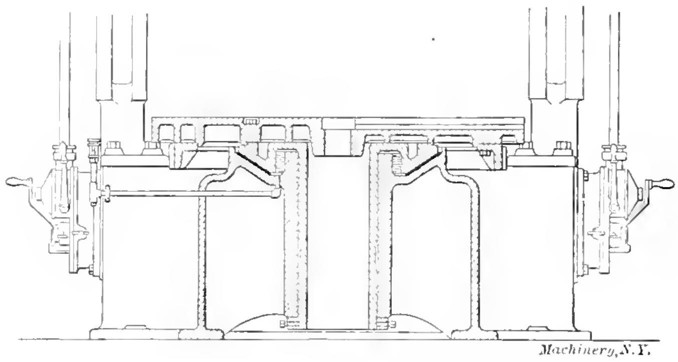

Fig. 4. Special Annular Thrust Bearing Oiling Device.

In another department air compressors for pressures up to 150 pounds per square inch are built in single, compound, duplex, horizontal, and vertical types, for a considerable range of duties. Sand blast apparatus for cleaning castings, removing scale from plates, etc., is another prominent line, also built in its own special section of the works, while still another department is concerned with the manufacture of pulleys and line shaft fittings generally, the pulleys having cast iron arms and steel rims.

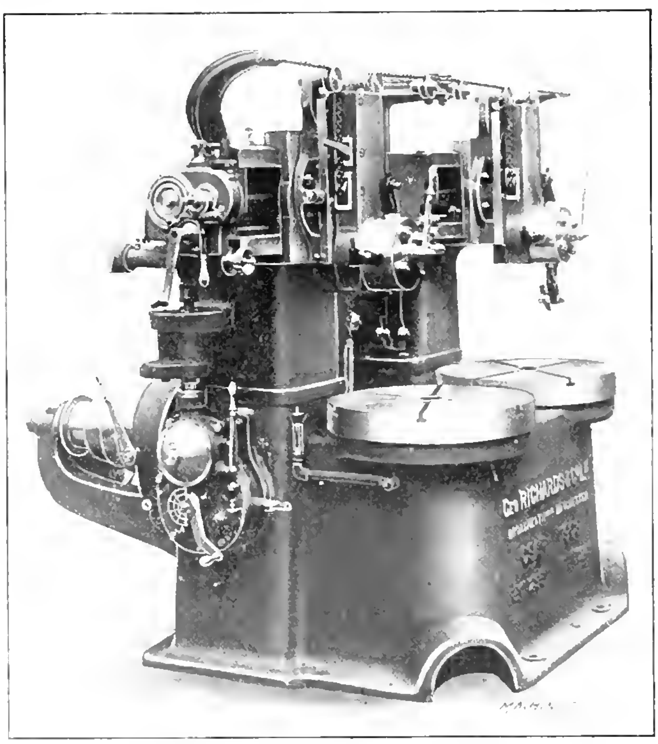
Fig 5. Richards Duplex Boring and Turning Mill.

All the departments are well employed and demonstrate that a reasonably wide range of specialties may be successfully dealt with by the same concern if the organization is arranged to assure consistent attention being given to the different units comprised, and overlapping at the same time avoided.

* * *

Figures recently prepared by a leading English firm for their own information showed that a weekly saving of more than \$2 was being effected in wages for every \$1 of running cost of the pneumatic plant, the latter including interest on capital outlay, depreciation, power charges and maintenance.

THE CONFIDENCES OF A MANUFACTURER.

The manufacturer in question is a real one—not a mythical personage, as might be imagined from the tenor of the ideas he expresses. Not only is he real, but cheerful and prosperous as well, and an advertiser in MACHINERY, though whether this is the cause or the effect of his cheerfulness and prosperity I am unable to say. We met in the course of a railroad journey and (drawn by some affinity in ideas, perhaps) drifted gradually into the conversation of which the gist is given in the following paragraphs.

My traveling companion is the financial and mechanical moving spirit in two manufacturing enterprises, of which one is an old-established firm of many years standing, while the other is a comparatively recent undertaking. Both of these enterprises are successful, though in the case of the latter one, at least, the nature of the product is such that much time and thought had to be expended in overcoming an initial prejudice on the part of the consumer. The most interesting part of the conversation related to his methods of treating his employes, and building up an organization of workmen and foremen into a solid and efficient body, reasonably satisfied as to their own conditions and prospects, and loyal to the firm which employs them.

In his more recent enterprise, especially, care and conscience are required on the part of the workmen. Errors may be made which are not easily detected by inspection, but which are quickly found by the purchaser. Owing to these requirements, my friend has come to the conclusion that for his business, at least, the matter of character is of far more importance than that of quickness of wit or "smartness." There is, of course, nothing new in this idea, and it is being constantly set forth by venerable life-insurance directors with close-cropped side-whiskers, as a rule of guidance for their younger brethren just starting in life. In the case of my friend, however, the conclusion seems to have been arrived at from a "strictly business" standpoint. It has been his experience that lack of technical ability in a workman can be made up—given a little time, a little assistance, and that perseverance which forms a part of the kind of character this man prefers.

In consequence of these ideas, when he finds that he needs a new man for a position of responsibility, his procedure is a little different, possibly, from that usually taken. He selects from among his workmen a man who has shown himself to be intelligent, rather inclined to reserve than otherwise, and above all, conscientious. Such a man might not at first thought seem to make as good boss-timber as a more confident, self-assertive workman. His way of introducing him to his new job, however, inspires these desirable qualities as fast as they are needed.

The most natural thing to do under the circumstances is to tack up a notice in the washroom saying, "On and after November 15 and until further notice, John Smith will be foreman of the Strap Hanger Department, etc." Instead of this my friend does not even tell the man himself that he has been promoted, let alone telling the men under him. Whenever a question arises as to the proper way to do a certain piece of work, the workman who makes the inquiry is told to ask John Smith about it, as the superintendent is busy. John Smith is told to answer these questions as well as he can, and ask help from above when he is unable to answer. Later on the work is given out to the men through John Smith. As time goes on, with occasional assistance, he gradually and naturally assumes more and more authority, and attains to greater and greater self-confidence. In fact the man grows with his position. If it had been suddenly thrust on him at the beginning, the chances are that his self-distrust would have seriously handicapped him, and perhaps also the workmen would not have felt that he was just the kind of man they would have picked out for the position. One of the qualities insisted on is that of reserve. This does not mean grouchiness or conceit, but simply the quality which keeps him just enough removed from his neighbors to prevent them from too easily finding out the weak points in his character.

The commercial value of conscience is shown particularly

in this man's business. There enters into his product a certain part made of tool steel, which has to be manufactured in large quantities. The functions of this part are vital, and the value of the product depends absolutely upon its reliability. The heat treatment given it is especially important. Made in large quantities, as it is, it is necessary to use wholesale methods. In annealing, the pieces are packed into the furnace in a certain unvarying way, subjected to a definitely determined degree of heat for a predetermined time, with fuel and air of unvarying composition; the manner and time of cooling is also uniform. The same definiteness is followed in the hardening process. It will be seen that the same conditions can be repeated absolutely day after day, so that the same results should be obtained day after day—provided that the quality of the steel used is unvarying. I asked him what steel he used, and where he obtained it. He gave me the name of an English maker. "Can they not make as good steel in this country?" I asked. "They know as much, and perhaps more, about making good steel here than they do in England, or anywhere in Europe, so there is no doubt that they can—but they don't. This question of 'care and conscience' enters into the matter too much. The president, treasurer, and chairman of the board of directors of an

". . . to tack up a notice in the wash-room. . "

American steel company may have all the will in the world to make steel of the uniform quality I require, but unless there is a conscientiousness of a high order permeating the whole force, from the highest clear down to the workmen in immediate contact with the metal, some of the hundred-and-one trifles that go to make up perfection in the matter of steel making will be slighted, and the product will show it. American steel does sometimes show this slighting carelessness.

My friend considers it important to have the workmen feel at home in the shop. For instance, if a workman has come there from some other shop, far or near, and proves to be a careful and skillful man, the proprietor feels that he would like to have other men of the same kind, acquaintances of his, working there with him. To this end, if it comes directly or indirectly to his ears that the new man has considerable to say about what "Henry Higgins" used to say and do in the old shop, without letting this man know why or how it was done, the foreman will approach him some day and inquire if he knows of a good workman for the department he is engaged in. "The firm is in need of men of about your kind, and we thought perhaps you might know of some one in the shop you came from who would make a good workman for us." "Sure," says he, "there is Henry Higgins," and so Henry Higgins comes. With the men as well acquainted with each other as they are when the force is collected in this way, there is much less shifting and changing of the force than occurs in shops where no attention is given to matters of this kind.

This proprietor expressed the condition of his shop as being "unbalanced." It is generally the aim to have just enough men in each department of a factory to do the work of that department as fast as it is sent there from the previous one, so that the various operations all move in unison, and the work goes through the shop in a steady stream. Such a shop would be called "balanced." The work of this business, however, is so dependent on getting workmen of the right kind, that the proprietor feels this matter to be of more importance than steady, even production; so whenever a good man is found, he is put to work, even though the department he is placed in piles the work up ahead of the next in order. This, however, acts as a stimulus on the next department, which in turn has to scratch around for more help—and so it goes throughout the shop, there being thus a continual impetus to increase the working force. This unbalanced condition may be likened to the process of walking, which has been described as "continued falling," the body losing the balance at each step, the putting out of the foot saving the man from a tumble, and advancing him by another yard at the same time.

The most startling thing about this manufacturer was the fact that he was an ardent believer in the eight-hour day. "If we cannot shorten to at least eight the hours of what in many lines of work must be more or less drudgery," said he, "then the wonderful improvements in machines and processes which have been made in the last few decades have failed of any useful effect." He is not running his own plant on the eight-hour day, by any means. As conditions are, it would not be quite as profitable as he could wish; and besides that, he believes it unwise to go too far ahead of the procession in a matter of this kind. He has the purpose steadily in view, however, of reducing the hours of labor in his shops to the figure given as fast as the improvements he is introducing will make it profitable, and as fast as the spread of the idea of shorter working hours among other shops makes it advisable.

There are some of these ideas, of course, which my friend has never confided to his workmen. The writer repeats these ideas in the strictest confidence, and earnestly requests his readers to take care that they spread no further. R. E. F.

* * *

FLY-WHEELS FOR PLANERS.

In the *Journal of the Worcester Polytechnic Institute*, Mr. H. P. Fairfield describes a series of tests undertaken to learn something of the conditions which obtain when an induction motor is used to furnish the power to drive a planer with and without a fly-wheel. The tests were made with a 10 horsepower motor driving a 36 x 36-inch x 10-foot planer. The object of the tests was to determine what would be the effect upon the power consumed by changing the length of stroke, and by the use of a fly-wheel. In order to keep the weight and diameter of the fly-wheel as small as possible, it was mounted on the shaft having the highest rotating speed, in this case on the motor shaft itself. The design of the fly-wheel was sufficient to store energy to take care of the shock of reversal without materially changing the speed of the motor. The results of the tests show that on a planer of the capacity of the one tested, at one-half stroke, or 5 feet in length, with no fly-wheel, the current consumption was 1.85 K. W. hour. With a 10-foot stroke, without fly-wheel, the consumption was 1.63 K. W. hour. For the same length of strokes with a fly-wheel the consumption was 1.3 and 1.24 K. W. hour, respectively. In other words, without the fly-wheel the long stroke required 12 per cent less power than the short stroke; with the fly-wheel, the short stroke was performed with 29.5 per cent less power, and the long stroke with 24 per cent less than without the fly-wheel. The fly-wheel was responsible for the greatest saving in power, and the saving gained by grouping the work for a maximum length of stroke was comparatively small as regards power. Another advantage in the use of the fly-wheel was the faster average rate of production due to the absence of slowdowns and tardy reversals. In some shops this would outweigh the power saving in importance. The tests incidentally displayed the value of electric drive when investigating machine performance; with belt drive from a line shaft it would have been difficult to measure the power consumed.

INCREASING THE BOILER CAPACITY.

GEORGE P. PEARCE.*

The article in the August issue, engineering edition, on possible increase in boiler capacity prompts me to point out where a considerable increase in capacity could easily be obtained in many of the mills and factories throughout the country without any expensive equipment at all. As a mechanical engineer, I have been brought into contact with a great variety of power installations, and I should estimate that eight out of every ten of the smaller, say up to 300 H.P., and many of the larger, installations are operated in a very unsatisfactory and unprofitable manner. The boilers have the capacity, but they are run under such miserable conditions that only about 40 to 60 per cent of their rated power can be obtained, when a little "know how" and a comparatively small expense, would easily and safely allow these boilers to be run up to 120 per cent or more, of their rated capacity.

The other day I was called to a small boiler house and asked if there was any way to avoid the purchase of a second boiler, as the one they had did not give enough steam. The boiler was in good shape and was fired nicely, but I noticed the fire did not burn as briskly as it ought to, although the damper was wide open. I stepped outside and looked at the stack; there was the trouble, a miserable 25-foot sheet iron affair with a great dint in one side on account of having blown down several years ago. It was also of smaller diameter than it should be even for a 60-foot stack. "Cut out the dint and add 40 feet to the stack, and you will get all the steam you can handle"—and they did.

"Come to Brown's mill at your earliest and see what is the matter with the power," read a letter one morning. When I arrived there I found that they had just put in some new machinery, and although everything would start up all right in the morning, yet about 10 A. M. the engine would begin to slow down to about two-thirds speed; the same thing also happened in the afternoon, and no matter how the engineer tried he could not get the steam up. "Boilers, again," I said, and we went into the boiler room. There was a nice brisk fire and a good 60-foot stack. This was about 8 A. M. I decided to stay around and wait for the power to drop. I noticed the coal was a poor grade of bituminous, containing a large quantity of dross. Pretty soon one side of the fire began to lose briskness and appear as though the draft was poor. I picked up the scraper and cleared part of a grate bar; there was the "hoodoo," a fine herring bone grate, designed for burning rice coal, the bars of which were becoming covered with a glass-like layer of dross which the engineer could not cut off with the slice bar without leaving the doors open long enough to lose steam. He had thus been getting along the best he could until noon hour, when he would clean his fires and "bar" most of the dross off. Of course the same thing happened in the afternoons. A first-class shaking grate completely cured all trouble here.

Jones had trouble with his boilers. He had two boilers and five engines, and he could not get a sufficient amount of steam. He had a good, well designed boiler-house, evidently equipped by a man who knew the business, so there was nothing wrong there. He was evidently getting plenty of steam and certainly was burning lots of coal. I looked at his engines—small slide valve affairs speeded up to the limit, pounding and rattling around as though every bearing had 1/8 inch wear that needed taking up. I thought I would indicate one, but found it had never been tapped for indicator connections, so I climbed out on the roof to have a look at the exhausts. There was only one exhaust head connected by a tee to two exhaust lines; three engines were on one line and two on the other. The exhaust steam from one line was charging head-on into the exhaust from the other; the exhaust pipes were much too small, and so was the exhaust head. I found out afterwards that only two engines were originally used, and three more had been added on to the old lines. I borrowed the steam gage from the boiler and attached it to one of the exhaust pipes; it showed between 12 and 15 pounds. I also noticed that great quantities of hot water were used for soaking and washing purposes. This was heated with live steam. Upon investigation, it proved that a very small quantity of oil in this water would not be harmful, so I started in to make a few changes. First, two new larger exhaust lines were put in, the one from the two engines going to the old exhaust head, and the one from the three engines discharging into a new head. An automatic back pressure valve was placed on each line and set to three pounds. The engines were all equipped with automatic positive feed lubricators, which I set to feed about 1½ pint per week, or about 1-10 of what was going through the old sight feeds. Then the exhaust steam was connected to the large water heating tanks. These changes alone made a great saving in steam, it now only being necessary to lightly fire the boilers. At the first opportunity I had the engines thoroughly lined up and rebabbitted, and at the same time had them drilled for indicator connections; then I carefully set the valves. This, combined with the lining up and overhauling, reduced the steam consumption so much that one boiler could easily be forced to do all the work. These are only a few instances where considerable expense was saved by proper attention to what may have appeared to be small details.

Let me advise all who are considering the installing of more boilers to carefully go over every detail of their present plant. See that the air spaces in the grate bars are correct; see that the fireman keeps his fires clean, fires evenly, and at regular intervals. Examine the bridge wall and see that it is not built too high or covered with a thick layer of soot; see that the side walls do not allow air to leak in; see that the combustion chamber is clear and the flues regularly kept clean. Next get inside the boilers and see how much scale is round the flues and plates. Be sure that the steam line gets only dry steam. Test the draft, and if poor, measure the stack for length and area and make it right. Look up the feed-water lines, and if you are using an exhaust feed-water heater, see if it is delivering water to the boiler at least 200 degrees F. If not, find out what is the trouble; perhaps the pipes are so choked up with scale that the water has to go through with considerable velocity, thus not being in the heater long enough to absorb sufficient heat. The water is also insulated to a considerable extent by the scale. Then again the drip pipe may not be taking the condensation away fast enough, and the heater be partly filled with cool water. If you have not got a feed-water heater, get one, or make one; a barrel and some old pipe will do. If you now have got the boilers in good shape, and they are generating as much steam as boilers of that size can be expected to do, follow up what is being done with the steam. When did you have the engines indicated last? Are they running up to their full economy? Where is the exhaust steam going? Are you using live steam anywhere, where exhaust would do? Do not say you cannot use the exhaust, because it contains oil; a good oil separator will remove that. Remember exhaust steam is condensed and used for artificial ice—you don't taste oil there. Go over the steam traps and look for leaks. I know of cases where large steam traps have been blowing steam into a sewer for months before the loss was discovered. Also look over the steam lines and see that they are thoroughly protected against condensation. Then, after going over every detail in this manner, if you still find the steam supply insufficient, it is time to start considering an extra boiler. I would warn superintendents against placing too much reliance upon the boiler tests run by the engineer, as he naturally wants to show good results, and so gets conditions that are not every day conditions while running the test.

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* * *

A condition of general prosperity in commercial and industrial lines in Cincinnati during the year 1906 is indicated by the annual report of C. B. Murray, of the Cincinnati Chamber of Commerce. The value of machinery, machine tools, etc., manufactured during the year is placed at $18,000,000. The aggregate value of the output of large and small factories of the city and immediate vicinity is estimated at approximately $345,000,000, compared with the preceding year's estimate of $330,000,000.

ITEMS OF MECHANICAL INTEREST.

NEW TYPE OF VARIABLE SPEED MOTOR.

It is well known that variations in the speed of an electric motor are made possible by varying the amount of current passing through the field winding. This variation is obtained by introducing a resistance in series with the shunt field, or by diverting some of the current in the series field through by-pass in the shape of a resistance. A new type of variable speed motor, described by L. Torda in the *Electrician*, has been brought out by the Morris Hawkins Co.,

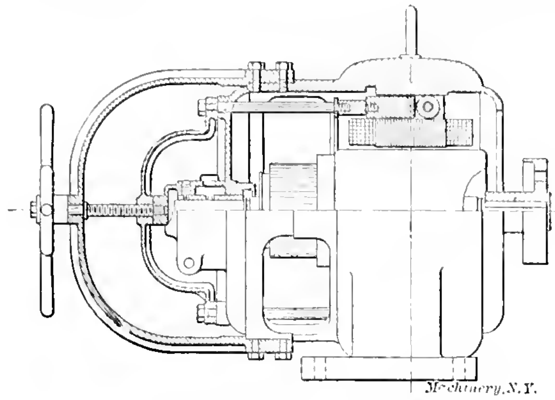


Fig. 1. New Type of Variable Speed Motor.

(address not given), in which a part of the magnet core is withdrawn in an axial direction. This is clearly shown in Fig. 1, where the machine is represented partly in section, also showing the hand-wheel and screw for withdrawing the core. The hand-wheel is mounted outside the end bracket at the commutator end of the machine. In Fig. 2 a diagram of the motor is shown, the armature and end brackets being removed in order to show the air gaps *A* formed by the withdrawal of the magnet core. This machine promises to be a very useful type for machine tool work, where there is a rapidly growing demand for a reliable and easily adjustable variable speed motor. There has been for some time in use in this country another type of variable speed motor working on a similar principle. In this, the Stow motor, however, a portion of the field magnet iron is withdrawn radially instead of axially. (See MACHINERY, December, 1904.) This, while being equally efficient a means for speed variation, does not, perhaps, permit of as simple design as does the motor mentioned.

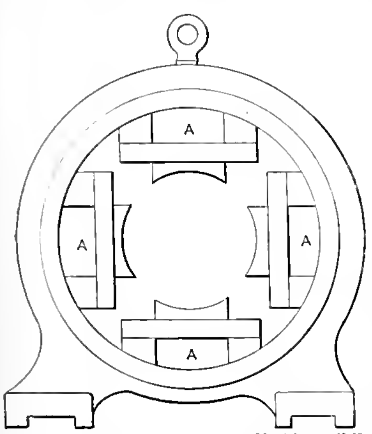


Fig. 2. Diagram showing Air Gaps formed by withdrawal of the Magnet Core.

THE STRESSES IN SCREW THREADS.

In the last report of the British Engine, Boiler and Electrical Insurance Company reference is made to the stresses in threaded bolts, and a graphical presentation of the subject is made, which clearly shows the effect of the difference in lead in bolt and nut upon the stresses in the thread. The difference in lead between the thread on the bolt and in the nut is one that is difficult to overcome. In fact, very few nuts have the same pitch as the bolts they are supposed to fit. The pressure between the threads of the nut and the bolt is therefore, generally, not the same on every thread. If the lead of the thread of the screw is longer than the lead of the nut, the stress will be concentrated on the lowest thread, but if the lead of the thread in the nut is longer than the lead of the bolt, the stress is greatest on the top thread. If the lead of the screw and in the nut be exactly equal, the stresses will be equally distributed. The cut shows in a clear manner the way in which the stresses are distributed in the three cases. It is evident that the risk of stripping the threads is far greater in cases where the lead of screw and nut differ, as there the stresses will be concentrated on one thread, and the threads are stripped or sheared off one by one. The danger of breaking the bolt is also

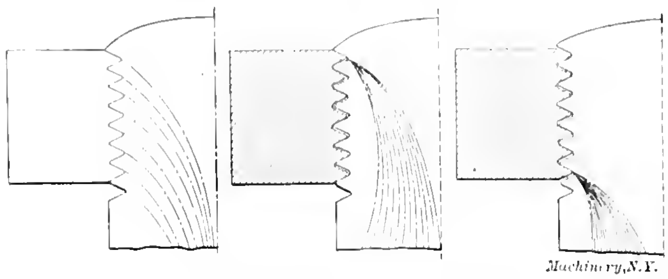
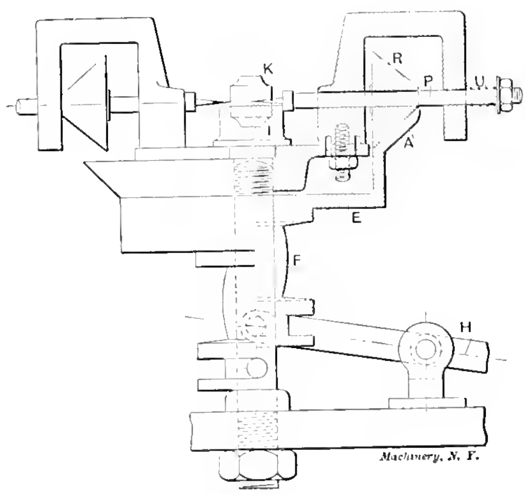


Diagram of Stresses in Screw Threads.

greater in that case, because, if the threads are strong enough to withstand stripping, then the whole force of tightening the nut will be applied on one thread, in the bottom of which a fracture is then the more easily started.

MULTI-SPINDLE DRILL WITH THE AXES OF THE DRILL SPINDLES ARRANGED RADIALLY.

In the *Zeitschrift für Werkzeugmaschinen und Werkzeuge* is shown a device for drilling simultaneously a number of holes radially in a piece of work. The work *K* is held in the collet *I*. The device is driven by a belt on pulley *F*, which is cast in one piece with a friction driver *E*. The pulley *F* with the friction driver *E* is raised up by means of lever *H* to engage with the friction rollers *R*, located on the drill spindles. By continued pressure on lever *H* the friction rollers are pressed inward against the action of springs *U*, and feed the drills into the work. When the pressure on lever *H* is released, the friction driver *E* and pulley *F* will move downward, and the springs *U* will move the drill spindles backwards, pulling the drills out from the drilled holes. In the cut, the one-half of the device which is sectioned shows the friction driver in engagement with the rollers *R* and the spindles fed in full depth, while the other half, not



Multiple-spindle Drill with Axes of Drill Spindles Radially Arranged.

sectioned, shows the spindles withdrawn. The device may, of course, be applied to reaming operations also, and in the cut the device is used for reaming small tapered holes.

[It is evident that the device, as shown, would not be of great practical value, if not somewhat modified in its design, because the surfaces in contact at *A*, being conical, are too wide for producing a good rolling action. A great deal of frictional resistance will be the result in the design shown, on account of the great variation in surface speeds between the outer and inner edges of the roller *R*. If the face of the driver *E* is less wide a better action will result. But even then the speed of the drill will vary greatly as the drill is fed into the work, depending upon that the driver will engage first with the largest and lastly with the smallest diameter of the friction roller, the speed thus increasing as the drill is fed inward.—EDITOR.]

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THE FRENCH MACHINE TOOL TRADE.

The Marquis de Dion, of the Dion-Bouton Co., in a late interview stated that without the American machine tools which have been imported during the past few years, the automobile trade of France would practically not exist to-day; but the recent progress made by European machine tool builders has materially changed conditions and affected American trade, and now the French as well as all European automobile builders can purchase almost everything they need in Germany and England, and to some extent in France, at prices generally below those quoted for American tools, although European manufacturers still look to America for ingenious and advanced ideas in machine design which will still further reduce the cost of production and enable them to manufacture higher grades of cars at a lower cost.

It is unfortunate that our manufacturers have been obliged in a way to neglect the French trade during the past two or three years. They have largely lost the benefits which should have come from their exhibits at the Paris Exposition in 1900, and it will be an uphill struggle against German tools sold at much lower prices than we meet, including delivery on the Continent. It is perhaps not generally known that German tool manufacturers receive an allowance from their Government on all machinery sales for export, so that American builders are not only handicapped by our tariff regulations and the high cost of labor and material, but have to meet the —in effect—subsidized German manufacturers when competing for French trade.

* * *

UNIT SYSTEM OF MACHINE DESIGN.

The new vertical spindle milling machine, shown in the "New Machinery and Tools" section of this issue, is a good example of the use of the so-called unit system of machine design. By the unit system we mean assemblages of shafts, gears, clutches, etc., mounted in separate frames or casings, each, when assembled, being a mechanism independent of the support afforded by the main frame. The idea is an old one, the first example probably being the engine lathe head-stock, which almost invariably is built independent of the bed. It has been employed in other examples of machine tool construction to considerable extent, but like some other good things the idea has not been developed as much as it might profitably be, in our opinion.

The gear box for speed or feed change, the lathe apron, lathe head-stock, and many similar parts of machine tools are familiar examples which lend themselves admirably to this plan of design, but can it not be carried further? Not only can the manufacture be standardized more readily for a certain machine, but the design of new sizes, or of entirely different machines, often can be made much quicker and at far less cost by utilizing units of other machines.

The idea is especially worthy of the serious consideration of special machine tool builders; as, for example, of planer type milling machines, horizontal boring machines and other tools, which in the larger sizes are quite commonly modified to suit the individual customer. The cost of designing, of pattern work, and of the shop system of construction that must be followed, makes the building of special machinery much more costly than that of a regular product, of course; but if groups of mechanisms could be standardized and assembled in the various designs, it would considerably facilitate the production, and to an extent reduce the cost.

* * *

MOTOR-DRIVEN MACHINE TOOLS.

An editorial investigation of the proportion of machine tools equipped with individual motor drive, now being put out by the builders, has resulted in some interesting facts. The statement was published recently in a monthly contemporary that 70 per cent of the output of one large machinery house was motor-driven and about 50 per cent of another was so equipped. This appears to be an over-estimate so far as the total is concerned. The real situation seems to be about as follows:

Planer type milling machines, horizontal boring machines, gun lathes, planers 6 x 6 feet and larger, big boring mills, large swing engine lathes, heavy radial drills, and machine tools in general, designated by that vague and indefinite term "heavy," are equipped by the builders for individual motor drive to about 50 per cent of the total output, but on light machine tools the proportion of motor drive is much smaller. One well-known concern building knee-type milling machines states that only 1.2 per cent of its machines is fitted with the motor drive. Another large concern building engine lathes states that from 4 to 10 per cent of engine lathes of 18-inch swing and under are so equipped, and on the larger sizes up to 36 inches the proportion fitted with motor drive runs from 11 up to 40 per cent. The still larger sizes (42 and 48-inch) reported were all fitted with motor drive. In the boring mill field one concern reports that out of 500 mills 112 were supplied with motor drive, this being about 22½ per cent. A machine tool and supply house estimates that not more than 5 or 10 per cent of the machine tools purchased through the house are individually motor-driven. A prominent milling machine company reports from 5 to 10 per cent of its total output fitted with motors. A large machine tool concern in Philadelphia states that 34 per cent of its product, including tool and drill grinding machines, was equipped with motor drive, while exclusive of grinding machines about 50 per cent was so fitted. This report was for the year 1906, and the proportion runs slightly larger for 1907. A well-known lathe builder in Worcester states that about 8 per cent of his output of engine lathes has direct-connected motor drive.

Without further quoting, the situation, roughly, is that about half of the large heavy machines are motor-driven, and from 5 to 10 per cent of engine lathes, milling machines, drills, etc. Very likely the proportion will increase relatively faster with some slackening off in trade, as more attention can be given to this and other features of design. The heavy demand for machine tools during the past two or three years doubtless has had the effect of making some builders disregard the motor drive. They have confined their work to building standard machines, leaving the electrical equipment to the users. Owing to this condition, it is fair to say that probably a considerably larger proportion of machines was actually fitted with individual motors than indicated by the above figures, the users applying the motors themselves.

THE AUTOMOBILE SITUATION.

The slowing down of the automobile business during the past summer is a matter that should have the attention of thoughtful men in any way affected by its general prosperity. Is the industry, as at present developed, on a firm foundation, and what is its probable future, are questions that trouble us. In the October, 1906, issue an editorial appeared in which the probability of the pleasure automobile in a measure experiencing the same fate as has overtaken the bicycle was discussed, and in the December issue the replies of a number of prominent automobile concerns were printed. These naturally defended the automobile, but it was conceded, either directly or by inference, that the *real* future of the automobile is largely whatever its deserts as a business machine may merit.

The present development of high-speed and costly cars, designed for the pleasure of an idle, extravagant class, holds forth little of promise for the future. In the first place, all pleasures which have no object but that of mere gratification of the senses soon pall and become distasteful. Such, we believe, is already the existing condition with a considerable class as regards automobiling. It cannot be expected that the speed madness which has led hundreds and thousands of automobile drivers to rush along country roads, raising great clouds of dust and causing terror and semi-panic throughout the whole countryside, could be a permanent condition. In the second place, even if the class now following this sport could find permanent pleasure in it, the productive power of the country, rich though it is, could not indefinitely sustain such unprofitable diversions on the part of large numbers of its citizens.

The automobile will surely supplant the horse and horse-drawn vehicle, but it will do so primarily for business reasons. For example, a family in town or country which now must keep one horse or two to fetch and carry will eventually come to use the automobile instead for the same purpose, and it will incidentally use it for pleasure also, the same as the horse is used now, but the large majority of such families will not keep an automobile for pleasure alone, nor will they invest in high-priced machines. The business of trucking in all cities and towns has grown more and more expensive from year to year because of the care and maintenance of horses, and it seems that this field also must be profitable for motor-driven trucks, although very little, comparatively, has been done as yet. The reason, of course, is that the manufacturers naturally have catered to the trade that was most profitable for the time being. This may prove to be a short-sighted policy in the long run.

* * *

LIABILITY OF EMPLOYERS.

As there is but little question that the President's proposition in regard to employers' liability for injuries inflicted on workmen while at work will be acted upon by our legislative bodies within a near future, it seems that rather too little attention has been given to this matter by the technical press in general. It has been contended, and not without reason, that to make the employer liable for all injuries inflicted upon workmen while at work is not fully just, because many an injury is caused by inexcusable personal carelessness. As an example of this class of accidents an English contemporary mentions a case at Cambridge, England, where two men proceeded to take off the cover of a boiler for cleaning purposes under the impression that there was no steam in the boiler, as the pressure gage stood at zero. They had taken out all the bolts, and then proceeded to force off the cover, when a rush of steam occurred which scalded one of the men to death. Another similar case occurred at Schenectady, where two men proceeded to take off the cover of a large vessel, 5 feet in diameter and 10 feet in length, under the mistaken impression that pressure was relieved, whereas the steam had not been allowed to escape. As reported, after a number of the bolts were removed, the cylinder head was suddenly blown off, killing the two men engaged and causing the cylinder to shoot backward, demolishing a water tower and a windmill, and finally alighting on the railway, where it killed a third man about 500 feet from its original position. The folly of attempting to remove a manhole cover from a boiler before steam pressure is entirely relieved would seem so obvious that one would imagine the necessity for pointing it out would never occur, but these two fatalities, arising from acts of this kind, show not only the possibility of such occurrences, but the necessity of calling attention to them. They also show how carefully some men must be guarded against their own ignorance, carelessness and folly, and that employers may be unfairly charged with responsibility for things not within their control.

But, on the other hand, it is admitted by all fair-minded persons that something must be done in order to relieve the suffering and the burden on those depending on the injured or killed worker, no matter what the cause of the accident. And if, as in Germany and Great Britain, we place the responsibility, financially, on the employer, the result will finally be, not that the employer is burdened directly to any greater extent than now, but simply that he acts as an insurance agent for his men. He will not personally shoulder the liability, but will turn over that responsibility to an insurance company, while, in turn, the premiums he pays originally must come out of the productive labor of his men. The benefits derived from this system, however, are manifold. In the first place the community will be burdened by less dependents forced upon it by industrial activity. Secondly, adequate safeguarding of life and limb will greatly increase in our shops, since the insurance companies will insist upon the best safety appliances in order to accept the risks.

In England the original workmen's compensation act, placing the burden of industrial accidents upon employers, was passed ten years ago, against strong opposition from both employers and labor organizations. Experience has proved, however, that the criticisms of the act were ill-founded, and so experience undoubtedly would prove in this country. At the present time the United States is the only industrial nation in which the burden of industrial accidents is borne nearly wholly by the workmen. The subject is one certain to be agitated with increasing vigor from this time forward, and everybody concerned in our industrial development must sooner or later give some attention to this subject. Our present waste of industrial working force, of life and limb, is appalling, and in many cases due safety appliances are lacking. When proper allowances have been made for carelessness of employes, there still remains a heavy charge against the employer. The liability laws would tend to increase proper safeguarding of the health and life of our industrial workers, and as it seems as if making the employer directly responsible would be the best means for bringing about a better appreciation of the value of human life, this step must be taken. It will in the long run place no burden on the employer. The productive workers in our industries must finally pay the insurance in any case, and an effective means of bringing about a desirable result should not be scoffed at, even if it at first seems as if it placed too much responsibility on the employer of labor.

* * *

NEW RAIL-MAKING PLANTS.

It has been announced that the Jones & Laughlin Steel Co., of Pittsburg, will enter the rail-making business, and will establish at its new plant near Aliequippa, Pa., one of the largest steel rail mills in the country. The Jones & Laughlin Steel Co., as is well known, is the largest independent steel company in the country, and it has been the most active competitor of the United States Steel Corporation, commonly called the steel trust, in all other steel manufacture except that of steel rails. It is not known exactly when the new rail mill will be in operation, but the company has made a statement to the effect that it will be within a short time. The Bethlehem Steel Co. started a rail mill in the first part of September, and has been engaged since then in rolling rails for the Union Pacific. This company abandoned the making of rails about ten years ago, but has concluded to take up this manufacture again. The new mill is arranged for the manufacture of basic open-hearth rails, low in phosphorus. Attention will also be given to the manufacture of rails containing special alloys, such as nickel, chromium and vanadium.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

The Pekin-Paris automobile contest, which was mentioned in our May issue, was finished in August, the winner finishing the run in about 60 days.

Work has begun on the electrification of 150 miles of suburban railway leading into San Francisco and Oakland. It is believed that this is warranted by the enormous suburban business of the railroads around San Francisco, which is almost as great as that of the New Jersey roads in the neighborhood of New York.

Necessary funds have been provided for the purchase of a reflecting telescope to be installed at the observatory of the Carnegie Institution of Mount Wilson, California, which will be the largest hitherto made. The mirror of this telescope will be 100 inches in diameter, and the focal length 50 feet, while hitherto 60 inches has been the limit for the diameter. The mass of glass of which the mirror is composed is 13 inches thick, and the weight is about 4½ tons.

It has been proposed, says *Industritidningen Norden*, to use electromagnets for lifting and handling large panes of glass. As glass is a non-magnetic material, the proposition at first seems rather difficult of realization, but it is accomplished by placing a piece of sheet iron under the glass and applying one or more electromagnets on the upper face of the glass. The electromagnets attract the sheet iron and thereby hold the glass suspended while moving.

A correspondent to the *Railroad Gazette*, writing about the rusting of steel rails, refers to a report of J. W. Post, chief engineer of the Netherlands State railroads, relating to iron ties that had been bedded in gravel and sand ballast for thirty-five years. The original weight of the ties was 125 pounds. They decreased in weight from rust and wear, on an average, one-quarter of a pound in every year. Thus the total decrease in weight in thirty-five years was 8.75 pounds.

Attorney-General Bonaparte has directed the various United States Attorneys to institute suits against a large number of railroad companies to recover penalties incurred by them for alleged violations of the safety appliance law. The facts upon which these prosecutions are based were reported to the Interstate Commerce Commission by its inspectors of safety appliances. The violations which constitute the basis of the prosecutions number 287, distributed among 37 operating companies.

The Chicago tunnel system for handling freight, mails, etc., which has been very quietly developed, will in the near future further increase its freight business, it being reported that contracts have been made with twenty-six railways for the handling of their freight in the business district. The system comprises thirty miles of tunnel with narrow gage track. The mail is already carried by these tunnels between the railroad stations and the post office. The large establishments have tracks running right into their basements, while there are six regular freight stations in the business district for the use of smaller shippers.

The new Cunarder *Lusitania* broke all previous Atlantic speed records on her second westward voyage, crossing the ocean at an average speed of 24 knots. The liner arrived in New York early in the morning on Friday, October 11, having left Queenstown in the forenoon the previous Sunday. The time consumed in her passage from Daunt's Rock, off Queenstown, to Sandy Hook Lightship was 4 days, 19 hours, and 52 minutes, due allowance having been given to the five hours time difference. The best previous record is that of *Kaiser Wilhelm II.*, which crossed the ocean at a speed of 23.58 knots. The best day's run was 617 sea miles; the previous record for a day's run, 601 sea miles, was held by the *Deutschland*.

The tendency in Germany when using concrete for railway bridges seems to be to rather use plain concrete than reinforced. It is reported that lately three railroad bridges have been completed on the Bavarian State Railways, all erected of plain concrete and having spans 187, 211, and 211 feet, respectively. In one case the rise of the main arch is only about one-sixth of the width of the span. One of these bridges carries four railway tracks, and the other two only two. It is stated that the cost of these bridges is from 17 to 20 per cent less than that estimated for steel bridges. The ultimate saving will, of course, be considerably more, inasmuch as practically no maintenance is necessary in the case of concrete structures of this character.

The battery tunnel in New York, under the East River, connecting the lower end of Manhattan with Brooklyn, is rapidly approaching completion. The tunnel under the river itself is practically finished. The building of this tunnel presented a number of new engineering problems which developed difficulties which could not be foreseen. The tubes which enclose the tunnel rest partly on rock, partly on silt, and partly on fine sand, and great difficulties have been experienced in regard to preventing the tubes from setting. Concrete piles have been placed under the tubes where they rest on the fine sand, and these piles have been carried down to a depth of 75 feet in order to provide an adequate safeguard, although Mr. George Rice, chief engineer of the construction, considered this precaution unnecessary. If nothing unforeseen arises, it is likely that trains may be run through the tunnel some time during this month.

A horizontal tandem steam engine with cylinders 52 and 90 inches diameter by 60 inches stroke was recently built by the Wm. Tod Co., Youngstown, Ohio, to drive a 43-inch three-high blooming mill in the Carnegie Steel Co.'s plant at Youngstown. This engine is designed to develop 4,000 indicated horse-power at 58 revolutions per minute, and a maximum power of 7,000 indicated horse-power. It is claimed that this is the greatest horse-power ever transmitted by a single crankpin. The weight of the flywheel is 240,000 pounds, this great weight being required on account of the power required to be stored in the fly-wheel when breaking down an ingot, it being estimated that as much as 14,000 horse-power will be required for short periods. The main journals are 30 x 58 inches, and the shaft is 36 inches diameter in the center. The crankpin is 20 x 16 inches, and the total weight of the engine is 500 tons.

We mentioned in the engineering review of our July issue about the salvage of the White Star liner *Suevic*, which had run aground near the Scilly Islands, and the aft portion of which was taken to Southampton, to be provided with a new bow, the old bow having been left on the rocks. According to the *Practical Engineer*, a new bow has now been built for this ship by Harland & Wolff, of Belfast, and this portion of the ship will be towed from Belfast to Southampton, where the ship will be rendered complete once more. It is probably the first time that a ship was ever launched piecemeal. The new fragment, if that expression may be employed, is said to be almost as tall as it is long, and there were some difficulties connected with its launching. The portion of the new bow which will be immediately joined to the old aft portion remaining of the *Suevic*, will be enclosed with a casing of steel plates during the voyage to Southampton.

While aluminum for overhead transmission lines has been employed to some extent in this country, its use in underground circuits has been prohibitive because of the comparatively high cost of aluminum, the impurities which reduce the electrical conductivity, and the difficulty of satisfactory joints. According to the *Mechanical Engineer*, these drawbacks have been successfully overcome by an English firm,

Johnson & Phillips, Ltd., of Old Charlton, Kent. This firm supplies insulated aluminum cables of a conductivity equal to copper at a price which shows a considerable saving when compared with the price of copper conductors, particularly when as high as before the slump in September. The great drawback to the use of aluminum for electrical purposes in the past has been the difficulty of obtaining it sufficiently pure. At the present time aluminum may be obtained with a purity of 99.9 per cent, the average purity of commercial aluminum being 99.6 per cent.

It has been stated over and over again in the daily as well as in the technical press that steam turbines do not find favor with the Germans, and particularly that German naval officers were skeptical in regard to the newly-developed motor. In view of this, the reports of the trials of a new torpedo boat recently launched at Kiel, the most prominent German naval station, are of so much the greater interest. This torpedo boat attained at the official tests a speed of 33.9 knots on the measured test mile with adverse weather conditions, and during a trial of a duration of three hours she attained an average speed of slightly over 33 knots. The turbines indicated 13,000 horse-power. The torpedo boat proved itself capable of going backward at a speed of 16.9 knots against strong wind and heavy sea. The boat has a displacement of 565 tons. The German navy is to be equipped with several torpedo boats driven by steam turbines. The German merchant marine is also reported as considering turbine-driven vessels.

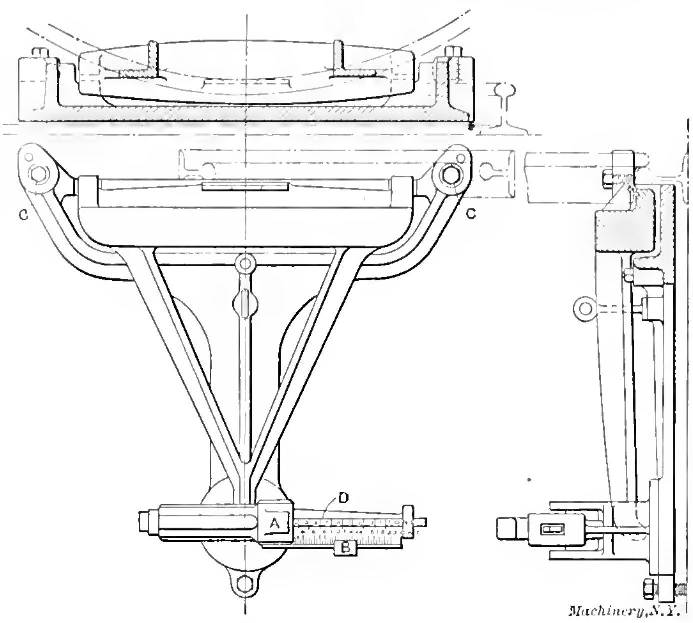
The United States Government has erected a wireless telegraph station at the New York Navy Yard. The station is intended to make possible direct communication between the Navy Department at Washington and the Navy Yard in New York, independent of the commercial telegraph companies. It is stated that it is the purpose of the government to establish a series of wireless telegraph stations which will connect Washington with all important cities along the sea coast, and thus practically free the government from dependence upon the telegraph companies. In view of the difficulties experienced of late in regard to the manner in which the commercial telegraph companies have carried out their duties toward the public, it would seem in place that the government also took such action as to make all legitimate business enterprises of the country independent of the present commercial telegraph companies whose performance of their obligations has been discredited to such an extent as to make governmental action fully warranted.

The question of utilizing the abundant water power of the more mountainous countries in Europe for the electrification of railways has often been referred to in our columns. The latest project of this kind is that of the state railways of Bavaria. It is estimated that 700,000 horse-power can be obtained from Bavarian streams, but it is suggested that only 200,000 horse-power should be reserved by the state for the working of the railways. For a start the ministry for the railways proposes only to utilize 92,000 horse-power. It is claimed that the hydro-electric working of the railways is certain to give a considerable profit over the one now obtained by working the railroads with steam. The annual economy is estimated at $1,750,000, obtainable by working only the railroads in southern Bavaria by electricity. Great attention has also, at the present time, been given to the available water power in France. The available coal deposits in that country will, at the present consumption, be exhausted before many years, and this condition naturally increases the value of the water falls. While the water powers of France have not been gaged with very great accuracy, the total hydraulic power available in France is, according to *Engineering*, estimated to be between 9,000,000 and 10,000,000 horse-power. As the effective horse-power hours used at the present time in the whole country correspond to a continuous operation at the rate of less than 4,000,000 horse-power, the available water power, if fully utilized, would be enough for a long time to come.

LOCOMOTIVE WEIGHING MACHINE.

Engineering, September 13, 1907.

The machine illustrated in the accompanying cut has been designed for the purpose of determining accurately, and with little trouble, the load on any wheel of a locomotive without necessitating the use of a costly locomotive weighing table. The device illustrated consists essentially of a cast steel bracket, with a lever which transfers the weight of the wheel to a balance beam. The bracket is of Y-shape, the extremities of its two arms resting upon the rail, one at each side of the wheel. The lever is fitted with three knife edges, one



Device for Weighing the Load on Locomotive Wheels.

pair of which bear on finished surfaces of the bracket and act as a fulcrum, while the other knife edge is located centrally beneath the wheel. By screwing down the set screws *C* in the arms of the bracket, the lever is raised until the weight of the wheel is taken by the central knife-edge. The scale beam *D* is connected with the weighing lever by a system of compound levers, the same as in an ordinary scale, and the two weights *A* and *B* are each, respectively, the sliding poises for the two scales for the weight in tons and hundredweights.

THE IMPORTANCE OF NITROGEN IN CASE-HARDENING.

Paper by Mr. G. Shaw Scott, read before the Iron and Steel Institute, September Meeting, 1907.

In this paper some experimental data is recorded, showing the importance of nitrogen in the case-hardening process. A certain steel was selected which had been found specially suitable for case-hardening. This steel had the following composition: Carbon, 0.14; silicon, 0.01; sulphur, 0.08; phosphorus, 0.03; manganese, 0.58; iron (by difference) 99.16. Samples of this steel were case-hardened in small cast-iron boxes, being packed in a variety of materials such as burnt leather, wood charcoal, anthracite coal, sugar charcoal, potassium, ferro-cyanide, potassium cyanide, petroleum, gas, bone, horn, graphite, bone black, acetylene, barium carbonate, coal gas, etc. It was demonstrated that there was no carbon penetration in bars heated for four hours at 700 degrees C. (1,292 degrees F.), and that a temperature of 800 degrees C. (1,472 degrees F.) was about the minimum temperature at which carbon penetration took place to an appreciable extent.

Samples treated for four hours at a temperature of 900 degrees C. (1,652 degrees F.) showed a carbon penetration of 0.063 inch. It was demonstrated that this temperature gave uniformly better results than higher temperatures. Barium carbonate and wood charcoal gave about two times as deep a carbon penetration in four hours as wood charcoal alone, and about one-third deeper penetration than burnt leather. But when the heat was sufficiently prolonged, the several mixtures gave approximately the same results. All the case-hardening materials in common use contain nitro-

gen in some form or other, or have the power of utilizing atmospheric nitrogen, and it appears that nitrogen is the active element in promoting carbon penetration, although the free gas has no effect on steel itself. Ammonia, which is a prominent constituent of case-hardening materials, is the chief supplier of nitrogen, and experiments were made that showed that ammonia gas caused deep carbon penetration with materials that without its presence had only slight carburizing effect.

RATIO OF GENERATOR CAPACITY TO MOTOR HORSE-POWER IN ELECTRIC DRIVE INSTALLATIONS.

Mr. George R. Henderson, in *Proceedings of the New England Railroad Club.*

The percentage of generator capacity to the sum of the rated motor horse-powers is somewhat uncertain, but it is lower, perhaps, than generally imagined. At the 1903 convention of the Master Mechanics' Association a committee reporting on electrically driven shops stated that 40 per cent of the aggregate horse-power of the tools could be taken, and to this added the constant and average lighting load in order to determine the capacity of the generators required, without including in the list of such motors those required for cranes, transfer tables or turntables; but the question of a spare unit should always receive consideration. The Master Mechanics' proceedings for 1900 stated that at the Baldwin Locomotive Works, the switchboard load averaged only about 27 per cent of the total motor rating, in this case the crane motors being included. At the Topeka shops a switchboard load equal to 38 per cent of the various motors, exclusive of those on the cranes, was found to obtain. At the McKee's Rocks shop the power consumption was about 30 per cent of the motor rating. The actual installation of some large and modern shops is very interesting. At Collinwood the total generator capacity (after deducting requirements for lights) was 50 per cent of the sum of the motor ratings, not counting those upon the cranes. At McKee's Rocks shop it was 47 per cent on the same basis; at the Angus shop, Montreal, 37 per cent. The new Parsons shop of the M., K. & T. Railway has a generator capacity of about 75 per cent of the total rated motor capacity. Of course the question of the size of generators and also spare units affects this to a certain extent, and the best way to study the question is to lay out a hypothetical load diagram and determine from this the most economical size of units.

PHYSICAL CHARACTERISTICS OF CAST IRON.

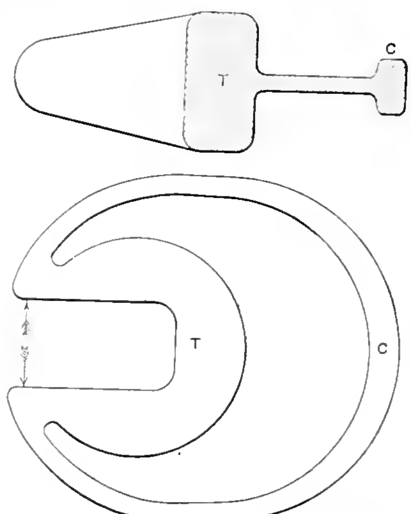
Abstract of paper by James Christie, read before the Engineers' Club of Philadelphia, April 20, 1907.

Cast iron is probably the most complex, variable and uncertain form in which iron is used. Not only is the amount of extraneous metals and metalloids variable, but the condition in which the associated carbon exists, and the character of this association, are determined largely by the influence of silicon and possibly other metalloids. Again, the physical properties of the metal are influenced by casting temperature, rate of cooling, etc., so that altogether we can only assume the probable strength and stiffness of a casting in the most general way, and forecast results, which will suit an average, from which individual castings may vary widely in extremes.

For heavy machinery, where cast iron is used in heavy masses through which working stresses are imperfectly distributed, the metal probably is much softer and weaker in the middle of the mass, where it has cooled slowly, than at outer surface, where the metal has more rapidly cooled. Furthermore, castings are usually under considerable internal strain, due to unequal contraction, and although this internal strain gradually disappears, it may have some disturbing influence after the casting has been put in service. It is good practice to assume an ultimate tensile strength of 16,000 pounds per square inch for ordinary iron castings, and to limit working stresses from 2,000 to 4,000 pounds per square inch, according to the conditions and character of the service.

Cast iron offers a high resistance to compressive stress, and although this resistance varies within wide limitations, it may be assumed as a working basis to be about six times that of the tensile strength, or, say, 95,000 pounds per square inch of section.

In the middle of the past century, as cast iron became extensively applied to structural purposes, its physical properties were studied with great care, and the experiments of Hodgkinson and Fairbairn in England, and of their contemporaries, yielded a valuable fund of information on the subject. Seeking a section of beam which should exhibit the highest ultimate strength in proportion to area of cross-section, or of the weight of metal employed, Hodgkinson advocated a section in which the tension flange exceeded the compression flange about six to one in sectional area, the web usually tapering in thickness from the tension flange, diminishing toward the other flange. This form of beam was largely adopted, and took precedence as long as cast iron was used for beams in structures. We find that the same method of reasoning influenced the machine designer in disposing cast iron to seeming advantage in the construction of machines, massing the metal to resist tension, and permitting high unit stress on metal in compression; and especially is this observed in machines of the open jaw or gap type, such as presses, punching and shearing machines, etc. The author of the paper here abstracted believes that usually the unit stresses should be little, if any, higher in compression



Machinery, N.Y.

Illustration of Common Design Intended to Equalize Stresses in Cast Iron.

than in tension, for the following reasons. In machinery rigidity or stiffness is usually the chief consideration; many machines do not fulfil the intended purpose properly, not by failure through fracture, but by want of sufficient stiffness. Deflection has to be limited, and when that is done, breaking from excessive tension is sufficiently guarded against. As cast iron yields to compression as much as with the same unit stresses it yields to tension, it follows that the compressive stress should not exceed the tensile strength per unit of section if it is desired to dispose a given mass of metal with least deflection. It is believed that rupture sometimes occurs in a machine apparently through tension, where the origin of the weakness could be traced to a want of material to sufficiently resist compression, the improperly supported tension side severing by cross-bending or transverse stress.

Taking for illustration an open gap machines with frame as illustrated in the cut, with tension at *T* and compression at *C*, if the section is so shaped that the compressive unit stress is six times that of the tensile unit stress, then, elastic moduli being equal, the frame will yield at *C* six times as much by compression as it does by tension at *T*. This permits an oscillation of the mass at *T* around its center. If this oscillation becomes dangerous, by extent or frequency, the frame will break by cross-bending at the mass *T*, giving the impression that more material is needed to resist tension, whereas the fact may be that more material should be placed at *C* to prevent excessive yield by compression.

When rapidly alternating stresses occur, it is acknowledged that provision must be made for something more than the greatest stress in one direction alone. There are still dif-

ferences of opinion and practice on this subject among bridge designers. Some maintain that when the alternations are of slow recurrence, so as to permit actual rest between reversals, no special increase of section is required. Others specify that the sum of the sections required for the stress in opposite direction should be used to suit the conditions. There can be little doubt that the latter estimate is not too great for machinery when the oscillation of the forces occurs with great rapidity, and especially when the metal under consideration is cast iron, with a modulus of elasticity about one-half that of steel or wrought iron. It is a safe general rule for ordinary cast iron in machine construction to limit tensile stress to 4,000 pounds per square inch of section, under the most favorable circumstances; to 3,000 pounds when loads are suddenly applied; and to 2,000 pounds when the force alternates in direction; these unit loads are to be further limited to suit the ratio of length to section, as required for columns or any members in alternate extension or compression, or for beams or members subjected to alternating transverse stresses.

MODERN MACHINERY AND ITS FUTURE DEVELOPMENT.

Abstract of paper by Mr. H. I. Brackenbury, read before the British Association.

In the following it is intended to touch but slightly on the design of machinery, but rather to give an account of those forces which have tended to make machine tools develop along certain lines, and to show that there are forces now at work which considerably alter our views and ideas as to the value of certain classes of machinery. These remarks will be limited to small machinery, as being of the most general interest, and only those machines which cover the same ground as the engine lathe will be considered.

Classification of Machine Tools.

Modern machine tools may be classed as follows:

a. Automatic machinery, for which the tools are designed, made, and set in the machines by highly skilled labor, the material being fed into the machines by unskilled labor.

b. Semi-automatic machines, for which the tools are generally formed to give the work the required shape, and stops set on the machine to give the required lengths and depths of the cuts, the operator having little more to do than to pull or turn certain handles. Under this class come turret lathes, screw milling machines, screw machines, etc., in fact, all those machines where the tools can be made and set by skilled labor, and then worked by less skilled labor.

c. Machines which develop the work under the guidance of skilled labor to a drawing or sample, the sizes being obtained by the use of gages or the micrometer. Such machines are the engine lathe, heavy turret lathes fitted with lead screws, etc.

d. Grinding machines for finishing work, where considerable skill is required in the handling of gages, but very little skill to work the machine.

It has been the aim of many machine users to push work from class *c* into class *b*, and from *b* to *a*, and this the machine builders have encouraged, bringing the automatic and semi-automatic machines to great perfection. But they have tried to carry this too far, even under the old conditions; and it might be proved that the conditions, upon which the value of automatic and semi-automatic machines rested, have been completely upset by the general adoption of high-speed steel, and that the claims of the old simple type of engine lathe come once more to the front. These are the days of specialization. Manufacturers tend to specialize in one size of article as much as in one class of article. Meanwhile machine tools have become more and more complicated, one type of machine being suitable to cope with a large variety of work, but in the future they will tend to return to the simpler patterns of former years; but one machine will be designed for turning out one class of article, or rather for doing one or two operations on one article.

Relative Cost of Hand and Automatic Machinery.

Until a few years ago, the time and labor required for rough drilling, turning, etc., was a very large consideration in the total cost, including material; and it was, therefore, desirable to do much of this work with automatic machinery, where one man could attend to, say, four machines. But by the introduction of high-speed steel the cost of roughing-out has been immensely reduced, certainly as low as one-third the former cost. The price of material and of the more intricate types of machines has risen, the result being a complete alteration of the proportionate value of the labor to the cost of material and machine charges. The production of one automatic machine on the larger class of work is slower than the production of a hand-worked machine; and, therefore, extra capital charges are involved for shop room.

The price of an automatic machine is at least double the price of a hand machine suitable for turning out the same piece of work; and very often on the automatic, more material must be used, and of a more expensive nature, a point which the machine builders are apt to leave out of consideration. Future development will not be in the direction of larger and more complicated turret or automatic lathes, but in the direction of simple machines which can be attended to by operators of average intellect and who have not had much previous experience of machinery.

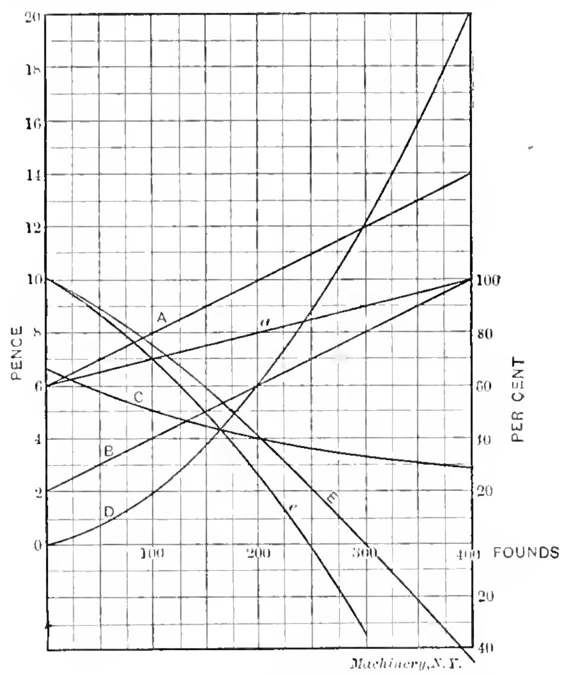


Fig. 1. Diagram of Relation of Cost of Running Automatic and Hand Machines.

Formula for Determining the Cost of Machine Operations.

The following formula may be used to compare the value of various machines in turning out work:

$$\text{Cost per piece in cents} = \frac{\text{Wages per hour in cents} + \dfrac{\text{Price of machine in dollars}}{125}}{\text{Number of pieces made per hour}} + \frac{\text{Cost of tools and setting up in cents}}{\text{Total number of pieces}} + \text{cost of material per piece in cents.*}$$

This formula seems complicated, but all this must be taken into consideration in comparing the economic value of different machines for producing the same piece of work.

If we now turn our attention to the curves drawn in the diagram, Fig. 1, we will find there the relative cost of running ordinary lathes and automatics. (In this diagram the English money standards have been retained.)

The curve *A* indicates the cost of running hand machines of various first costs, with a charge for attendance of 6 pence per hour, and a charge of $\frac{\text{cost of machine}}{5}$ per annum for interest, depreciation, floor space and repairs, which works out at 2 pence per hour per 100 pounds.

Curve *B* indicates the cost of running automatic machines with a charge for attendance of 2 pence, and machine charge as above. The 2 pence is supposing a charge of 8 pence an hour for attending four automatics; and except on the simplest work, this figure would be exceeded.

* In this formula the money values given have been reduced to American money standards.

Curve *C* represents the saving of running automatic machines in place of hand machines. It must be understood that this comparison involves running cost only, and does not take, so far, into account the amount of work turned out.

Curve *D*, finally, shows the actual cost of doing on an automatic machine a number of pieces of work which could be done on a hand machine in an hour. The automatic is taken at the same price as the hand machine. It is assumed that more work can be done in an hour by an automatic machine of under 200 pounds cost than can be done by a hand machine, and that above 200 pounds cost the automatic does less work than the hand machine. This is confirmed by actual practice. In the curve, which shows merely the tendency of the piece price to rise on expensive automatics, the ratio of production of the automatic is to the hand machine as 2 is to the price of the machine in hundreds of pounds, that is, if the machine costs 100 pounds, the production is in the ratio of 2 to 1. At a price of 200 pounds for the automatic, the ratio is 2 to 2. At 300 pounds 2 to 3, etc.

It may be said that the automatic machines show a saving when the capital cost is not more than 250 pounds each. After this figure a loss is shown which increases very rapidly. This is best shown by curves *E* and *e*, which give the percentage gained or lost by using automatic machines of various values, as compared to hand machines. Curve *E* is for automatic machines of the same value as hand machines, but in curve *e* the hand machines are taken at half the cost of the automatics; probably a suitable hand machine, to do work being done in an automatic, would cost less than half the automatic.

Figures are often shown which seem to prove the great value of even large automatics and expensive and complicated turret lathes. In certain cases these figures are correct, but in many cases the saving is largely due to the carefully thought-out method of doing the work, where formerly little, if any, attention had been given to the study of economy in the old machines. A case is pointed out where the time for doing a piece of work was reduced by the use of a large and expensive turret lathe from 4½ hours to one hour. There being more of the same work to do, it was determined to try what could be done in the old lathes. A few special tools were made, and the method of procedure very carefully thought out. The result was a time of 1 hour and 10 minutes for the work.

We now turn our attention to a set of curves, Fig. 2, showing the actual proportionate cost of wages only on bolts made, *A*, in an engine lathe, *B*, in a turret lathe, and *C*, in an automatic. It will again be noticed that the automatic shows a large saving on the smaller sizes; for the larger sizes the engine lathes show the cheapest method. The turret lathes show much the same as the engine lathes, but the machine charges would be much higher for both the automatics and the turret machines.

The Proper Application of Automatic Machines.

The automatic shows to the best advantage on simple work, when the cutting time is a large proportion of the whole time. The reason for this is that the time taken to change from tool to tool on the automatic machine is longer than that required on the hand turret machine. Thus, the longer the cutting time, and the fewer the number of tools employed, the better is the result from the automatic. Of course, these curves are hardly even approximately correct for any article of manufacture, but they show the tendency very clearly of the work to become more and more expensive as the size of the automatic machine increases. It is certain that more than one manufacturer who has started a new shop with the idea of doing as much as possible by automatic machines to keep down labor cost, has been surprised to find that some other shop with a few cheap machines is turning out the work quite as cheaply, and when slack time comes he considers with sorrow the capital locked up in his beautiful battery of automatics. Now, from the foregoing we may safely argue that the large automatic machine is a creation of the past, and that the future will bring no further development in this direction. The simple automatic machines of small size are of the greatest value. The complicated machines for work requiring many short operations are not economical. Tracing the history of the automatic machinery, we find it was largely due to the bicycle becoming such a universal favorite, thousands and thousands of small parts being required of an exact similarity. Comparing the price of the first safety bicycles to the present prices, one will obtain an idea of what this automatic machinery has done to cheapen the production of small parts in large numbers.

The turret lathe has increased in size and power within recent years. For many purposes, when there are many short operations to be done at one setting, and little material to be removed, these machines are very valuable. The proper sphere for large and expensive turret lathes is for finishing work of a complicated nature, and it is in this direction that the machine will be developed. To occupy a machine costing perhaps 500 pounds with work which can be roughed out in a machine costing a little over 100 pounds, and worked with cheaper labor, is quite out of the question.

We come then to this conclusion: The use of automatic turning machines is for small work of a simple nature; the use of large, expensive turret lathes is for finishing work of a complicated nature or form, requiring considerable variety of tools.

The Future of Simple Hand Machines.

To rough the work to nearly the finished sizes we require simple machines: *a*, heavy, simple, and cheap turret lathes for boring and chuck work; *b*, heavy, simple, and cheap engine lathes; *c*, similar to *b*, but fitted with scroll or plate for forming the work to shape. Curiously enough, these machines, which seem the most simple and easy of perfection, give the most room for development. The reason of this is that the great value of roughing-out work in cheap machines with cheap labor has not been sufficiently grasped. In the design of these roughing-out machines the driving should be done by means of a single pulley running on a back shaft with a wide belt, and not a cone pulley; the change of speeds would be obtained by means of sliding gear wheels made, of course, of steel. The teeth should be of small pitch, and not necessarily wide. We may take a lesson here from what the small gears in motor cars are able to stand.

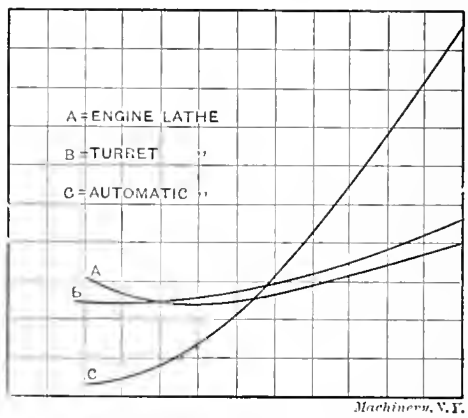


Fig. 2. Diagram showing Relative Cost of Labor for Bolts made in Different Machines.

The obvious disadvantages of the cone pulley are two: *a*, with wide belts to change the speed it is a time-wasting process and apt to be dangerous to the inexperienced; *b*, a varying power is passed through the belt. Taking as an example a lathe of well-known make, the horse-power carried by the belt varies from 12.95 to 4.57. Evidently the value of a large range of speeds is very doubtful when it is combined with such a range of horse-power.

The feed should be obtained by means of a lead screw of ample dimensions, bearing in mind that the pressure required to feed the tool is equal at times to the pressure required for cutting. The feed changes should be given by sliding gear wheels. The nut should be of cast iron, as this gives a longer life than the usual gun-metal nut. The bed and headstock should be cast in one, and should be of ample weight. The bed should be one with square edges and a step on the cutting side, permitting of less twisting action on the saddle. The section of bed should be of the double-H beam type. Ample provision must be made for taking up the thrust by

means of ball bearings or wide collars. In designing these machines one must keep in mind that the aim is not a perfect machine, but a machine of simple construction, simple to work and cheap to buy, and of considerable power. These machines should not be arranged for screw cutting.

There remains now the question of threading work. Bolts and such work should, of course, be threaded by means of self-opening dies, as this is much the cheapest method. But where great accuracy of pitch, or threads of coarse pitch, such as worms, are required, recourse must be had to either the lathe or the thread milling machine. This latter machine is the most universally useful, and there is a great future before this type of machine.

Concluding his paper, the author said that he feared many would come to the conclusion that he advocated a retrograde policy in drawing attention to the merits of the simplest machines. "But in advocating these machines," he said, "I do not wish to bring back the old methods of using them, for the most careful consideration is required to find the method which will give the best results. I, least of anyone, would wish to belittle the value of the small automatic and large complicated turret lathes which have been brought to such wonderful perfection in modern times, but I ask machine users to keep such machines in their proper places, and weigh carefully the merits of simpler and cheaper machinery."

AMERICAN MACHINE TOOLS IN EUROPE.

Page's Weekly, August 1, 1907.

An English journal devoted to the motor car industry recently stated that American as well as German machine tools were used in that industry in preference to British tools, and that the British manufacturer, owing to his lack of appreciation of modern requirements, falls short when his product is compared with that of American and German origin. From an inquiry which was made by the publication from which the present article is abstracted we find that while the original charge made by the motor car journal mentioned is undoubtedly overdrawn in some respects, in some British shops American tools are used even to a greater extent than one would at first feel inclined to believe. Thus we find that Messrs. Dean & Burden Brothers, Ltd., of Scout Motor Works, Salisbury, state that they regret to say that of their machine tools only about 15 to 20 per cent are British. "The majority of the British machine tools," they say, "are not so accurately made, neither are they so handy to manipulate as the foreign, except, perhaps, in the case of one or two English machine tool manufacturers whose prices are very high indeed. These particular manufacturers do not make all machine tools necessary for the motor work, so that if a motor firm felt inclined to pay the price, even then it would be difficult to get all the tools from British firms."

Another firm, that of Legros & Knowles, Ltd., of Willesden Junction, says that of all their machines 40 per cent are of American origin. Others report a large proportion of American tools, while, of course, a great many state that they use British tools to the greatest extent and find them fully satisfactory.

What really is most interesting to American manufacturers of machine tools, however, is not so much the praise of American tools, although that is gratifying, but rather the criticism of some American tools and methods. One firm, while stating that the Americans excel in drilling and grinding machines, mentions that for tool-room work, the British lathe is superior to the average American lathe. Slow deliveries, of course, continues to appear as the standing charge against the American manufacturer, but it seems as if this charge applies to British makers as well. One firm finds that American tools are not, generally speaking, equal to the British for continuous use for any length of time under the stress of high-speed steel. It appears that as a rule the comparative lightness of American tools, which has always been a characteristic feature, is a strong argument against American machine tools. The many special features and attachments of American tools, not to be found in British machines, seem to be one of the strongholds of American tools on the British market.

POWER REQUIRED FOR CRANES AND HOISTS.*

ULRICH PETERS.†

Ulrich Petera.‡

Whatever the type may be—traveling, gib, gantry and similar travelers, except such as derricks, shear cranes and other special hoisting devices—there is ordinarily, at least, a so-called trolley by means of which the functions placed in a hoisting machine are performed, that is the hoisting, holding, traversing and lowering the load. In one sense of the word, a crane or traveler without a trolley or single crab finds little representation in the present industry for permanent service in yards, shops, mills and factories.

The distinction between trolley and crab is most easily decided upon by noticing whether the load is suspended from a truck which usually carries its own power generator for hoisting and traversing, independent of the other parts of the crane, or whether the load is hung on a truck helpless without the driving mechanism attached in connection to the crane. In the first case we speak about a crane trolley, while in the other often about a crane crab. Of course, there are instances, sometimes,

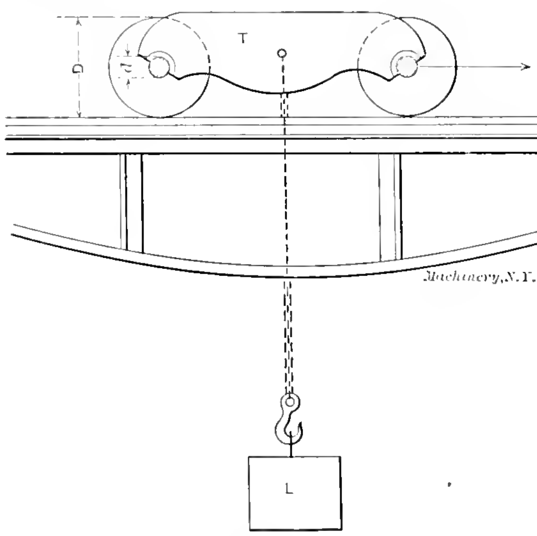


Fig. 1. Diagram of Crane Trolley.

where it is not so easy to decide whether we have a crab, a trolley, or a mongrel of both before us.

The intelligent figuring of the motive and hoisting power required for certain types of trolleys and crabs may cause us some little worry. No doubt, a short repetition of the elementary mechanics of the parts entering into crane and trolley construction may be helpful to many interested readers in following up the derivation of the later formulas covering the whole combination of a trolley or crab construction.

I. Power Required to Move a Trolley or Crane Bridge.

The resistances to be overcome are:

1. Rolling friction of trolley wheels $= P_1$.
2. Journal friction of trolley wheel axles $= P_2$.
3. Inertia or kinetic energy of trolley and load $= P_3$.

Considering all resistances applied at the axle, Fig. 1, we know

* For previous articles on this and kindred subjects, see: The Efficiency of Mechanism, March and April, 1903; and Formulas for Force Required to Move Crane Trolleys, October, 1907.

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$$P_1 = \frac{f_1\,(T + L)}{D}$$

and

$$P_2 = \frac{f_2\,(T + L)\,d}{D}$$

in which

T = weight of trolley (see Fig. 1).

L = load.

f_1 = coefficient for rolling friction = 0.002 (f_1 about 0.001 to 0.003 for cast iron on steel).

f_2 = coefficient of journal friction. (For starting, f_2 = 0.1

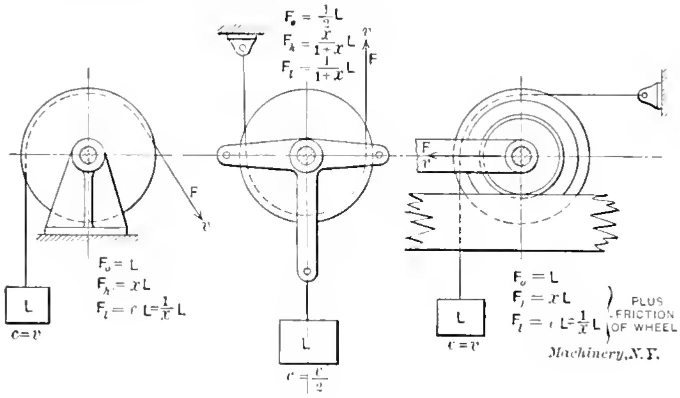

Fig. 2. Fig. 3. Fig. 4.

and running, f_2 = 0.01, assuming a load on brasses 1,000 to 3,000 pounds per square inch.)

d = diameter of journal.

D = diameter of trolley wheels.

Combining

$$P_1 + P_2 = \frac{L + T}{D}\,(f_1 + f_2\,d) \qquad (1)$$

gives a formula for the power required when neglecting the inertia, or when the trolley is in motion.

Denoting the specified trolley speed as v feet per minute, and t as the time in seconds in which the trolley under full load is required to come to the full or maximum speed v, then in accordance with the principles of mechanics, the accelerating force

$$P = \frac{v\,(T + L)}{1{,}932\,t}.$$

It is obvious for exact calculations that the resistance P of the trolley, trolley gearing and load, due to inertia, is to be added to equation (1), especially when the stipulated maximum trolley speed is over 100 feet per minute.

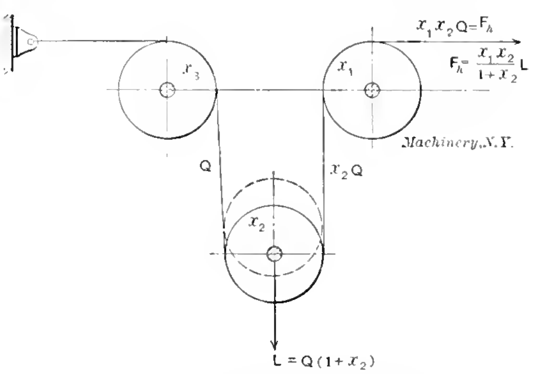

Fig. 5. Notations, Fixed and Movable Sheaves, Two Parts of Rope.

The reduced final equation for the total force P_t required to move or set in motion a trolley under full load is therefore

$$P_t = P_1 + P_2 + P_3 = (T + L)\left(\frac{f_1 + f_2\,d}{D} + \frac{v}{1932\,t}\right) \qquad (2)$$

Similar conclusions can be drawn for the required motive power of crane bridges.

Here I wish to remark that it is close enough for all practical cases to assume that the moments of inertia of all rotating parts of trolley or bridge (gears, drum, brake, etc.) are counterbalanced by the more or less flexible inertia of the suspended weight or load which effects the unavoidable swinging of the lower hook block when suddenly starting or stopping the movement of the trolley. For practical purposes it would be a useless attempt to construct "ounce-wise" formulas on "pound-fool" relations of the actual conditions under which cranes do the work; as, for instance, in regard to variation of load, greasing, attendance, repairs and exposure. In respect to these circumstances, it is, however, not absolutely necessary for the crane builder to contrive the most extreme working conditions in order to design and build a crane. The factors of safety of sufficient allowance (5 to 10) in the elementary parts making up the crane trolley will generally—not always—take care of abnormal conditions that may arise, such as, in particular, initial overload caused by improper greasing and attendance. The friction coefficients already noted, and the coefficients given later on, are for average normal conditions which, of course, may be subjected to certain flexibilities, according to the whims of the attending or not-attending craneman, or the whims of the designer. So, for instance, the axle journal brasses could be replaced by roller bearings, etc. On the other hand, the trolley track, which is perfectly level, may become considerably inclined under the deflection of the bridge caused by the trolley loaded to its capacity. Especially will this deflection be the more noticeable on long span or cantilever cranes, causing often a considerable additional trolley resistance due to the created grade of trolley track.

The advisability of roller bearings in cranes has been questioned very often. But on the other hand, the practical crane designer will foresee the deflection, and, if necessary, allow an appropriate artificial deflection in the top chord of his girder in an opposite direction, instead of leaving it to the

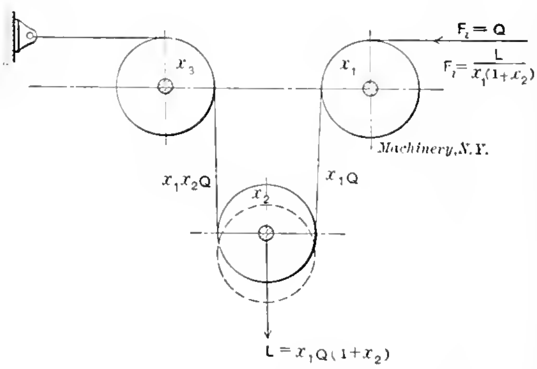

Fig. 6. Notations, Fixed and Movable Sheaves, Two Parts of Rope.

superintendent, as an afterthought, to send up his machinists with so-called "Dutchmen" pieces to fix up the trolley track.

Example: A 10-ton crane trolley, weighing 3½ tons, is to have a trolley speed of 100 feet per minute. The size of trolley wheel is D = 10 inches; and axle journal d = 2 inches. How much power will it require:

1. To start the trolley when loaded to its capacity?
2. To bring it up to full speed in 10 seconds?
3. To move the trolley at a constant speed?

Answer 1.

$$P_t' = 27{,}000\left(\frac{0.002}{10} + \frac{0.1 \times 2}{10} + \frac{100}{1932 \times 10}\right)$$
$$= 686 \text{ pounds.}$$

Answer 2.

$$P_t'' = 27{,}000\left(\frac{0.002}{10} + \frac{0.01 \times 2}{10} + \frac{100}{1932 \times 10}\right)$$
$$= 200 \text{ pounds.}$$

Answer 3.

$$P_t''' = 27{,}000\left(\frac{0.002}{10} + \frac{0.01 \times 2}{10}\right)$$
$$= 60 \text{ pounds.}$$

The equivalent for 33,000 foot-pounds per minute is one horse-power. It follows, therefore, that for a maximum trolley speed of 100 feet per minute,

$$\frac{686 \times 100}{33{,}000} = 2.1 \text{ H.P. is required for starting the trolley;}$$

$$\frac{200 \times 100}{33{,}000} = 0.6 \text{ H.P. is required while speeding up the trolley;}$$

and
$$\frac{60 \times 100}{33{,}000} = 0.2 \text{ H.P. is required for moving the trolley at uniform speed.}$$

In case an electric motor, coupled to a series of cut gear reductions, the total efficiency of which is assumed to be about 80 per cent, furnishes the motive power, the required size of motor follows from

$$\frac{2.1}{0.8} \cong 2.5 \text{ H.P.}$$

[NOTE.—The sign $\cong$ signifies "approximately equals."]

The motor should have a high starting torque, and a permissible overload of about 50 per cent (100 per cent is not unusual).

II. The Fixed, Loose and Moving Sheaves.

If we now refer to Figs. 2, 3, 4, 5 and 6, let

F_o = theoretical force or pull.

F_h = actual hoisting force.

$$F_l\, v = L\, c \qquad (4b)$$

Substituting from above for $F_h = \frac{1}{e} F_o = x F_o$, in which $\frac{1}{e} = x$ symbolizes the coefficient of efficiency.

This coefficient has been determined experimentally for several hoisting elements, such as the sheave, block, windlass, gearing, reduction, etc. Even for complete cranes of certain types and definite design the coefficient of efficiency has been determined by experiments. For any new design, this coefficient can be figured as per following analysis:

It has been proved by mathematics that the efficiency c of a whole machine is the product of all the efficiencies of each elementary part of which the machine is constituted. Knowing once the efficiency of each elementary part, the total efficiency of any combination can then be easily found by multiplying

$$e_1\, e_2\, e_3\, e_4 \ldots\ldots = e. \qquad (5)$$

Or, as $\frac{1}{e} = x$, the coefficient of efficiency

$$x = \frac{1}{e} = \frac{1}{e_1} \times \frac{1}{e_2} \times \frac{1}{e_3} \times \frac{1}{e_4} \ldots = x_1\, x_2\, x_3\, x_4 \ \ldots \qquad (5a)$$

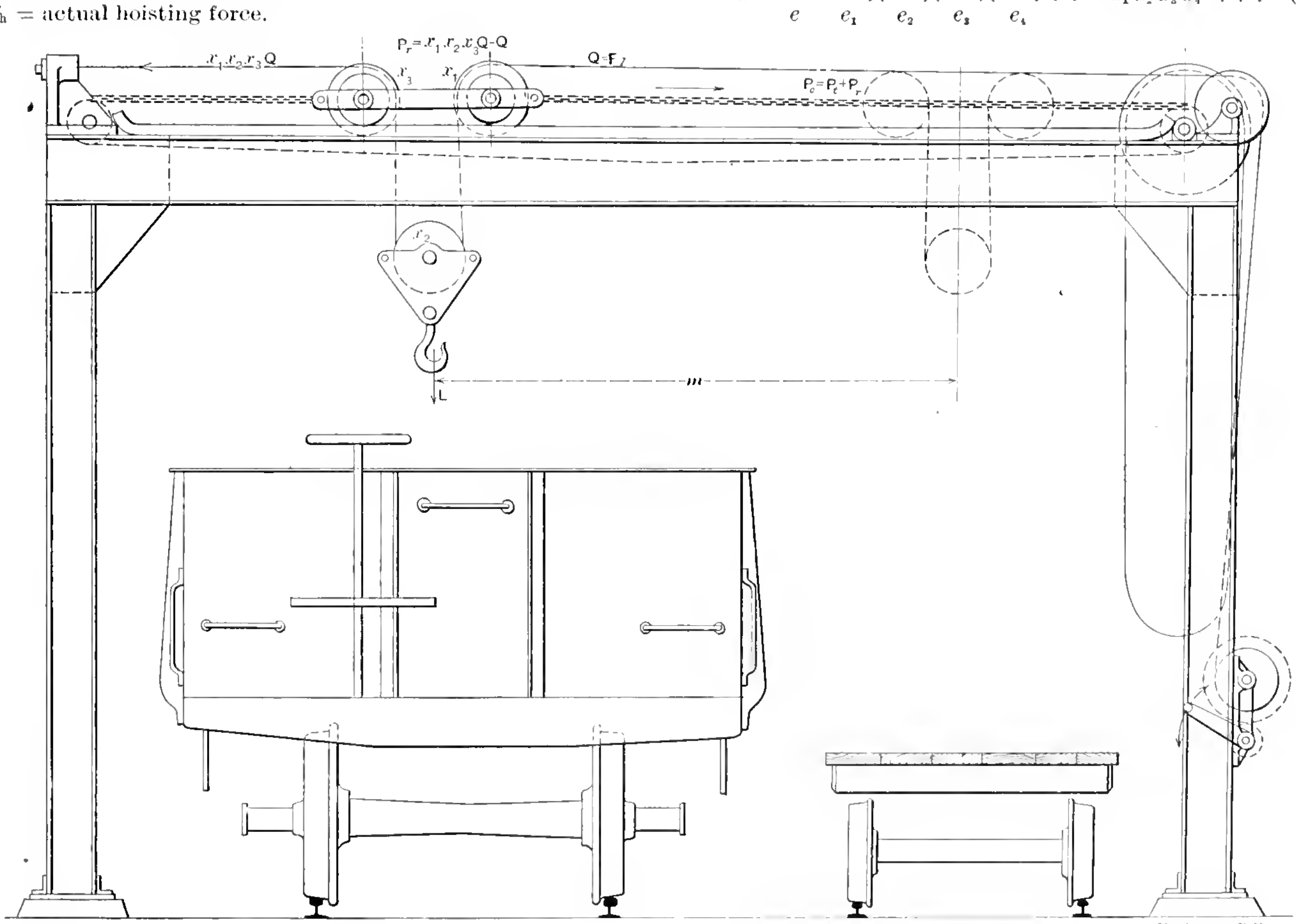

Fig. 7. Hand Crane Trolley Traversing with Suspended Load.

F_l = actual lowering force (brake resistance).

L = load.

Q = tension of rope.

The efficiency of any hoisting rig is:

$$e = \frac{F_o}{F_h} \qquad (3)$$

If, further,

v = the speed of the rope or chain end at which the force F_h, F_l or F_o is applied,

c = the hoisting or lowering speed of load L,

Then $\frac{c}{v}$ = the transmission ratio of the hoist.

The theoretical work required, per velocity time unit, to lift or lower the load:

$$F_o\, v = L\, c \qquad (4)$$

The actual work to raise the load:

$$F_h\, v = L\, c \qquad (4a)$$

The actual brake work to lower the load:

In order to raise the load in Figs. 2, 3 and 4, it is obvious that F_h must be greater than the tension L, from load. On the other hand, F_l will be smaller than L when lowering the load. This is all due to the pin friction in the sheave, chain friction, or stiffness of rope. As a rule, it could be said that the greater tension is always on the side from which the chain or rope runs off the sheave.

For hemp rope sheaves the coefficient of efficiency is:

$$x = 1 + \frac{0.06 \text{ to } 0.18\, i^2}{R} + \frac{2\, f\, r \sin\frac{a}{2}}{R} \qquad (6)$$

For wire rope and chain sheaves the same is:

$$x = 1 + \frac{0.2 \text{ to } 0.3\, i}{R} + \frac{2\, f\, r \sin\frac{a}{2}}{R} \qquad (6a)$$

In these equations

i = diameter of chain or rope;

f = friction coefficient of sheave pin $\cong 0.08$;

r = half diameter of sheave pin;
R = half diameter of sheave;
a = angle of rope or chain turn.

For parallel tension members, a = 180 degrees:

$$x = 1 + \frac{0.06 \text{ to } 0.18\ i^2}{R} + \frac{2f'r}{R} \text{ for hemp rope sheaves;}$$

$$x = 1 + \frac{0.2 \text{ to } 0.3\ i}{R} + \frac{2f'r}{R} \text{ for chain or wire rope sheaves.}$$

The coefficient for wire rope sheaves is not as yet sufficiently determined. Approximately it may be figured to the same formula as used for chain sheaves.

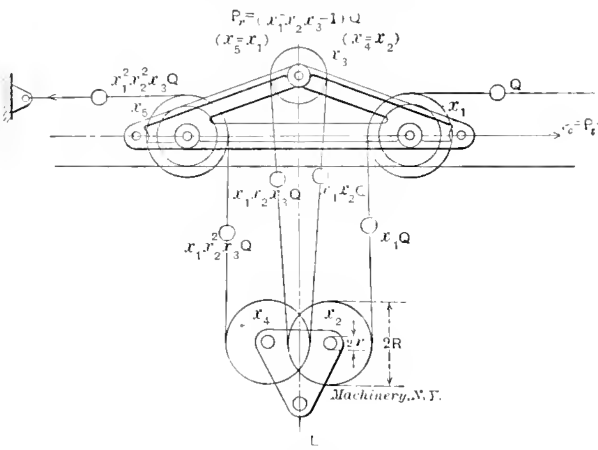

Fig. 8. Notations used in Calculating Efficiency, Four Parts of Rope.

For sprockets a value $x \cong 1.06$ is often used.

For gear reductions, about 1:5, the efficiency is on an average: $e \cong 0.92$; $x \cong 1.087$.

As seen in diagrams Fig. 5 and Fig. 6, the hoisting force $F_h = \frac{x_1 x_2}{1 + x_2} L$, and the force for lowering the load $F_l = \frac{1}{x_1(1 + x_2)} L$

Combining and evolving the above we have, in general, for n sheaves.

$$F_h = x_1 (x_1 x_2 x_3 \ldots x_{n-1}) F_l \qquad (7)$$

Or, if the coefficient of efficiency of the first sheave $x_1 = x_n$ of the last sheave, then

$$F_h = (x_1 x_2 x_3 \ldots x_n) F_l \qquad (7a)$$

As examples we will investigate the single sheave crab Fig. 7, the double sheave crab Fig. 8, and the triple sheave crab Fig. 9.

Without any hesitation, we could say that in all three cases the total power P_c to move the crab will be composed of:

1. The total force P_t to move the trolley as already discussed, and
2. The total resistance P_r of crab rigging.

Therefore

$$P_c = P_t + P_r.$$

a. Resistance P_t of crab trolley.

Neglecting the weight T and the inertia force P_3 of the trolley or crab, the pull P_t to move the crab will be simply

$$P_t = \frac{L}{D}(f_1 + f_2 d)$$

Assuming in our examples:	Fig. 7	Fig. 8.	Fig. 9.
The maximum load	L = 3 tons	5 tons	10 tons
Diameter of truck wheel	D = 7½ in.	8¾ in.	10 in.
Diameter of truck wheel pin ...	d = 1½ in.	1¾ in.	2 in.

Inserting the values, and choosing $f_1 = 0.002$ and $f_2 = 0.08$:

$$P_t = \frac{6000}{7.5}(0.002 + 0.08 \times 1.5) = 976 \text{ pounds for } L = 3 \text{ tons,}$$

$$P_t = \frac{10000}{8.75}(0.002 + 0.08 \times 1.75) = 1623 \text{ pounds for } L = 5 \text{ tons,}$$

$$P_t = \frac{20000}{10}(0.002 + 0.08 \times 2) = 3240 \text{ pounds for } L = 10 \text{ tons.}$$

b. Resistance P_r of crab rigging.

If we move the crab to the position shown dotted in Fig. 7, the load L will, of course, move the same distance horizontally, but its height or elevation will not be changed; that is, the potential energy of the load will remain the same. The shifting of the crab, however, will cause the rope or chain to run off the same distance in feet over all sheaves in a direction opposite to the motion of the crab, Figs. 7, 8 and 9.

Considering now the rope tension, we can assume a certain tension Q in one end of the rope or chain, Figs. 7, 8 and 9. While the rope is passing over the several sheaves x_1 x_2 x_3 . . . etc., the tension in the rope increases on the paying off side; and, as already pointed out, by the amount $x_1 Q$ after passing the first sheave, $x_1 x_2 Q$ after running off the second sheave, etc., all due, each time, to the friction of sheaves, rope or chain. The final tension will be in Fig. 7 = $x_1^2 x_2 Q$, in Fig. 8 = $x_1^2 x_2^2 x_3 Q$, and in Fig. 9 = $x_1^2 x_2^3 x_3^2 Q$, by making the corresponding sheaves alike.

Assuming, now, such a slippery track as that there will be no friction whatever in the trolley wheels, so that the trolley resistance may be placed at $P_t = O$. It is evident, then, that the rigging resistance:

$$P_r = x_1^2 x_2 Q - Q = (x_1^2 x_2 - 1) Q \text{ in Fig. 7.}$$
$$P_r = (x_1^2 x_2^2 x_3 - 1) Q \text{ in Fig. 8.}$$
and
$$P_r = (x_1^2 x_2^3 x_3^2 - 1) Q \text{ in Fig. 9.}$$

In this equation $Q = F_l$, the force for lowering the load, and from $L = x_1 Q + x_1 x_2 Q$ (Fig. 7), we have

$$Q = F_l = \frac{L}{x(1 + x_2)} \qquad (8)$$

From

$L = Q[(x_1 + x_1 x_2) + (x_1 x_2 x_3 + x_1 x_2^2 x_3)]$ (Fig. 8) we get

$$Q = F_l = \frac{L}{x_1(1 + x_2)(1 + x_2 x_3)} \qquad (8a)$$

From $L = Q[(x_1 + x_1 x_2) + (x_1 x_2 x_3 + x_1 x_2^2 x_3) + (x_1 x_2^2 x_3^2 + x_1 x_2^3 x_3^2)]$ (Fig. 9) we have

$$Q = F_l = \frac{L}{x_1(1 + x_2)(1 + x_2 x_3 + x_2^2 x_3^2)} \qquad (8b)$$

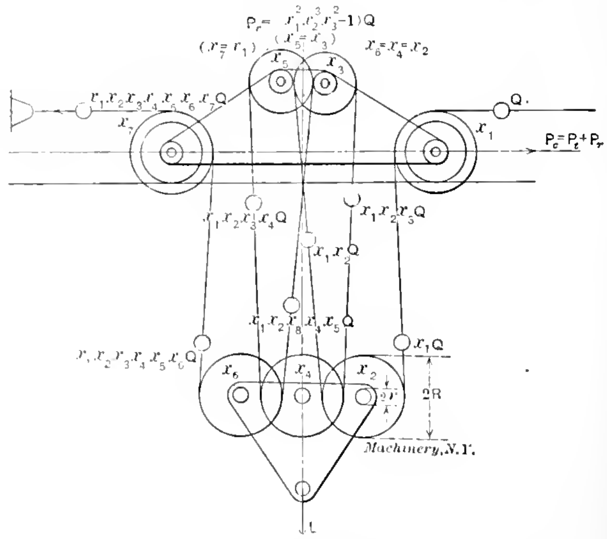

Fig. 9. Notations used in Calculating Efficiency, Six Parts of Rope.

Analogous will be the hoisting force or pull:

$$F_h = x F_l = \frac{x_1 x_2}{1 + x_2} L \text{ .... in Fig. 7.}$$

$$F_h = \frac{x_1 x_2^2 x_3}{(1 + x_2)(1 + x_2 x_3)} L \text{ .... in Fig. 8.}$$

$$F_h = \frac{x_1 x_2^3 x_3^2}{(1 + x_2)(1 + x_2 x_3 + x_2^2 x_3^2)} L \text{ .. in Fig. 9.}$$

Substituting the value found for Q in above equations for P_r, we finally get:

$$P_r = \frac{x_1^2 x_2 - 1}{x_1(1 + x_2)} L \text{ .... in Fig. 7.} \qquad (9)$$

$$P_r = \frac{x_1^2 x_2^2 x_3 - 1}{x_1(1 + x_2)(1 + x_2 x_3)} L \text{ .... in Fig. 8.} \qquad (9a)$$

$$P_r = \frac{x_1^2 x_2^3 x_3^2 - 1}{x_1 (1 + x_2)(1 + x_2 x_3 + x_2^2 x_3^2)} L. \text{ in Fig. 9.} \quad (9b)$$

The more the number of sheaves of various diameters in a rigging, the more voluminous these formulas become.

Illustrating the proceeding by numerical examples, we will assume for the sheave crabs, Figs. 7, 8 and 9:

	Fig. 7. Single Sheave.	Fig. 8. Double Sheave.	Fig. 9. Triple Sheave.
The maximum load..	$L = 3$ tons.	5 tons.	10 tons.
Size of chain or rope.	$i = \frac{1}{2}$ inch.	$\frac{1}{2}$ inch.	$\frac{1}{2}$ inch.
Size of sheave pin . .	$2r = 1\frac{1}{2}$ "	$1\frac{3}{4}$ "	2 "

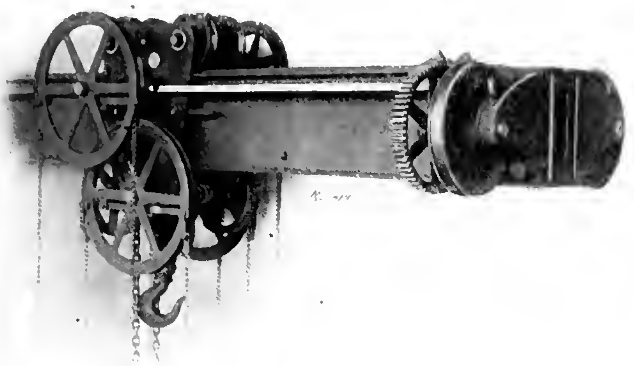

Fig. 10. Typical Hand Chain Crane Trolley.

As usual we may take the chain sheave diameter $2R = 20\ i = 10$ inches, and the sheave diameter for wire ropes $2R = 30\ i = 15$ inches.

To assure a more uniform wear inside as well as outside of the rope, the sheaves should, if possible, be made even larger. Adopting, therefore, for ½-inch steel wire rope $2R = 18$ inches, in general, and $2R = 15$ inches for the equalizing sheaves, Fig. 8 and Fig. 9.

For the sheaves x_1, referring again to Figs. 5, 6, 7, 8 and 9, we have from formula (6a):

For chain sheave $2R = 10$ inches.

$$x_1 = 1 + \frac{(0.2 \text{ to } 0.3)\ \frac{1}{2}}{5} + \frac{2 \times 0.08 \times \frac{3}{4}}{5} \sin 45^\circ$$

$= 1.037$ to $1.047 \cong 1.042$ for $2r = 1\frac{1}{2}$ inch, Fig. 7.
$x_1 = 1.040$ to $1.050 \cong 1.045$ for $2r = 1\frac{3}{4}$ inch, Fig. 8.
$x_1 = 1.043$ to $1.053 \cong 1.048$ for $2r = 2$ inches, Fig. 9.

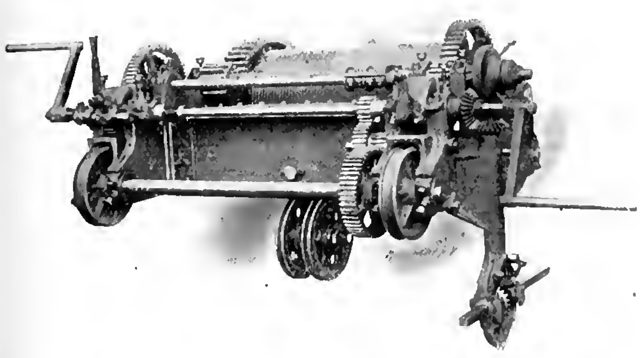

Fig. 11. Typical Crank Crane Trolley.

For wire rope sheave $2R = 18$ inches.
$x_1 = 1.021$ to $1.027 \cong 1.024$ for $2r = 1\frac{1}{2}$ inch, Fig. 7.
$x_1 = 1.022$ to $1.028 \cong 1.025$ for $2r = 1\frac{3}{4}$ inch, Fig. 8.
$x_1 = 1.024$ to $1.030 \cong 1.027$ for $2r = 2$ inches, Fig. 9.

For the loose sheaves x_2 and x_3 we have for chain, if $a = 180$ degrees, $2R = 10$ inches:
$x_2 = 1.044$ to $1.054 \cong 1.049$ for $2r = 1\frac{1}{2}$ inch, Fig. 7.
$x_2 = 1.048$ to $1.058 \cong 1.053$ for $2r = 1\frac{3}{4}$ inch, Fig. 8.
$x_2 = 1.052$ to $1.062 \cong 1.057$ for $2r = 2$ inches, Fig. 9.

Using wire rope, $2R = 18$ inches:
$x_2 = 1.0246$ to $1.0312 \cong 1.0279$ for $2r = 1\frac{1}{2}$ inch, Fig. 7.
$x_2 = 1.0267$ to $1.0333 \cong 1.0300$ for $2r = 1\frac{3}{4}$ inch, Fig. 8.
$x_2 = 1.0289$ to $1.0355 \cong 1.0322$ for $2r = 2$ inches, Fig. 9.

and for equalizing sheaves x_3 if $2R = 15$:
$x_3 = 1.0299$ to $1.0363 \cong 1.0331$ for $2r = 1\frac{1}{2}$ inch, Fig. 7.
$x_3 = 1.0321$ to $1.0388 \cong 1.0335$ for $2r = 1\frac{3}{4}$ inch, Fig. 8.
$x_3 = 1.0346$ to $1.0413 \cong 1.0380$ for $2r = 2$ inches, Fig. 9.

According to the above values for x_1, x_2, x_3, we get for the required holding or brake pull $F_1 = Q$ for lowering the load L, from equations (8, 8a, and 8b), the numerical values:

Fig. 7. $L = 6{,}000$

$$Q = \frac{6{,}000}{1.042\ (1 + 1.049)} = 2{,}801 \text{ pounds for chain.}$$

$$Q = \frac{6{,}000}{1.024\ (1 + 1.0279)} = 2{,}890 \text{ pounds for wire rope.}$$

Fig. 8. $L = 10{,}000$

$$Q = \frac{10{,}000}{1.042\ (1 + 1.049)\ (1 + \overline{1.049}^2)} = 2230 \text{ pounds for chain.}$$

$$Q = \frac{10{,}000}{1.024\ (1 + 1.0279)\ (1 + 1.0279 \times 1.0331)} = 2335 \text{ pounds for wire rope.}$$

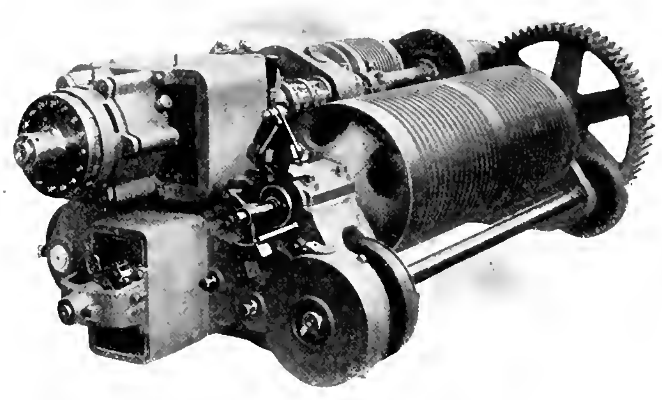

Fig. 12. Typical Two-motor Crane Trolley.

Fig. 9. $L = 20{,}000$

$$Q = \frac{20{,}000}{1.042\ (1 + 1.049)\ (1 + \overline{1.049}^2 + \overline{1.049}^4)} = 2775 \text{ pounds for chain.}$$

$$Q = \frac{20{,}000}{1.024\ (1 + 1.0279)\ (1 + 1.0279 \times 1.0331 + \overline{1.0279}^2 \times \overline{1.0331}^2)} = 3020 \text{ pounds for wire rope.}$$

In the hoisting direction, the pull or tension $F_h = x F_1$ for this kind of rope distribution. In other words, we have to multiply the above with the total coefficient of efficiency:

Fig. 7. $L = 6000 \begin{cases} F_h = x_1^2 x_2\ Q = 1.139 \times 2801 = 3190 \\ F_h = x_1^2 x_2\ Q = 1.078 \times 2890 = 3115 \end{cases}$ as above

Fig. 8. $L = 10000 \begin{cases} F_h = x_1^2 x_2^3\ Q = 1.253 \times 2230 = 2794 \\ F_h = x_1^2 x_2^2 x_3\ Q = 1.145 \times 2335 = 2674 \end{cases}$ as above $x_3 = x_2$

Fig. 9. $L = 20000 \begin{cases} F_h = x_1^2 x_2^5\ Q = 1.379 \times 2775 = 3827 \\ F_h = x_1^2 x_2^3 x_3^2\ Q = 1.215 \times 3020 = 3669 \end{cases}$ as above $x_3 = x_2$

Above results show that, according to existing chain and wire rope tables, the sizes of chains or wire ropes were chosen about right in the beginning. Otherwise, new calculations with respective changes in the dimensions would be required. The figures also show plainly that in general a chain rigging requires more power than a wire rope rigging.

Figuring out, now, the resistance in traversing the crab due to the rigging only, from 9, 9a and 9b:

Fig. 7. $L = 3$ tons $\begin{cases} P_r = 0.093 \times 2801 = 260 \\ P_r = 0.053 \times 2890 = 153 \end{cases}$ as above

Fig. 8. $L = 5$ tons $\begin{cases} P_r = 0.203 \times 2230 = 452 \\ P_r = 0.118 \times 2335 = 276 \end{cases}$ as above

Fig. 9. $L = 10$ tons $\begin{cases} P_r = 0.323 \times 2775 = 896 \\ P_r = 0.187 \times 3020 = 565 \end{cases}$ as above

And summarizing at last the total pull P_c for the crab, we get from $P_c = P_t + P_r$.

Fig. 7. $L = 3$ tons $\begin{cases} P_c = 976 + 260 = 1236 \text{ pounds for chain} \\ P_c = 976 + 153 = 1129 \text{ pounds for wire rope} \end{cases}$

Fig. 8. $L = 5$ tons $\begin{cases} P_c = 1623 + 452 = 2075 \text{ pounds for chain} \\ P_c = 1623 + 327 = 1950 \text{ pounds for wire rope} \end{cases}$

Fig. 9. $L = 10$ tons $\begin{cases} P_c = 3240 + 754 = 3994 \text{ pounds for chain} \\ P_c = 3240 + 565 = 3805 \text{ pounds for wire rope} \end{cases}$

In the preceding examples we have again demonstrated the old fact that comparatively a much higher efficiency of wear in ropes, étc., as well as of motive power, can be attained from the individually or direct driven cranes now in general use, Figs. 10, 11 and 12. In practice, there are, however, sometimes, the factors of first cost, frequency and speed of handling, etc., which suggest a much cheaper and simpler hoist.

* * *

CONSTRUCTION OF THE DETROIT RIVER TUNNEL.

The building of a railroad tunnel in a shipyard would seem to be about on a par with the manufacture of post-holes in a factory, but that, in part, is actually what was done in the construction of the Detroit River tunnel which is to connect Windsor in Canada with Detroit in the United States. It is being built by the Lake Shore & Michigan Southern Railroad, which for many years has maintained a costly car ferry service there for its freight and passenger traffic. The tunnel is being built to give an all-rail connection, and will contain two tracks, or rather, the twin tubes will contain two tracks, there being a tube for each track. The river bed is of a character that discouraged the building of a tunnel close to the river-bed surface, and this location was highly desirable in order to keep the dip down under the river within a limit (41 feet) that would give a readily negotiable grade. In fact, it was desirable that the tunnel should be actually above the river bed at its deepest parts in order to keep within the desired grade, and the construction employed permitted this to be done.

The method adopted is largely the plan of Mr. W. J. Wilgus, formerly vice-president of the New York Central Railroad, and broadly consists of dredging a ditch or channel across the river bed and sinking a pair of steel tubes in the bed thus prepared. The twin tunnel tubes were built in sections 260 feet long, ten sections in all. Each tube is 23 feet 4 inches diameter, and is built of ⅜-inch steel plate. The twin tubes are joined sideways by transverse steel plate diaphragms which embrace the tubes and project beyond them a short distance all around. The diaphragms are spaced about 12 feet apart and are an important part of the construction. The accompanying cut shows one of the twin tunnel sections being floated down the river from the shipyard at St. Clair. They are enclosed in a scow-like structure composed of 3-inch planks bolted onto the ends of the diaphragm sheets. The ends of the tubes were planked across also, the tubes then displacing water sufficient to float them. The end planking served the purpose of floating the twin tubes to the desired location and the side planking formed a cofferdam or enclosing box for tons of liquid cement that were poured around the tubes after they were sunk into the river bed and connected. When completed the tunnel will consist of a massive concrete shell surrounding the steel tubes.

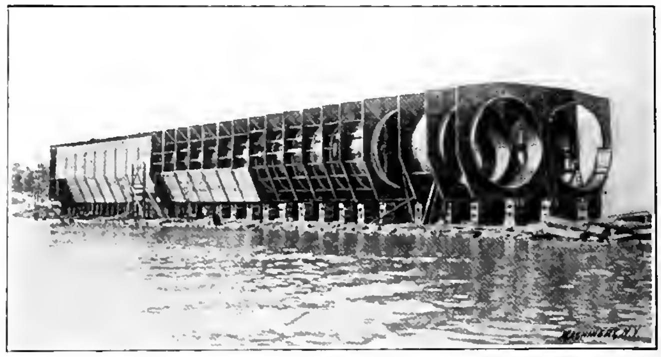

Fig. 1. Section of Tunnel in St. Clair Shipyard, showing Diaphragm Construction.

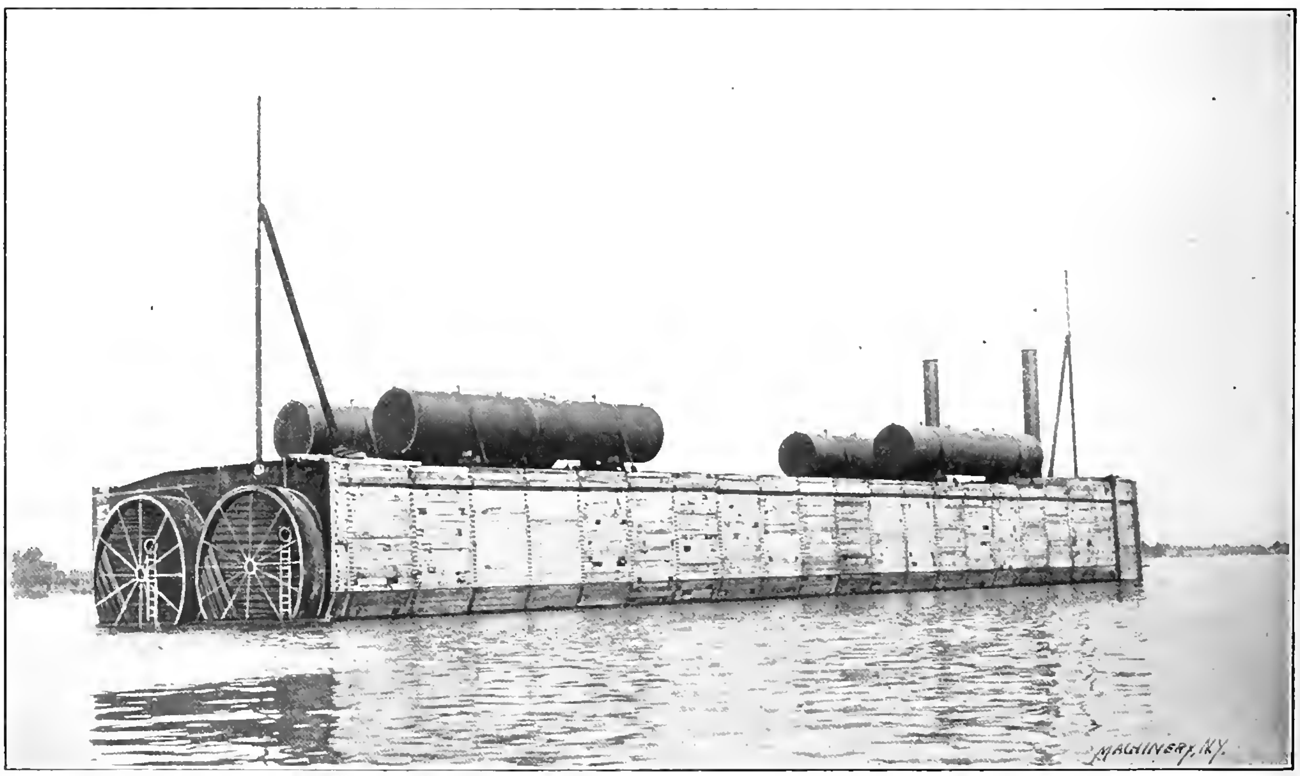

Fig. 2. Complete Tunnel Section being Floated down the River to the Tunnel Location, where it was Sunk to the River Bed.

The cylinders shown on top of the tunnel section are temporary attachments employed for slowly lowering the section to the river bed. An idea of the size of the section is obtained from the fact that the four cylinders are each 10 feet diameter and 60 feet long. After they have served their purpose in lowering a section they are raised and used again on the succeeding sections.

The sub-aqueous section of the tunnel is 2,625 feet long, the westerly open cut 1,540 feet, the westerly approach 2,129 feet, easterly approach 3,193 feet, easterly open cut 3,300 feet, making a total distance of excavation 12,786 feet, or a trifle more than 2.42 miles. The tunnel will cost $10,000,000 and will be completed by June, 1909. Its annual capacity will be 1,000,000 cars, or three times the present facilities afforded by the car ferries.

PUNCH PUNCH

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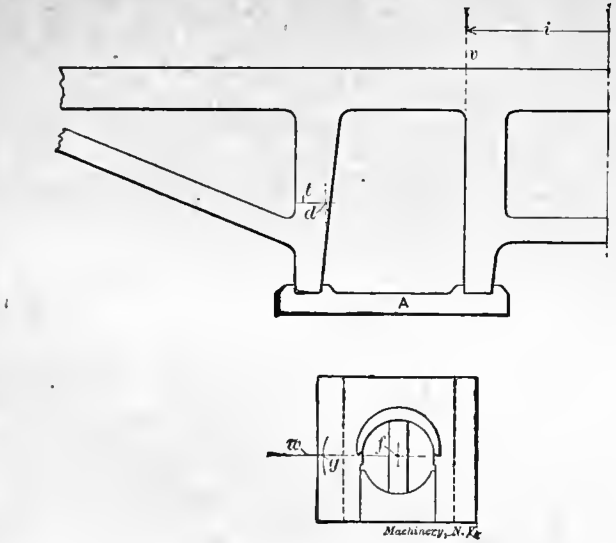
SHOP OPERATION SHEET NO. 43.

Franklin D. Jones. MACHINERY, November, 1907.



To Line Up Locomotive Shoes and Wedges.

1. Run fine lines through each cylinder, and let them extend back of the main jaws. Set the lines perfectly central with the front and back counterbores of the cylinders.

2. Place a straight-edge, *B*, upon the supports *C*, and across the faces of the front main jaws. Set the straight-edge *B* at right angles to the lines through the cylinders.

3. Scribe horizontal lines *t* on the inside and the outside of all back jaws, keeping the distance from the top of the frame to these lines, equal to the distance from the top of the frame to the center of the straight-edge *B*.

4. Hold a pair of hermaphrodite calipers against the straight-edge *B*, and scribe arcs intersecting those horizontal lines *t* which are on the main back jaws. The points of the intersection of these lines, will be the square centers *a*.

5. Remove the straight-edge *B*, and clamp both main wedges *D* in position, placing them about 1/4 inch above the pedestal braces, as shown by the dotted lines. Place a square on top of the frame, and scribe a line *r*, from the inner top edge of each main wedge *D*. Remove the wedges.

6. Insert between the pedestal braces and the frames, on both sides, wooden centers *E*, placing them flush with the outside of the frames. Scribe lines *s*, *u*, and *v*, from the faces of each front jaw, on both sides of the engine. With a pair of dividers, locate the center *b*, midway between the lines *r*, and *s*. Scribe a line at right angles to the top of the frame, through the center *b*, and down far enough to intersect the horizontal line *t*. The intersection of these two lines is the jaw center *c*. In a similar manner, locate the jaw center on the opposite side of the engine. With a pair of dividers, see if the distances from the square centers *a*, to the jaw centers *c*, are equal on both sides of the engine. If they are not,

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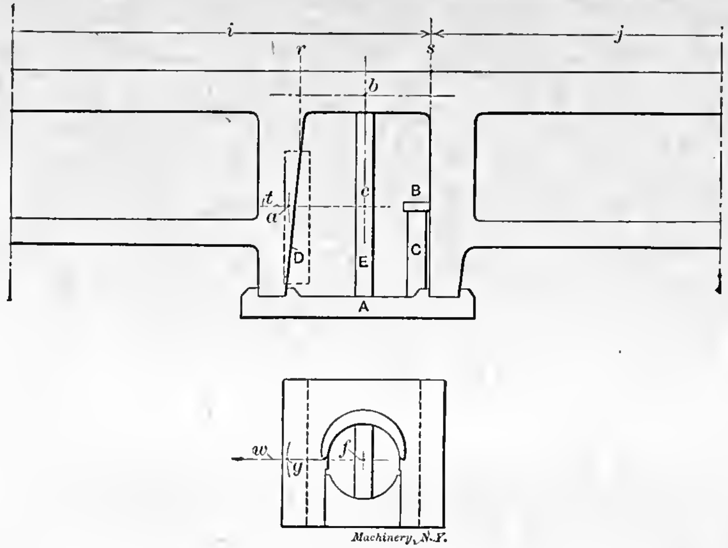

To Line Up Locomotive Shoes and Wedges (Continued).

move one jaw center forward, and the other backward, one-half the difference, making the distances equal.

7. Set a long pair of trammels, equal to the distance *i*. Try the corresponding distance on the opposite side of the engine. If these two distances are not equal, move the trammel point one-half the difference; then with one trammel point into the main square center *a*, scribe an arc intersecting the horizontal line *t*. The point of intersection will be the square center *d*. In a similar manner, locate a square center on the inside of the jaw, also on both sides of the opposite jaw. Now set the trammels to the distance *j*, try the opposite side; if there is a difference, again move the trammel point one-half this difference, and proceed to locate square centers *e* as before.

NOTE.—When the connecting-rods have solid ends, set the trammels to the length of the rods when locating square centers *d*, and *e*, from the main square center *a*.

8. Place all driving boxes on the floor in their respective positions, with their tops toward the rail, and their outer sides upward. Locate the centers *f*, which represent the centers of the axles. On the outside back flange of each box, scribe lines *w*, through the centers *f*, and at right angles to the back edge of the flange. Now set a pair of dividers equal to the distance from the main jaw center *c*, to the square center *a*. Transfer this measurement to all the driving boxes, locating the centers *g*.

9. Remove the wooden centers *E*, and clamp all the shoes in their respective positions. Hold the transfer plate *F* against the front face of one of the driving boxes, and set the hermaphrodite calipers to the distance *k*. Now insert the point of the calipers into the square center of the jaws to

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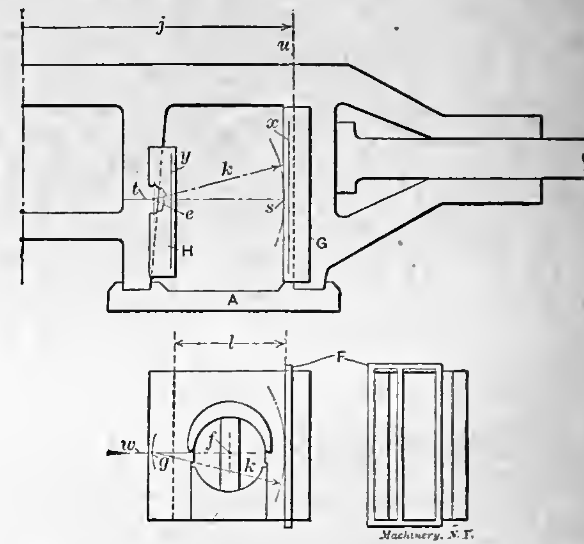


To Line Up Locomotive Shoes and Wedges (Continued).

which the box belongs—say square center *e*—and determine the thickness of the liner to be riveted to the shoe. Remove the shoe and rivet a liner of the required thickness to the back, allowing an extra 1/32 inch for planing the face of the shoe.

10. After liners have been riveted to all the shoes, again clamp them in position, and beginning with, say shoe *G*, chip away a small spot *s*, on the face of the shoe just opposite the square center *e*. Chip and file this spot, until the hermaphrodite calipers set to distance *k*, touch it lightly. Chip and file a second spot, opposite the inside square center, until the hermaphrodites (calipering from the inside square center) touch the spot lightly as before. Scribe a line *x*, which is at right angles to the top of the frame, on the outside flange of the shoe.

11. Clamp all wedges in position, placing them 1/4 inch above the pedestal braces. Caliper each box, and determine the thickness of the liner to be riveted to each respective wedge, adding enough to allow for planing.

12. After liners have been riveted to all the wedges, again clamp them in position, and beginning with say wedge *H*, chip and file spots on the face of the wedge, opposite the spots *s* on the face of the shoe, making the distance between them equal to the thickness *l*, of the driving box. Scribe a line *y* on the flange of the wedge, parallel to the line *x*.

NOTE.—After all the shoes and wedges have been treated in this way, they are ready to be planed. They will be set lengthwise on the planer by the lines *x* and *y*, and crosswise by the spots *s*, which are parallel with the square centers. The planer tool should just scrape these spots, allowing them to remain visible.

EMERGENCY METHODS IN GEAR CUTTING.

The accompanying cuts tell the story of two jobs of gear cutting which were performed in rather unusual ways. The pictures were taken in the shops of Gould & Eberhardt of Newark, N. J. The work illustrated was done some little time ago, but it is not less interesting on that account.

Fig. 1 shows the way in which a wide face internal gear was cut. The length of the travel required for milling the teeth was considerably greater than it was possible to obtain with the usual internal gear-cutting attachment for the automatic gear cutter. The teeth also were quite large (being 4-pitch), so that an internal attachment would have been worked nearly to its limit in forming the teeth. On account of these difficulties, when the order for cutting this internal gear came to the shop, the ingenuity of the man in charge of the work was at once taxed to provide some means of completing it accurately and cheaply. The half-tone shows so well how this was done that little description is needed.

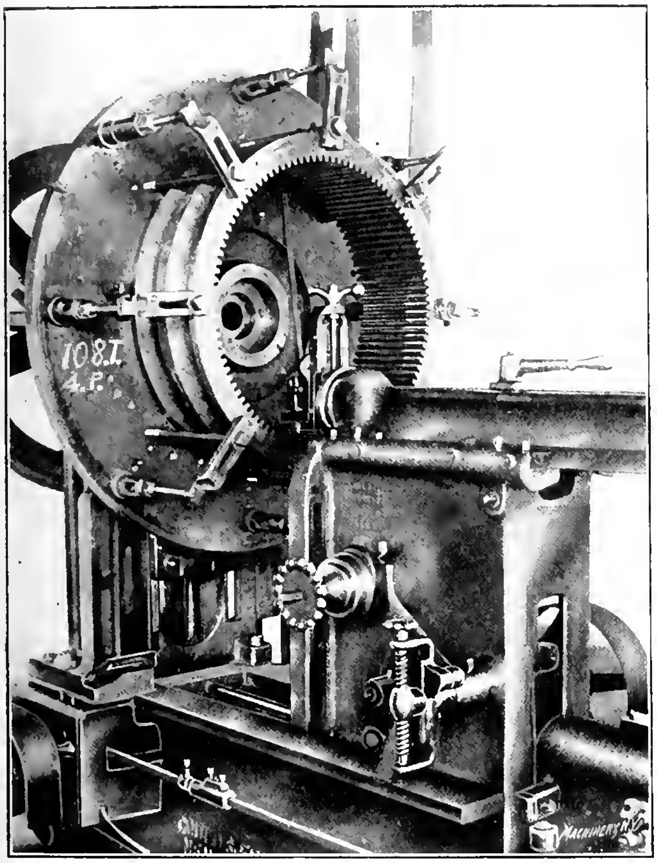


Fig. 1. A Hybrid Machine, at Work on a Wide-faced Internal Gear.

As may be seen, the cutter slide was removed from an automatic gear cutter, and the column of a shaper clamped in place on the plane top of the machine in its stead. The work was clamped on the face-plate in the usual manner, and the proper change gears placed on the machine for the required indexing. Roughing and finishing tools properly shaped for the teeth of the gear were provided, and used in the regular tool-post of the shaper. The work spindle was raised to bring the work to the proper height in relation to the tool. With the shaper driven at the proper speed from a temporary countershaft, the teeth were worked out by feeding the tool-post of the shaper down by hand. When a tooth had been cut to the proper depth, the tool was raised again, and the work indexed, the operator tripping the indexing mechanism, which was connected with the countershaft.

Fig. 2 shows an unusually large pair of spiral gears for operating some large valves in the New York Subway power house. Figs. 3 and 4 show how the teeth were cut in the larger of these two gears. At present, the shops are fully equipped with machinery which makes it possible to handle spiral gearing of this size without resorting to unusual means, but at the time the work was done there was only one machine in the shop capable of handling it, and that was over-burdened with work to such an extent as to make it inadvisable to change off to cut the teeth in this gear, if it could be avoided. Therefore an engine lathe was rigged up as shown.

Fig. 4 shows best the details of the special rigging used. In spite of its apparent complexity, it is almost entirely composed of parts of other machines and involves very little that

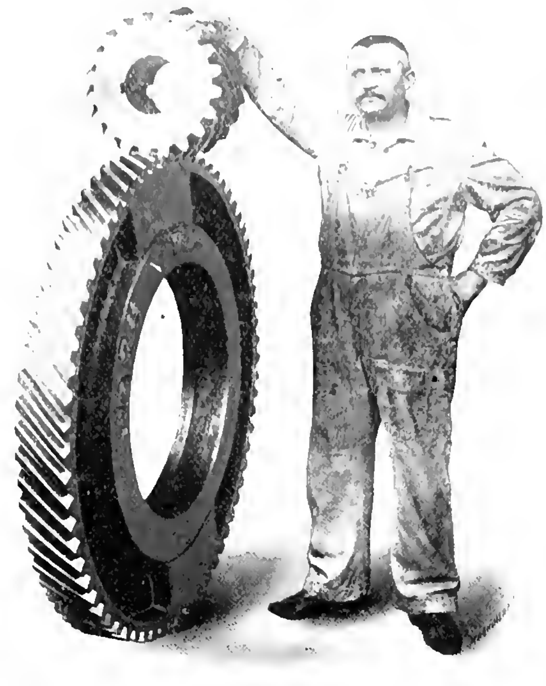


Fig. 2. A Pair of Spiral Gears of Unusual Size.

had to be made specially. As may be seen in Fig. 3, the teeth are cut by end mills formed to the normal section of the tooth spaces desired. Two roughing and one finishing cutter are shown. A suitable head, *F*, Fig. 4, with a spindle for these end mills, was provided, and fastened to the tool slide of a New Haven lathe of about 4 or 5 feet swing. This spindle was driven by a pressed steel pulley, *P*, belted to an electric motor, *G*, temporarily brought into position for that purpose; a pair of intermediate weighted idlers on arm *E* served to keep the belt tight and still allow movement to the spindle.

In cutting a spiral, it is necessary to rotate the work and

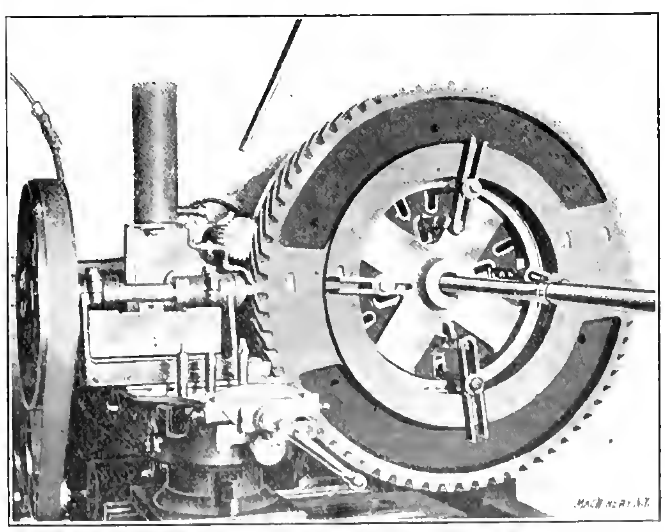


Fig. 3 View of Completed Gear in Lathe.

feed the tool longitudinally at the same time. The connection between these two movements must be positive, with the proper ratio to give the pitch of spiral desired. To effect this, a spur gear of large diameter was clamped between the work and the face-plate, as shown at *A* in Fig. 4. This meshed with pinion *B*, keyed to a shaft which, at its other end, carried gear *C*, which is the first of a train of gearing ending in pinion *D* on the feed screw of the compound rest of the lathe. The top slide of the compound rest, as shown, was arranged to be parallel with the lathe spindle. With this arrangement and with gears of the proper ratio between *C* and *D*, if the

feed motion of the compound rest is operated, it is evident that the face-plate and the work will be revolved at a ratio producing the spiral desired for the gear being cut. To obtain a power feed, the following mechanism is used. Driving pulley O of the motor was wide enough to accommodate, beside the spindle driving belt, a narrower one driving pulley K, which was supported in boxes mounted in lathe steady rests H, suitably located and fastened for the purpose. The shaft driven by pulley K carried at its inner end a bevel gear meshing with another shaft, supported in the same way by lathe steady rests. This shaft carried a small pulley L, belted to the lower feed cone of the lathe. From here the feed mechanism is carried to the feed screw of the compound rest, through the usual lathe mechanism. It is understood, of course, that the regular spindle drive was not used at all, the driving belt being thrown off and the cone and back gears thrown out, so that the only motion imparted to the face-plate was that due to the compound gearing connecting it with the feed mechanism of the cutter spindle.

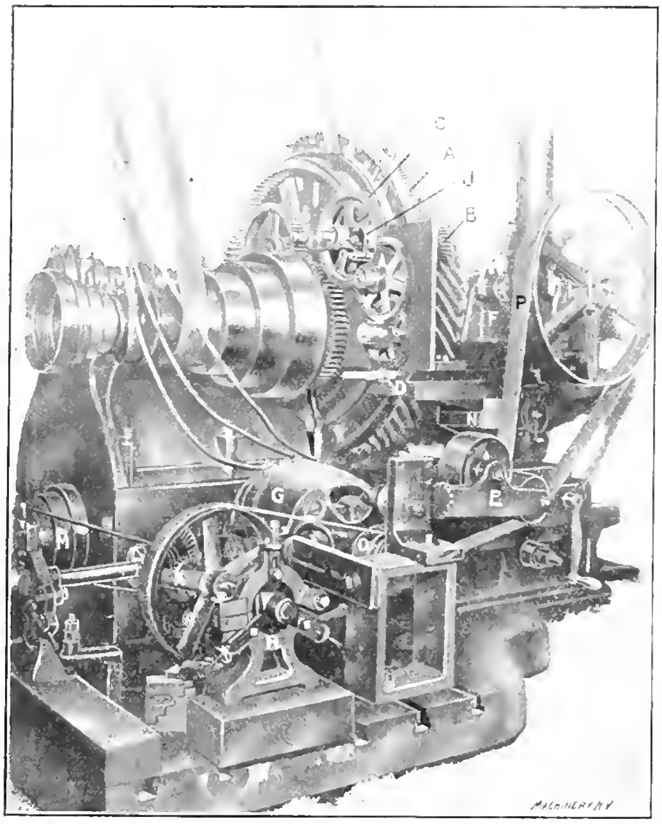


Fig. 4 New Haven Lathe, Rigged up to Cut Spiral Gears.

Provision had to be made for indexing, of course. Owing to the selection of a suitable number of teeth for gears A and B, this was done quite simply. Gear C is loose on its shaft, and arm J is pinned to it. This arm carries a locking-pin, as shown, which may engage with either one of eight holes in the rim of gear C. After one tooth has been cut, the locking-pin in arm J is withdrawn, and the arm rotated the required number of holes in the rim. This rotates the face-plate and the work independently of the spiral mechanism. For withdrawing the cutter from the work to return it for a new cut, and also for adjusting the depth of the cut, it is necessary to use some other means than the regular cross slide of the carriage. This had to be located permanently in position in order to keep pinion B properly in mesh with gear A. To give the cutter the required adjustability in and out from the center line of the lathe, the head on which it is mounted is arranged to slide in and out on a supplementary base which is clamped to the slide, X, of the compound rest.

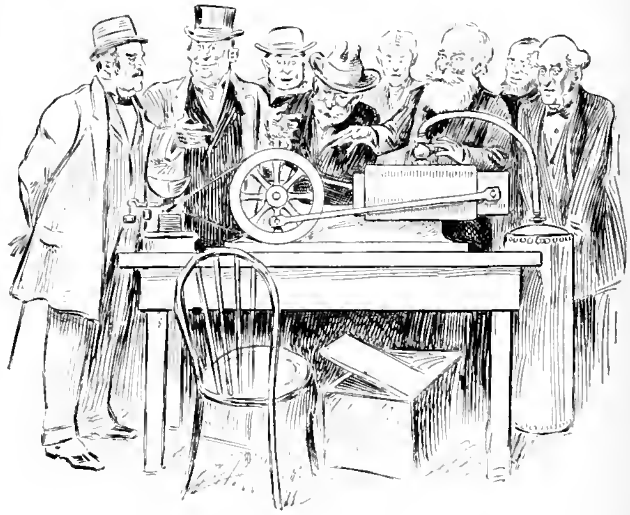
These photographs are interesting as showing what can be done if it has to be done. The rigging up of the second job was somewhat complicated, perhaps, though justified by the circumstances. The first arrangement shown is one worth while remembering. While it is a makeshift combination, it is by no means an inefficient one, and may well take a place in accepted practice for work of unusual dimensions.

DEMONSTRATING AN INVENTION.

M. E. CANEK.

We all are like the man from Missouri—"we want to be shown;" so if you have an invention that makes two blades of grass grow where only one grew before, so to speak, the way to change your opponents' ridicule into open admiration is to actually demonstrate that you can do what you claim.

In this way reasoned Algernon Stonesaw, who had discovered a fact utterly missed or ignored by all steam engineers or designers from the time of the immortal Watt down to the existing NOW—and Stonesaw. "What is this alleged fact?" you inquire. Simply that in any ordinary engine cylinder—steam or gas—at least half the power is wasted because the pressure on the cylinder head is not utilized! There the piston is working back and forth under thousands of pounds pressure, but the cylinder head stands stock-still doing not an ounce of work. "Now," reasoned Stonesaw, "if I provide a movable cylinder head in the form of a second piston and connect it to the crankshaft with a connecting-rod or a pair of them, I will get twice the power." So forthwith he built an engine having two pistons in one cylinder bore, one piston being connected to the crankshaft in the usual way, and the other connected to it by a pair of connecting-rods alongside the cylinder.



"Here is a practical demonstration of the value of our idea, gentlemen."

After having completed the model he made a trial and found to his satisfaction that his logical deduction was sustained by the facts. Thereupon followed the period of forming a stock company with the very modest capital of $60,000 (considering the importance of the invention) and the floating of the stock. The eminent patent lawyer, S. Moothtalk, who had taken out the solemnly-worded patent papers by which this great invention was protected, was made chief promotor. But somehow the public seemed shy. Mechanical engineers had a very irritating way of saying that the thing could not develop an ounce of power more than an ordinary engine for the same steam or gas consumption.

Stonesaw proceeded to show them that they were mistaken, and his original model was brought to New York and rigged up in a handsome office for the purpose of demonstration. In the absence of a boiler plant, a cylinder of carbonic acid gas was installed which added a certain degree of scientific mystery to the outfit. Then a small prony brake was rigged on the flywheel, and all was ready for the "before-and-after-taking" test. The double connecting-rods attached to the rear piston were disconnected and the rear piston blocked. Then with 80 pounds pressure the single piston driving the crankshaft was able to sustain a load of say 25 pounds at the end of a lever arm one foot long. Having shown the utmost power obtainable by this rig to the assembled and admiring spectators, Stonesaw would quickly attach the forked connecting-rods and release the rear piston. Upon turning on the pressure, the prony brake would now sustain a load, not of 25 pounds only, but of over 50 pounds. And then the chief promotor would say: "Here is a practical demonstration of the value of our idea, gentlemen. How much stock will you take?"

ACME AND SQUARE THREAD TAPS IN SETS.*

While it has not become the generally adopted custom to make the three taps in a set of hand taps with the U. S. or V standard thread of different diameters, so that each tap cuts a certain proportion of the metal to be removed in forming the thread, this construction becomes imperative when making taps with Acme or square threads. The reason for this is that the pitch of the thread of taps with the latter class of threads is usually coarser for corresponding diameters, and the same size tap is therefore required to remove more metal in this case than if it were provided with 60-degree threads. The shape of the Acme and square threads, with their wide flats at the top of the thread, also increases the

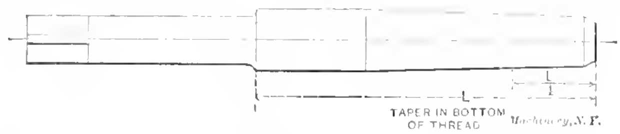


Fig. 1. General Appearance of Acme Thread Tap.

resistance to the cut, if the full depth of the thread should be produced with one tap. For these reasons Acme and square thread taps, intended for cutting a complete thread from a nut blank, and not intended merely for finishing a thread cut in a lathe, are always made in sets, each tap in the set being smaller in diameter than the one following.

While for Acme and square thread taps, three taps in a set are undoubtedly the most common, these taps may be made with only two taps in a set for very fine pitches, and with as much as five taps in a set for very coarse pitches. The last tap in these sets is not made on the principle of a bottoming tap, as Acme and square threads are seldom used except in nuts which are threaded straight through. There is, in fact, a more liberal chamfer on all the taps in the set than is common with ordinary taps.

Formulas for Diametral Dimensions of Acme and Square Thread Taps in Sets.

On account of the clearance required, by the standard formulas for Acme threads, on the top of the thread between the screw and the nut, the actual diameter of the last or finishing tap in the set must be larger than the standard or nominal diameter of the screw. If

A = actual diameter of finishing tap, and

B = root diameter of the thread,

the relations of these values to the nominal or standard diameter of the tap are

A = nominal diameter + 0.020 inch.

B = nominal diameter —

$$\left(\frac{1}{\text{No. of threads per inch.}} + 0.020 \text{ inch.}\right)$$

In the square thread there is no standard clearance allowed on the top of the thread, and as the depth of the square thread equals one-half of the pitch, we have:

A = nominal diameter of tap, and

B = nominal diameter — pitch of thread.

As mentioned above, the most common way of making Acme and square thread taps is to make them with three taps in a set. The values necessary to obtain the diameter of the various taps in the set are given for Acme taps in Table I, and for square thread taps in Table II. These values are determined for Acme taps by means of the following formulas:

Diameter of first tap $= B + 0.45(A - B)$,

Diameter of second tap $= B + 0.8\ (A - B)$,

in which formulas (as before)

A = actual diameter of finishing tap = nominal diameter + 0.020 inch.

B = root diameter = nominal diameter —

$$\left(\frac{1}{\text{No. of threads per inch}} + 0.020 \text{ inch.}\right)$$

TABLE I. TABLE FOR MAKING ACME THREAD TAPS IN SETS OF THREE TAPS.

No. of Threads per inch.	Amount in Inches to be Added to Root Diameter of Tap to Obtain Diameter of Straight Part of Thread of		No. of Threads per inch.	Amount in Inches to be Added to Root Diameter of Tap to Obtain Diameter of Straight Part of Thread of	
	1st Tap.	2d Tap.		1st Tap.	2d Tap.
1	0.468	0.832	5	0.108	0.192
1½	0.318	0.566	5½	0.100	0.178
2	0.243	0.432	6	0.093	0.166
2½	0.198	0.352	7	0.082	0.146
3	0.168	0.298	8	0.074	0.132
3½	0.147	0.261	9	0.068	0.121
4	0.130	0.232	10	0.063	0.112
4½	0.118	0.210	12	0.055	0.098

TABLE II. TABLE FOR MAKING SQUARE THREAD TAPS IN SETS OF THREE TAPS.

No. of Threads per inch.	Amount in inches to be Added to Root Diameter of Tap to Obtain Diameter of Straight Part of Thread of		No. of Threads per inch.	Amount in Inches to be Added to Root Diameter of Tap to Obtain Diameter of Straight Part of Thread of	
	1st Tap.	2d Tap.		1st Tap.	2d Tap.
1	0.410	0.800	5	0.082	0.160
1½	0.273	0.533	5½	0.075	0.146
2	0.205	0.400	6	0.068	0.133
2½	0.164	0.320	7	0.059	0.114
3	0.137	0.267	8	0.051	0.100
3½	0.117	0.229	9	0.046	0.089
4	0.102	0.200	10	0.041	0.080
4½	0.091	0.178	12	0.034	0.067

For the square thread, Table II, the values are derived from the formulas:

Diameter of first tap $= B + 0.41(A - B)$,

Diameter of second tap $= B + 0.8\ (A - B)$,

in which formulas (as before)

A = actual diameter of tap = nominal diameter of tap.

B = root diameter = nominal diameter — pitch of thread.

The diameter at the end of the chamfer of the first tap should be equal to the root diameter of the thread + 0.010 inch. The diameter at the end of the chamfer of the second and third taps should be equal to the diameter of the straight portion of the next preceding tap — 0.005 inch.

It must be understood that the figures given in the tables possess a certain degree of flexibility, inasmuch as the making up of formulas necessarily requires some assumed standard to be selected embodying the best practice. Certain conditions may require deviations from the rules given. While the tables may not suit all possible conditions, they are made up so as to suit ordinary needs, and they are particularly valuable in suggesting the possibility of systematizing the making of tools altogether too often given up to guess work. In using

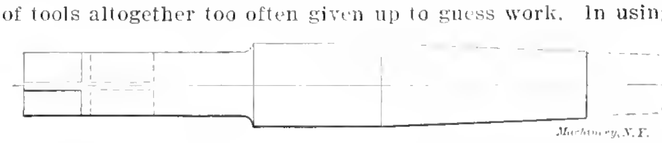


Fig. 2. Construction of Acme Thread Tap when Provided with Pilot.

Tables I and II, it is necessary first to find the root diameter by subtracting the double depth of the thread from the nominal diameter of the tap, and then add the amount stated opposite the pitch for the respective taps in the set.

It is difficult to draw a distinct line between hand taps and machine taps when these are provided with Acme or square threads, for while these taps are as a rule used as hand taps, the construction is that of a machine tap. In general practice, however, these taps are generally classified as hand taps.

When the dimensions for the diameter of each tap in the set have been ascertained, Table III may be used for finding the length dimensions for Acme taps, in sets of three taps, from ½ to 3 inches diameter. The dimensions in this table apply to single threaded taps. For multiple threaded taps, or taps with very coarse pitch relative to the diameter, it is advisable to lengthen the dimensions for the chamfered part of the thread, leaving the other dimensions as given in the table. The size of the square of these taps is not given, depending as it does upon the varying diameters of the shank, which in turn depend on the depth of the thread. The square

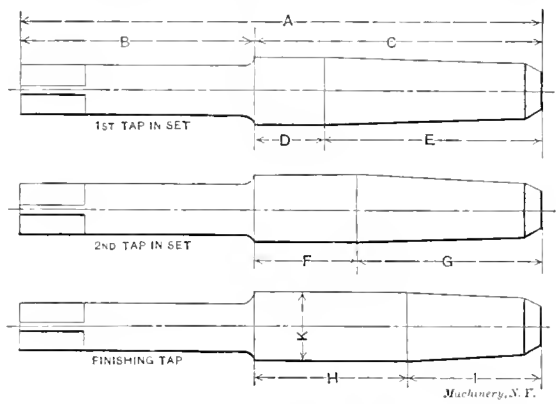
* For additional data relating to taps made in sets see the following articles previously published in MACHINERY: Acme Taps in Sets, January, 1905; Square Thread Taps in Sets, March, 1905; Proportions of Hand Taps in Sets, December, 1905.

should, however, always be made equal to ¾ × diameter of shank. Square thread taps are made according to the same table as Acme taps with the exception of the figures in the column K in Table III, representing the full diameter of the last tap in a set of Acme thread taps. In the case of square thread taps the column K should be equal to the nominal diameter of the tap, because, as has already been mentioned, no oversize allowance is customary in regard to these taps.

General Construction of Acme and Square Thread Taps.

It is here in place to point out some of the peculiarities in the construction of Acme and square thread taps. The first fap in a set should be turned to a taper in the bottom of the thread for a distance of about one-quarter of the whole length

TABLE III. DIMENSIONS OF ACME TAPS IN SETS OF THREE TAPS.



Nominal Diam.	A	B	C	D	E	F	G	H	I	K
½	4 ¼	1 ⅞	2 ⅜	½	1 ⅞	⅝	1 ¾	⅞	1 ½	0.520
9/16	4 ⅞	2 ⅛	2 ¾	9/16	2 3/16	¾	2	1	1 ¾	0.582
⅝	5 ½	2 ⅜	3 ¼	⅝	2 ½	⅞	2 ¼	1 ⅛	2	0.645
11/16	6	2 ½	3 ½	11/16	2 13/16	15/16	2 9/16	1 ¼	2 ¼	0.707
¾	6 ½	2 11/16	3 13/16	11/16	3 ⅛	1	2 13/16	1 ⅜	2 7/16	0.770
13/16	6 ¾	2 13/16	4 1/16	¾	3 5/16	1 1/16	3	1 7/16	2 ⅝	0.832
⅞	7 ¼	3	4 ¼	¾	3 ½	1 ⅛	3 ⅛	1 ½	2 ¾	0.895
15/16	7 9/16	3 ⅛	4 7/16	13/16	3 ⅝	1 3/16	3 ¼	1 9/16	2 ⅞	0.957
1	7 ⅞	3 ¼	4 ⅝	13/16	3 13/16	1 ¼	3 ⅜	1 ⅝	3	1.020
1 ⅛	8 ½	3 9/16	4 15/16	⅞	4 1/16	1 5/16	3 ⅝	1 ¾	3 3/16	1.145
1 ¼	9	3 ¾	5 ¼	15/16	4 5/16	1 ⅜	3 ⅞	1 ⅞	3 ⅜	1.270
1 ⅜	9 ½	4	5 ½	1	4 ½	1 7/16	4 1/16	2	3 ½	1.395
1 ½	10	4 ¼	5 ¾	1	4 ¾	1 ½	4 ¼	2 ⅛	3 ⅝	1.520
1 ⅝	10 ½	4 ½	6	1	5	1 ½	4 ½	2 ⅛	3 ⅞	1.645
1 ¾	11	4 ¾	6 ¼	1 1/16	5 3/16	1 9/16	4 11/16	2 ¼	4	1.770
1 ⅞	11 ⅜	4 ⅞	6 ½	1 1/16	5 7/16	1 9/16	4 15/16	2 ¼	4 ¼	1.895
2	11 ¾	5	6 ¾	1 ⅛	5 ⅝	1 ⅝	5 ⅛	2 ⅜	4 ⅜	2.020
2 ¼	12 ½	5 ¼	7 ¼	1 ⅛	6 ⅛	1 ¾	5 ½	2 ½	4 ¾	2.270
2 ½	13 ¼	5 ½	7 ¾	1 3/16	6 9/16	1 ⅞	5 ⅞	2 ⅝	5 ¼	2.520
2 ¾	14	5 ¾	8 ¼	1 ¼	7	2	6 ¼	2 ¾	5 ½	2.770
3	15	6 ¼	8 ¾	1 ¼	7 ½	2	6 ¾	3	5 ¾	3.020

of the threaded part as indicated in Fig. 1. The diameter at the root of the thread at the point of the first tap should thus be less than the standard root diameter. If the taper selected is such that the root diameter will be about 1/32 inch smaller at the point than the root diameter proper of the tap, that will be found to greatly increase the ease with which the tap can be started in the nut. The first tap in the set should also be provided with a groove or a secondary thread on top of the ordinary thread. This will aid in preventing the tap from reaming, instead of actually cutting a thread in the nut. This secondary thread may continue the full length of the chamfered portion of the first tap. The first tap should also preferably be provided with a short pilot as shown in Fig. 2 to guide the tap straight into the nut. When the pitch is very coarse, as compared with the diameter of the tap, or when the number of taps in a set is small in proportion to the work they are to perform, the first tap in the set should be provided with spiral flutes, forming a right angle with the angle of direction of the thread. In other words, the spiral of the flutes should be left-hand for a right-hand tap, and *vice versa*. This will greatly increase the cutting qualities of the tap. In fact, it evidently would increase the efficiency of all taps to flute them in this manner, but whenever it is not imperative it is avoided on account of the increased expense and difficulty.

When the first tap in a set is provided with a pilot, the diameter of this should be made a trifle smaller than the hole in the nut to be tapped (from 0.002 to 0.005 inch smaller). The length of the pilot should be about equal to the diameter of the tap, or, at least, not shorter than 0.75 times the diameter. The length of the pilot should project from the regular length of the thread of the taps in the set, but in order to make the total length of all the taps in the set the same, the length of the pilot should be subtracted from the length of the shank in the first tap. This is indicated by the dotted lines in the cut, Fig. 2, where the full lines show the second and third taps in a set, and the dotted, the pilot and the modification in the shank of the first tap.

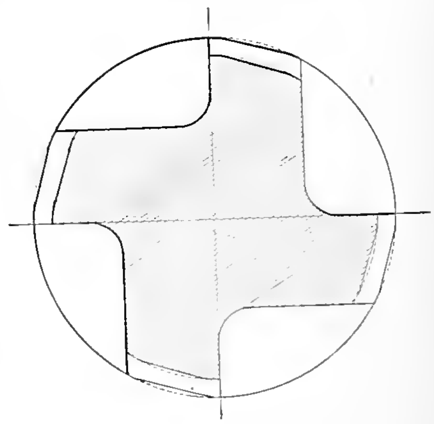


Fig. 3. Relief in the Center of the Thread.

Acme and square thread taps should be relieved on the top of the thread on the chamfered portion on all the taps in the set, and the finishing tap should be given relief in the center of the land (Fig. 3) on its straight or parallel portion. In such cases where the taps are used as machine taps, rather than as hand taps, they should be relieved in the angle of the thread, as well as on the top, for the whole length of the chamfered portion.

* * *

JAPANESE LACQUER.

According to the *Brass World*, the beautiful color found on high grade Japanese wear, produced by Japanese lacquer, has so far never been attained in any other country. While the metals and designs of Japanese goods can be readily produced, attempts to imitate the exact color and lacquering have resulted in failure. Nothing produced in America or Europe can approach it, even approximately. Japanese lacquer is the product of a tree known only in Japan, and is collected by a process similar to that used in obtaining turpentine from the pine tree. The sap is in the form of a thick white fluid; this turns dark brown and finally black. It is strained through a cloth and solidified by evaporation, after which the various varieties of lacquer are made from it by processes which are considered trade secrets. Some of it, the best quality, is bleached in the sun.

The liquid is applied to the surface of the metal with a brush and allowed to dry in a *moist* atmosphere for days. This practice is wholly unlike that of our own country, where the utmost care is taken to preserve the dryness of the room where varnishes or lacquers are baked. It is said that as many as 15 or 20 coats are given to the finest wares. The lacquer does not fade, but improves with age. It is not affected by water, spirits, nor acids. The Japanese are said to have applied it to the hulls of vessels to protect them from the action of the sea water, but the success of the trial is unknown. In the Centennial exposition at Philadelphia articles of wood were exhibited that had been in the sea for fifty years. The surface was covered with marine growths, but the lacquer remained unattacked. Crude lacquer is corrosive to the skin, and much care is required in handling it.

* * *

Many have smiled at the absurdity of "as big as a lump of chalk" or "as long as a piece of string" comparisons, but perhaps these are no more indefinite to many people than one noticed recently in a technical description of the manufacture of fountain pens. In the course of the account the writer mentions that raw rubber "is imported in lumps as large as the eggs of an ostrich." Now, when we stop to consider that perhaps not one American in 5,000 has ever seen an egg of an ostrich, the comparison has about as little significance to the average reader as the lump of chalk proposition.

LETTERS UPON PRACTICAL SUBJECTS.

GRINDING THREADING DIE CHASERS.

In the use of threading dies which must be ground at an abrupt angle to allow a full thread to be cut up to a shoulder, or to a neck, as in a set screw, the following is a common procedure. When resharpening, the dies, or chasers, as the case may be, are put in a fixture which is so arranged that the angle of the cutting edge relative to the center line of the die is the same on all the chasers, and also so adjusted that all the edges are ground to the same depth. When the die is used, however, it will often be found that in spite of

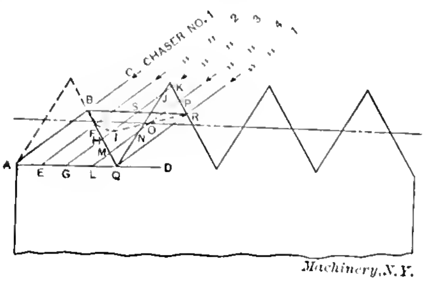


Fig. 1.

all precautions for getting the chasers similarly ground, one or two of them will be doing most of the work, and will accordingly become dull while the others are in good condition. Then the die is put back into the fixture and ground back an equal distance, on all chasers, using the same grinding angle as before, and it will often be found to be improved. Sometimes a second grinding is necessary before the die will work properly.

This matter had been brought to the writer's attention a number of times and had been the cause of a great deal of annoyance, so that an investigation of the causes was made, which resulted in the following solution of the difficulty. By grinding the chasers in accordance with this method, the trouble entirely disappeared, and it became possible to grind our chasers so that each one always did the proper amount of work.

In Fig. 1, the line *A B* represents the cutting edge of a chaser, the outline of a section of which is shown by the full lines. This chaser is ground at an angle *D A C*, with the center line, which angle will be called the grinding angle, and this angle is selected at random, as is usually the case, being in this instance rather abrupt, for cutting a full thread close to a shoulder. The total cutting edge on chaser No. 1 is *A B*. The line *E F* represents the total cutting edge on chaser No. 2, counting the chasers in a left-hand direction on a right-hand thread, and on a four-chaser die. Lines *G H* and *J K* are the cutting edges of chaser No. 3, and *L M* and *N P* the cutting edges of chaser No. 4, while *Q R* would be the cutting edge of chaser No. 1 again. In this case, chaser No. 3 is the first one to have the cutting edge divided into two or more parts. To get the total length of this, make *H I* equal to *J K*, then *G I* represents this total length. In the same way, *L O* is the total length of the cutting edge of chaser No. 4, *M O* being equal to *N P*. It will readily be seen that these cutting edges are not of the same length, and the discrepancy is made more graphic by connecting the points *B F I O R*; and also the points *B R* with a straight line. The line *B F I O R* will be called the indicating line. The distance *I S* is the amount that the cutting edge of chaser No. 1 is longer than that of chaser No. 3.

In service, a die having its chasers ground in this manner, will act as follows: Chaser No. 1 will take a broad, thin chip, and will crowd the work over on the opposite chaser, No. 3, which will be forced to carry a very thick chip, and if there is considerable difference in the length of cutting edges, this action seems to be all out of proportion to this difference. In fact, in this case, with the cutting edge of No. 3 only about 25 per cent less in length than No. 1, it probably would carry a chip three or four times as thick. By grinding the chaser back a distance *X Y* (Fig. 2), with the cutting edge at the same angle as in Fig. 1, it will be noted that the indicating line shows a much smaller variation in the length of cutting edges, those of No. 2 and No. 3 being approximately equal, and No. 1 and No. 4 also being nearly the same. The chasers will now show a marked improvement in operation. If they are ground back a little further the old trouble will reappear.

Fig. 3 shows a set of chasers which are ground at an angle of 30 degrees with the center line; that is, the grinding line connects the bottom of one thread with the top of the next thread behind. In this case it will be found, by measurement, or by reference to geometry, that the indicating line becomes straight, parallel to the center line, and midway between the top and bottom of the threads. This indicates that by grinding the chasers at this angle, the cutting edges become equal, and practice proved that each chaser will do its proper share of the work.

In Fig. 4, the grinding line connects the bottom of one thread with a point between the tops of the second and third threads behind, which makes the grinding angle less than 30 degrees and greater than 19 degrees. Here the indicating line deviates again from a straight line, but this deviation is very much less than in the first example. Fig. 5 shows a grinding angle such that the grinding line connects the bottom of one thread to the top of the third thread behind. Considering the pitch as the unit, this angle will be seen to be such that its tangent $= \frac{0.866}{2.5} = 0.34641$. This makes the angle a trifle over 19 degrees. It will readily be seen by comparing similar sides of similar triangles, that the cutting edges on all four chasers have the same length, and the indicating line is straight, as in Fig. 3.

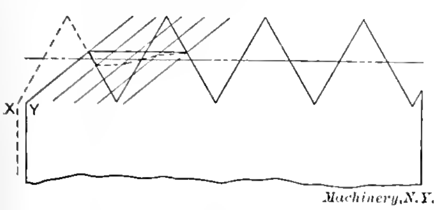


Fig. 2.

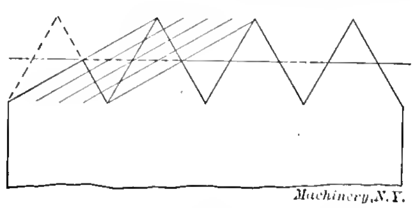


Fig. 3.

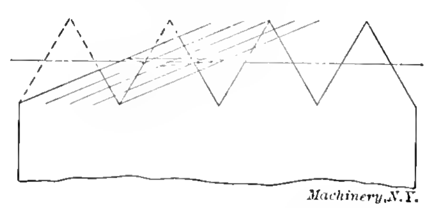


Fig. 4.

In general, in order to make the cutting edges of all the chasers equal, where the thread angle is 60 degrees, it is necessary to make the grinding angle such that its tangent will be equal to 0.866 ÷ (a whole number plus 0.5), or in other words, so that the grinding line will always be parallel to a line connecting the point at the root between two threads, with the top of some other thread. In a 60-degree thread, these angles will be found to be 60, 30, 19, 14, 11 degrees, etc. When ground at any angle less than 14 degrees, that is, with the chip distributed over four threads or more, the difference in the total lengths of cutting edges becomes negligible, and no attention need be paid to the angle other than to see that all chasers have the same angle, but as stated in the beginning, when the angle is abrupt, so that two or three threads do all the work, an observation of the foregoing

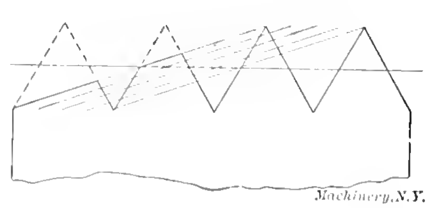


Fig. 5.

principles for securing equal lengths of cutting edges, will solve a surprising number of threading die enigmas.

Three Rivers, Mich. C. C. CLEVERDON.

OBTAINING THE PITCH OF A PROPELLER.

The word pitch, whenever applied to a propeller, is understood to mean the distance the wheel would travel forward in one revolution, provided it was working in a solid medium, as a bolt working in a nut. This is not the case with water, as it is displaced, or forced backward, causing a certain percentage of the propeller's theoretical forward movement, to be lost. This loss is generally termed the slip, and it will vary with the design of the propeller, and the conditions under which it is run. There are many ways, both graphical and mathematical, of determining the pitch of the blades of a propeller casting, but none will be found more simple than the one illustrated and discussed in this article, although, of course, the results obtained are only approximately correct.

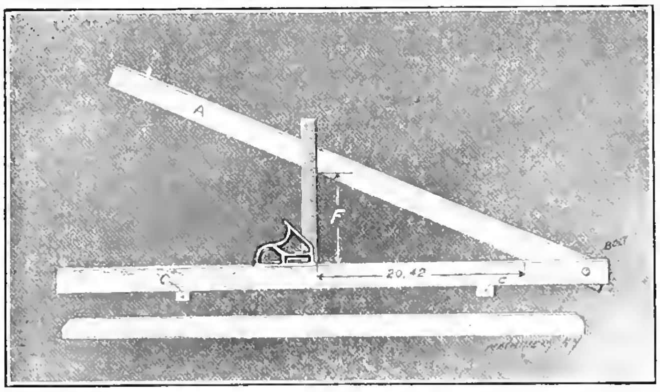


Fig. 1. The Tools necessary for obtaining the Pitch of a Propeller.

For an example, let it be assumed that the screw to be measured is 6 feet 8 inches diameter, with a pitch of 9 feet 3 inches; the latter dimension, of course, being the one to be found. In Fig. 1 is shown the necessary outfit required, consisting of three parallel strips about 36 inches long, 2 inches wide, and ¾ inch thick; also two little blocks about ¾ inch square. Two of the strips are fastened together with a bolt or screw, in the form of an angle, as shown, this arrangement permitting the adjustment of the leg *A*, while trying for the pitch. The two blocks *C* are bradded to the outer edge of the lower leg, and are intended for bearing points, as the edge of the strip would not rest evenly upon the winding surface of the blade.

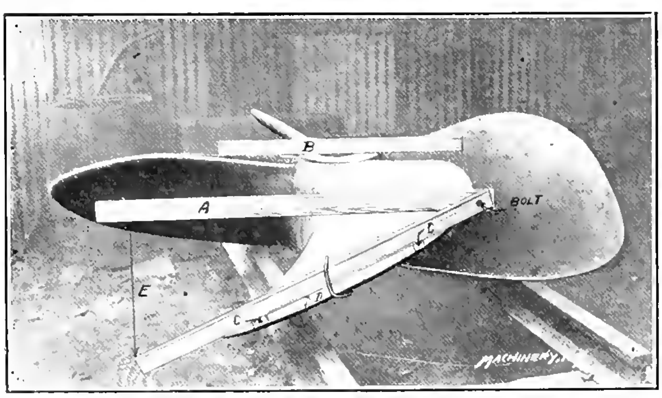


Fig. 2. Measuring the Pitch of a Propeller.

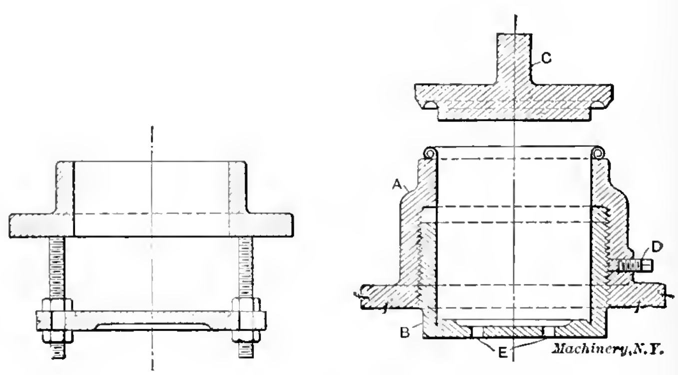
Fig. 2 illustrates the manner in which the device is applied. The strip *B* is placed across the hub, parallel with the angle, which is placed near the tip of the blade. Now, by sighting over the upper edge of the leg *A* of the angle, the leg is adjusted until it lies in the same plane as that of the upper edge of strip *B*. This operation is identical to sighting over parallels to detect the twist in a board or surface; only, in this case the leg of the angle is adjusted to suit the variation. Owing to a slight distortion, which is very apt to appear in the different blades of a screw, it is advisable to try each one, and then take the average of any difference which may be found. To obtain this variation, the distance *E* can be measured after each adjustment of the angle to the various blades, and then the angle set midway between the two extremes, for making our calculations. The distance *D*, which is the horizontal distance between the angle and the tip of the blade, is next measured, and then we are ready to calculate the pitch of the propeller.

Since the propeller is 6 feet 8 inches diameter, and the angle was placed 1 inch in from the tip of the blade, as shown at *D*, the diameter upon which the pitch was taken would be 6 feet 6 inches, and this diameter would have a circumferential length of 20.42 feet. Now, by applying the scale of 1 inch = 1 foot, we lay off 20.42 inches upon the upper edge of the lower leg of angle, as shown in Fig. 1, and applying a square as shown, measure the perpendicular distance *F*. This distance *F* is equivalent to the pitch of the screw, to a scale of 1 inch = 1 foot, and it would be 9¼ inches in this instance. This dimension, to a 1 inch = 1 foot scale, would equal 9 feet 3 inches, which would be the pitch of the screw. The reason for the above method is: since a true screw is formed by a right angle triangle wrapped around a cylinder, the base of said triangle will equal the circumference of the screw, the perpendicular will equal the pitch, and the hypothenuse will equal the length of the winding thread or helix.

Cleveland, O. H. J. MCCASLIN.

TWO CURLING DIES.

In Figs. 1 and 2 are shown two adjustable curling dies, such as are used for the curling, or false wiring, of straight tin buckets. Dies of this style can be used for curling the rims of buckets of various depths, by adjusting the bottom of the die to the depth of the bucket to be curled. The die



Figs. 1 and 2. Curling Dies for Curling the Rims of Buckets.

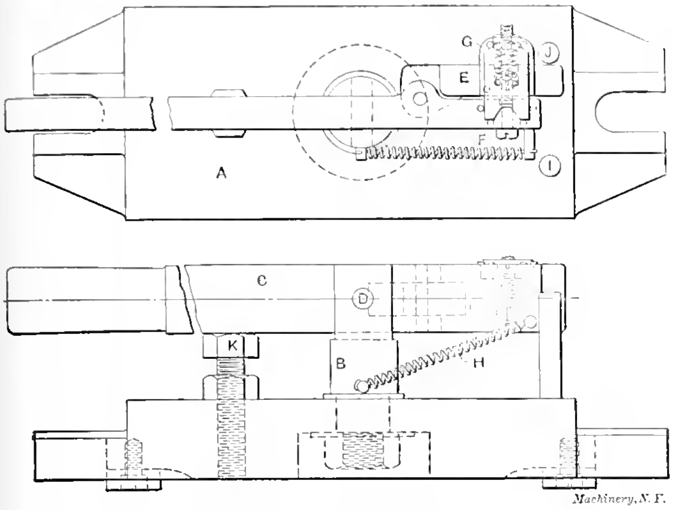
shown in Fig. 1 is an old-timer, and it was somewhat difficult to properly adjust the bottom of this die, as one side was very apt to be a little higher than the other, which caused trouble. Because of this trouble in connection with the adjustment, a new die was made, as shown in Fig. 2. The cast iron body *A* was faced off as indicated by the finishing marks *f*, and a thread cut on the inside as shown. The part *B* was then threaded to fit *A*, and these two parts were screwed together. They were then clamped to the face-plate of a lathe, and set by the finished surfaces *f* of *A*. The hole on the inside was then bored, and it was given 1/64 inch taper, so that the body of the bucket would enter with ease. The punch *C* was also made of cast iron, and finished so that it would give the diameter of curl desired.

This die is operated in a wiring press, which has a sliding table. The bottom part *B* is screwed down to nearly the depth of the bucket body, just enough stock projecting above the die to make the curl. The amount of stock required for the curl can easily be found by trial. When the part *B* is adjusted (which is done by inserting a suitable wrench in the holes *E*), it is held in place by the set screw *D*, which forces a threaded brass plug against it. At first this die was used for curling the tin over wire, but subsequently for double-curling, as shown in Fig. 2. To do this, it is first necessary to make a single curl, then screw the part *B* in about ¼ inch, and repeat the curling operation. Much time is saved when curling buckets in this way, and they are almost as strong as when wire is used. JULIUS F. A. VOGT.

Buffalo, N. Y.

SLOTTING FIXTURE FOR A HAND MILLER.

The accompanying drawing shows a slotting device, the principle of which can be applied to a variety of work where it is necessary to slot many pieces with rapidity. The part *A* is a cast iron block, which is bolted and keyed to a hand miller, and *B* is a post which swivels in *A*. At *C* is shown a lever with its fulcrum on the pin *D*. The jaw *E* is hinged to the lever and is held in a closed position by means of the spiral spring on the fillister screw *F*, the tension being controlled by lock-nuts. The tool-steel plate *G*, on which one end of the piece to be slotted rests, is screwed and doweled to the jaw *E*. The spring *H* holds the end of the lever down clear of the cutter, when it is not in operation.



Slotting Fixture for Hand Miller.

The fixture is first brought clear of the cutter by moving the machine table back; the jaws are then swung out from the machine, bringing the jaw *E* against the pin *I* which compresses the spring on *F* and thus separates the jaws, so that the piece to be slotted can be put in between the six locating pins. The pressure being then removed from the spring allows the latter to bind the piece securely in place. The lever is then swung so that the jaw *E* comes up against the pin *J*, and the lever itself rests on stop *K*. The table is then fed forward, bringing the piece against the bottom of the cutter, which slots it to the desired depth. The piece is released by a reversal of these operations. This fixture has proved satisfactory, as it is possible when the machine is ready for operation to turn out 300 pieces per hour. The principle of this fixture could be used for slotting screws.

Candiac, Canada. S. A. McDonald.

ANNEALING HIGH-SPEED STEEL.

From time to time there has appeared in the various trade papers directions for annealing high speed steel. As I have had a great deal of experience with annealing and hardening, being at the present time employed as a tool-hardener in the Government's service, and previously having been employed in this line of work in several large manufacturing establishments, I thought that an explanation of my methods might be of interest to some of the readers of Machinery.

In the first place there should be on hand a cast iron box, large enough to permit proper packing of the pieces to be annealed. Charcoal ashes or cast iron chips may be used for packing. Pack the work carefully, placing the larger pieces to the outside of the box, and the smaller pieces in the center. After the pieces are packed, they are then ready for the furnace. Heat slowly, raising the temperature to 1,470 degrees F. (dull cherry red). Then hold the heat at this point for about 5 hours, and finally raise the heat in the furnace to 1,650 degrees F. (cherry red). Shut off the fire, close the door, and let the furnace cool for 12 hours. The entire heating can be done in 5 hours, and the steel can be worked as nice as any annealed by the steel mills. This is not the only method of annealing, but it is the best method when the steel is considered.

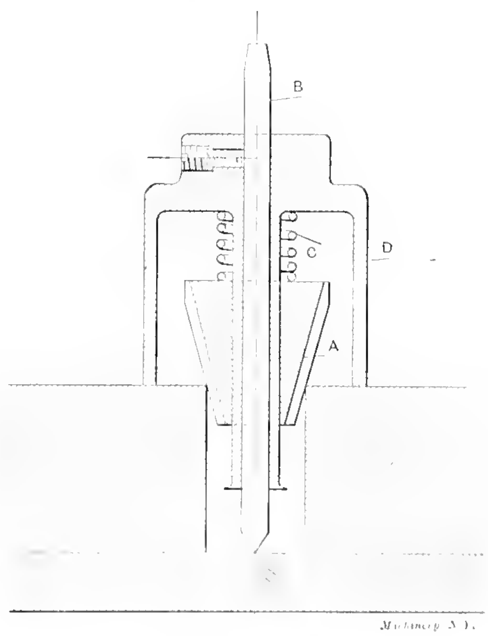
Annealing after hardening of high speed steel can be accomplished by the following method in about one hour. Where a change in the tool is required to be done quickly, I often take the tool and heat to 1,290 degrees F., then let it cool in the open air. Then heat the tool again, raising the temperature to 1,290 degrees F. (somber red), and hold it there for 40 minutes. It is then taken from the fire, and permitted to cool in the open air. When I have 5 hours to anneal in, however, I prefer the heat anneal. That I accomplish by heating the tool or piece constantly for 5 hours. After the piece has been heated for 5 hours at 1,290 degrees F. or less, I take it from the fire and let it cool in the open air. One can also raise the heat to 1,470 degrees F. (dull cherry red) and put the tool in lime to cool. Do not raise the heat to this degree, however, unless the piece is to be placed in lime. I only use these methods where a loss of time is to be considered. It is possible to anneal high speed steel at as low a heat as 977 degrees F., red visible in daylight, but this heat will not make the steel very soft.

There is also another method of annealing high speed steel. That is where a lead bath is in use. Take the piece to be annealed and place it in the lead while it is at a dull cherry red. If the lead is of sufficient bulk to hold the heat for several hours, it will not be necessary to continue the heat. Leave the work in the lead and remove it the next morning, by heating the lead again. Remove the tool as soon as the lead is hot enough not to adhere to the work. Then dip the work in oil, and then, returning to the lead bath, the lead will leave the work if the work is removed just as the oil burns off. After this the piece should be allowed to cool in the open air. Great care should be taken in heating high speed steel, as it is easily checked. C. U. Scott.

Davenport, Iowa.

CENTER PRICK PUNCH.

Having had occasion to drill a number of holes in a plate, which were to be laid out from a cumbersome piece already drilled, I had great trouble to get them located accurately. The holes were the same size as the bolts which had to enter both plates. I first tried marking out with a scriber, but owing to the number of holes this method was not satisfactory. This being a job which would be repeated, I thought it worth the punch shown in the cut. This consists of a center cone *A*,

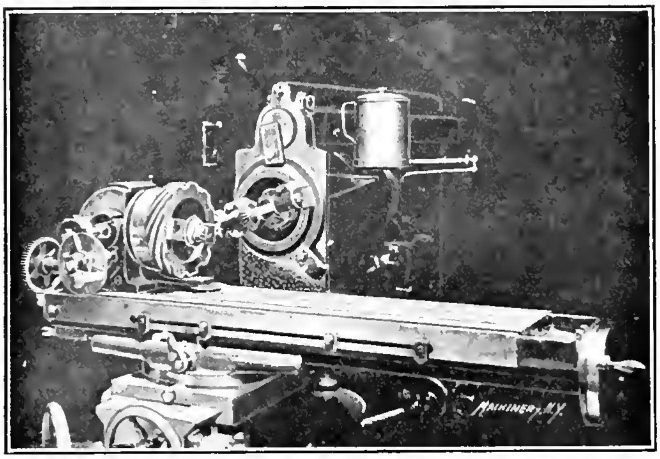


Center Prick Punch.

which is relieved so as to give a three-point contact, and serves to center punch *B* in the hole. The cone and spring *C* are placed on the body *D*, and the end knocked over as shown. The function of the body *D* is to insure the punch being perpendicular. By placing the cone in the hole and pressing the body until it rests on the top plate, the punch is accurately located in the center. With the headless screw and small spring the punch is prevented from slipping out, thus making a very neat and self-contained tool. Trixie.

HOME-MADE UNIVERSAL MILLING ATTACHMENT.

The cut shows a simple universal milling attachment, primarily intended for cutting spiral gears beyond the capacity of the universal milling machine, and illustrates plainly the cutting of a gear where the angle of the teeth is 78 degrees. Of course, the makers of milling machine attachments furnish special devices for this purpose, but they are quite expensive, and hardly as rigid or as well adapted for this particular work. As will be noticed in the design shown, the cutting is done on the side of the gear, level with the center



Home-made Universal Milling Attachment

line, instead of at the top, which greatly increases the capacity of the machine, as far as concerns the diameter of the work possible to handle. We have cut a number of spiral gears 24 inches in diameter on a No. 3 machine with this device. We have even used it for cutting some spur gears whose diameter was too large to be cut in the regular way. The whole device is extremely simple, being nothing but a circular flange fitted around the spindle bearing of the milling machine, with a pair of lugs carrying bearings, one inch in diameter, for the cutter spindle. This spindle, with its shoulder and bevel gears, is all made in one piece. The driving bevel gear is provided with taper shank, and placed directly in the tapered hole in the milling machine spindle. The circular frame or flange is clamped on the milling machine column at any angle desired, the periphery being graduated in degrees; the milling machine table, meanwhile, remains in its normal position. This device may not add to the beauty of the machine, but it has saved money.

Los Angeles, Cal. S. Byron Welcome.

GRINDING REAMERS.

Having read several articles on relief of teeth of reamers and cutters, I thought the method I use would be of interest to the readers of Machinery. I have reference to taper reamers, being ¼ inch taper per foot, and from ¼ to ¾ inch in diameter at the small end. They are used for reaming cold-rolled stock, and are used in a drill press. They must produce true, smooth holes, free from chatter marks. This has been my great trouble, as all reamers manufactured for the market have either 6 or 8 teeth, and are inclined to chatter and produce holes that are not true. I have had a six-tooth reamer ream a hexagonal hole.

The work is held in a chuck, free to move, but not to rotate, thus allowing for the reamer not being held true in the drill chuck. To get rid of the chatter marks, which I have blamed to reamers having an even number of teeth, I have made them with seven teeth, and get the best of results with them. For a roughing reamer, I made one with seven teeth, and cut a No. 4 left-hand buttress thread on same, bringing the thread to a sharp point. I left the reamer above size for grinding, and ground off the sharp points, giving a flat tooth about 1/16 inch long. I use a Cincinnati Milling Machine Co.'s grinder, using a cup-shaped wheel, the tooth rest being adjustable. The centers that support the reamer are placed as near as possible in line with the emery wheel arbor, the tooth rest is dropped to give proper clearance, about 1/16 inch for a ¾ inch reamer, and the tooth is ground at the cutting edge first. Then the tooth rest is dropped about 1/16 inch, bringing the heel of the tooth up to the wheel, and a fairly good cut taken. After each revolution of the reamer the rest is raised slightly, which gives an eccentrically shaped tooth. Care should be taken not to feed on the same tooth every time, as this will not give a true reamer, because, if the feed is used on the same tooth each time, you will find that tooth will be shorter than the rest. By this method one does not require extra centers, and I think one gets just as good results as when they are used.

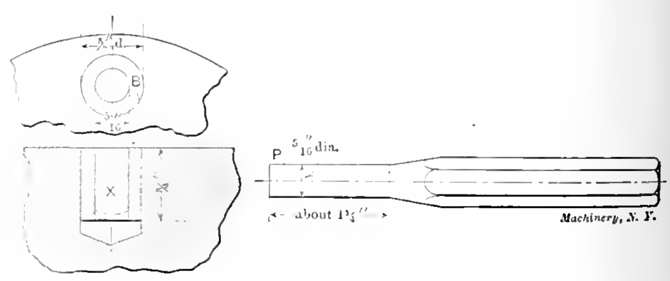
F. P. Hebard.

Muscatine, Iowa.

[The subject of preventing chatter in reamers is one that has caused many different opinions to be expressed. It seems certain, however, that if there is an even number of flutes in a reamer, if the cutting edges are unevenly spaced, the same satisfactory result should be obtained as with a reamer with uneven number of flutes. Spiral flutes have also been used as a remedy for chatter, but the expense of milling the spiral flutes, and the difficulty of grinding the cutting edges, have prevented reamers with such flutes from being used to any great extent. Why spiral fluted reamers do not chatter is because they are better supported all around the edges when cutting than are those with straight flutes. The increased support is also the reason for the superiority of the reamer with odd number of flutes, or with cutting edges irregularly spaced, over the reamer with equally spaced, even number of teeth. In the former case the reamer will always be supported at least on three edges, while in the latter case occasions may be conceived of where only two edges actually are in contact with the work. It is also certain that the proper clearance of the cutting edge has as much to do with the chatter of reamers as the spacing of the teeth. In fact, some mechanics believe that the clearance is the one important consideration. In March, 1897, we published a letter from Mr. F. W. Clough, in which this claim was strongly put forth. It is evident that any reamer will chatter unless the cutting edge is properly supported. An article, referring to proper clearance for reamers, by Mr. Fred Holz, former president of the Cincinnati Milling Machine Co., appeared in Machinery in June, 1904. It is safe to say that chatter can be avoided in as great degree as is possible by giving but a slight relief to the cutting edges, preferably an eccentric relief, and by at the same time spacing an even number of cutting edges at unequal distances around the periphery of the reamer.—Editor].

THE USEFULNESS OF HYDRAULIC PRESSURE.

The article by Mr. Calvin B. Ross in your issue of November, 1906, entitled the "Usefulness of Hydraulic Pressure," reminds me of an experience in which hydraulic pressure was used in a slightly more novel manner than the one



Simple Scheme for Removing Bushings.

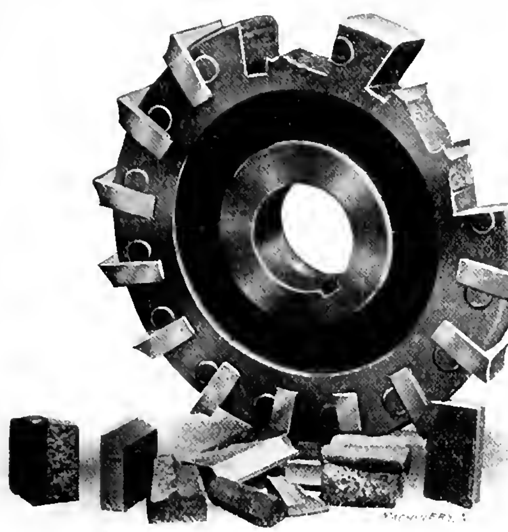
described by Mr. Ross, but with results equally effective. The occasion arose during the manufacture of some field gun mechanisms, when it was found that a number of hardened steel bushings *B* which had been driven very tightly into the breech blocks, as shown in the cut, must be taken out. The hole was too small to allow getting in anything in the form of a hook bolt strong enough to overcome the grip of the surrounding metal, and no other means of drawing out the bushings could be thought of at the time. After casting round for a short time for some method of overcoming the difficulty, the practical incompressibility of liquids suggested itself, and

we proceeded to remove the bushings in the following manner: A punch P was made, the round part of which was a close sliding fit in the hole of the bushing. Oil was then poured into the hole in which the bushing was driven, until it extended a small distance up into the bore of the bushing, the dotted line shown representing the surface of the oil. Then, by means of a few good solid blows on the head of the steel punch, while the punch was resting on the cushion of oil in the hole, the pressure of the oil on the under face of bushing was sufficient to start it out. It was only necessary to add more oil to that already in the hole, as the bushing was driven upward, so as to take up the increasing volume, and we soon had the satisfaction of being able to remove and replace any bushing at will. WALTER CANTELO.

Bridgeport, Conn.

A BROKEN MILLING CUTTER.

The half-tone shown herewith presents a view of a milling cutter made by one of the leading makers of such tools. The workmanship of this cutter was the best, but still it was not in service more than twenty minutes, milling cast iron at a



Inserted Blade Milling Cutter, too Weak in its Design.

feed of about one inch per minute and a speed of about 35 feet, before it broke as shown. The cutter was of a size of about 6 inches diameter by 1¼ inch wide. It seems to me that cutters of this size should have the teeth inserted in steel bodies instead of in bodies of cast iron, and, considering the slight difference in the cost, I fail to see why manufacturers do not make them this way. After this cutter had failed, I made a steel body to replace the broken one, and it has been in operation on the same class of work for a long time with a much coarser feed, but is showing no signs of weakness. M. H. W.

[Some manufacturers of inserted-blade milling cutters make a rule of using a steel body for small-sized cutters, say, up to about 7 inches in diameter; for larger sizes they use cast iron bodies whenever they use ordinary carbon steel blades, except if the width of the face of the cutter is less than 1½ inch, in which case machine steel bodies are used for all sizes. The Pratt & Whitney Co. make a rule of providing all cutters having high-speed steel blades with machine steel bodies.—EDITOR.]

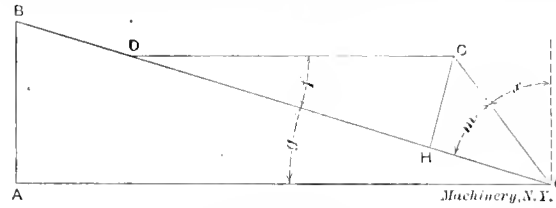
A BORING MILL PROBLEM.

I will attempt to give a solution of a boring mill problem, that I was called upon to solve, a few days ago. One of the "boys" had a job on a 12-foot mill, and in finishing this work, he was obliged to turn a taper of 1 inch in 3.25 inches. Now, the work was almost as large in diameter as the mill would turn, and he could not tip the boring head to the required angle and use the vertical feed, as the head would not go far enough out on the cross rail. Consequently it was necessary to use both the vertical, and the horizontal feeds. These feeds were geared up, so that their ratio was two to one, the tool feeding 2 inches horizontally to 1 inch vertically. It is obvious then, that if they were used simultaneously, the taper would be 1 inch in 2 inches. Now, the required taper was 1 inch in 3.25 inches; and the problem was to find the angle that the boring head should be set over to give this taper. This angle was found as follows: If $AB = 1$ inch, and $AO = 3.25$ inches, then the angle g = the angle that the surface of the work, when finished, makes with the mill table. Then, by the use of trigonometry, we find that

$$\tan g = \frac{AB}{AO} = \frac{1}{3.25} = 0.30769, \text{ and}$$

$$g = 17 \text{ degrees } 6 \text{ minutes.}$$

Now, the tool feeds 2 inches in one direction to 1 inch in the other; so let $DC = 2$ inches, and $CO = 1$ inch; then when



A Boring Mill Problem.

the boring head is set to angle x, the tool will finish the work to the required angle. It is obvious that the angle f equals angle g, or 17 degrees 6 minutes. Sin 17 degrees 6 minutes = 0.29404. Then $CH = 2 \times 0.29404 = 0.58808$.

$$\text{Sin } m = \frac{CH}{CO} = \frac{0.58808}{1} = 0.58808, \text{ and}$$

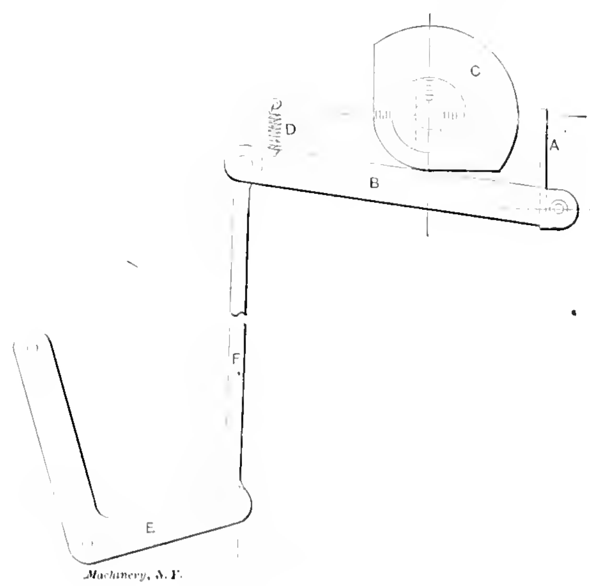
$$m = 36 \text{ degrees } 1 \text{ minute.}$$

Angle m plus angle $g = 53$ degrees 7 minutes, which, subtracted from 90 degrees equals angle x, which is the angle required. E. W. BEAN.

West Lynn, Mass.

AUTOMATIC STOP FOR DRILL PRESS.

The accompanying cut shows an automatic stop for a 20-inch Davis drill press used in connection with the hand feed. This automatic stop will start the drill when the feed lever is pulled down, and stop it when the lever is pushed back in position, the cam C being fastened to the feed shaft so that



Automatic Stop for Drill Press

its large diameter portion pushes the lever B down or permits it to spring up, according to the position of the feed lever. The piece A is of machine steel, 3/16 inch thick, and fastened in the slot provided for the clamping of the spindle sleeve The lever B swivels around the pivot at the end of A, and is held up to the cam C by a spring D. The foot lever is taken out, and the forged bell crank E operates the shifting rod for the belt. This crank is connected to the lever B by the connecting rod F. Both ends of the lever connecting rod and

bell crank should be case-hardened to prevent wearing too fast. The cam may be made of cast iron and fastened to the feed shaft by a set screw. S. OLIVER.

Great Barrington, Mass.

MANDREL BROKEN BY INTERNAL STRESSES.

The accompanying half-tones, Figs. 1 and 2, I believe, will be viewed with some curiosity by a number of MACHINERY'S readers. They show what was once a 1⅞-inch mandrel of standard form, manufactured by a well-known firm which has been putting them on the market for a number of years. The mandrel was purchased by us through a jobber, and when

Fig. 1. Mandrel Broken by Internal Stresses.

received was examined, and appeared to be all right in every respect. It was then wrapped in an oily cloth and put on a shelf in the tool-room. Five weeks later it was wanted, and on pulling the package out, the tool-room man was very much surprised to feel the package collapse in his hands. On unwrapping it, the mandrel was found broken in pieces as shown.

It had not been used in any manner, nor had it received any blows. It is therefore an interesting question what caused it to break so long after it was hardened, and why

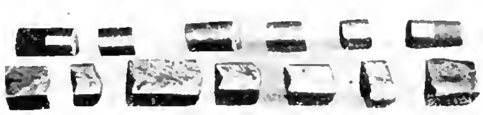


Fig. 2. The Pieces of the Broken Mandrel Arranged in their Natural Position.

it did not break when it was ground. We, of course, think that internal strain set up in hardening was the cause of the collapse. The grain of the fractures runs in various directions in the length, but none of the breaks show evidence of water cracks. I would be pleased to have any of the readers of MACHINERY explain the cause of such accidents, and how they can be guarded against by the purchaser, if such action is possible. C. W. M.

FAIR WAGES.

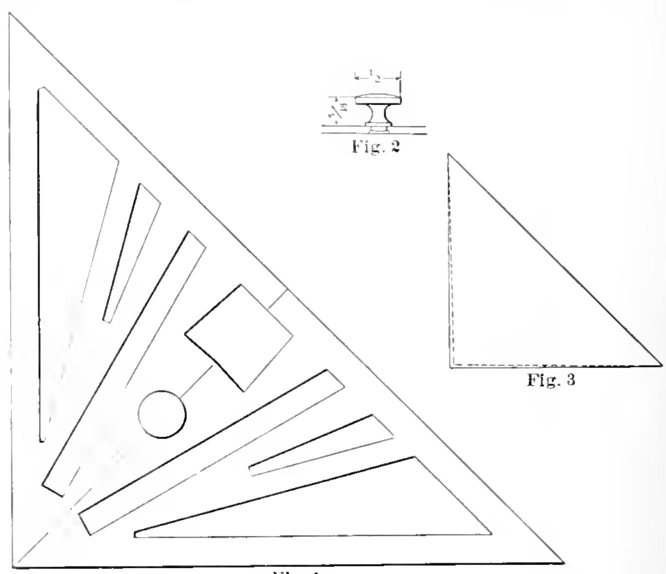
The question of wages has been uppermost with me lately. I have been working hard for some time, and it develops that my work is worth nothing. Not long ago I had a little job that I hustled through in good shape, and I made six or seven dollars an hour. What am I worth by the hour? What sense would there be in any one's gambling on my ability by hiring me by the hour? He would not know when I would be earning nothing, or when I would be at the top notch. Neither would I. I might make a suggestion to my employer some day that would save him hundreds of dollars, but if I am known as a machinist and am drawing 30 cents an hour, he would think I was a queer sort of a chap if I expected anything extra. There is a sort of inertia about this matter of wages. I tried to work in the premium plan in a shop once where I was superintendent. We had a lot of work on the big planer that we knew, from several years' work, just how long it took to do it. I offered the planer hand half his hourly rate extra for all he saved over the regular time. He said: "Do you mean it?" I said: "Yes. Why not?" He grinned and went to work. We had to hustle around to get the castings to him fast enough, and when the first pay day came around he drew more money than the foreman, and almost as much as I did.

Then there was trouble. The proprietor wanted to know what I was paying any planer hand such wages for, and the foreman wanted more pay. The proprietor said the foreman was no good, or he would have made the planer hand do the work as fast as it could be done on his old pay. He said he would fix that, so he went out and told the planer hand that he found that he had been cheated all these years, and now he was going to have those castings planed at the new speed for the old pay. So we lost a good foreman and a good planer hand. When the new men came I noticed that the castings were planed just as before, but the proprietor did not say a word. I guess he was too proud to say what he wanted to, but that was all the premium work that was done in that shop. ENTROPY.

DRAFTSMAN'S TRIANGLE.

The triangle is such an important tool for the draftsman that it should be made as convenient as possible. The Kelsey triangle was the first on the market that was provided with a knob for lifting about the board. This great convenience can only be used to advantage on a 45-degree triangle, and as I did not altogether like the Kelsey form, I worked out the design shown in the cut, which is the result of half a dozen experiments. The angles are 90, 75, 67½, 60, 45, 30, 22½, and 15 degrees, and each angle can be drawn from light edge. The angles of the opening near the center are the same as the angles of the head of a countersunk screw. A 45 degree line scratched on the under side is very convenient, but great care must be used to have it accurate. This triangle has been made by a number of draftsmen, and all prefer it to the old 60 and 45 degree combination. It is particularly useful to the designing draftsman. It has, however, a disadvantage for inking, as a line drawn by a slot opening is liable to be blotted when the triangle is slipped along.

To make such a triangle, get a piece of celluloid 0.070 inch thick. Make a drawing of the triangle full size and fasten the celluloid blank over it, so that the lines can be scratched as an aid to cutting. First, with a penknife start the openings, and, when large enough, use a hack saw. Finish



Draftsman's Triangle.

the edges with a file. After the slots have been worked out nearly to the finishing line it is a good plan to put the triangle away in a warm place for a couple of weeks, as it will shrink so as to impair the accuracy of the angles. The dotted lines in Fig. 3 show how the celluloid will shrink. After the celluloid has finally set, very little care is required to keep the angles accurate.

It is not necessary to tell a draftsman how to true up the outside edges. To true up the slot angles, the first thing to do is to draw with the T-square a base line. From this line lay off carefully all the angles that are on the triangle. With a file work out the slot edges of the triangle so that, when laid against the T-square, the edges will match the drawn lines perfectly. Any waviness or inaccuracy is clearly shown by this method.

The knob should be riveted in, but do not hammer hard

enough to buckle the celluloid. The hollow side of the celluloid should be down, as the triangle will then lay flat.

W. L. Breath.

Brooklyn, N. Y.

DRILLING CLEARANCE HOLES IN SOLID DIES.

The accompanying cut shows the manner in which I drill the clearance holes in solid dies. When I am through cutting the thread, I mark a circle *A* on which to locate the centers for the clearance holes of the dies. This I do before taking the die out of the lathe chuck. Then I divide this circle

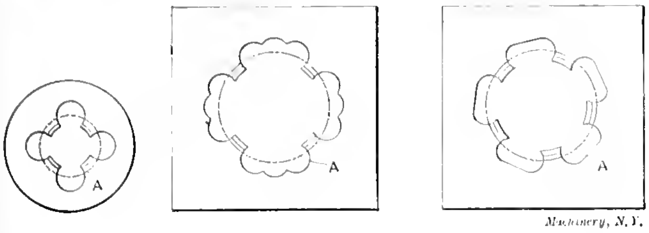


Fig. 1. Drilling Clearance Holes in Solid Dies.

according to the number of cutting edges I wish for in the die, and mark the division holes with a prick punch. I then drill the clearance hole first with a very small drill, say one that is 5/32 of an inch in diameter. After this I use a twist drill of proper size for the clearance hole, grinding the end down to a square-cutting face. This gives me a pilot in the center to fit the small hole originally drilled. In this manner I have no difficulty in drilling the clearance holes, and the drill has no tendency to run out. The way I grind the twist drill is shown in Fig. 2. In Fig. 1 are shown three examples of dies in which the clearance holes are produced by the method I have explained.

M. Schilling.

St. Paul, Minn.

[It seems as if the method of grinding down the twist drill so as to provide for a pilot and a square cutting edge is not a very good practice. In the first place, a counterbore with

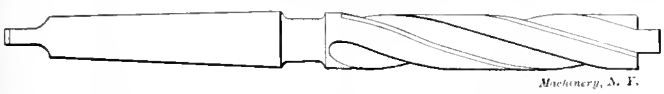


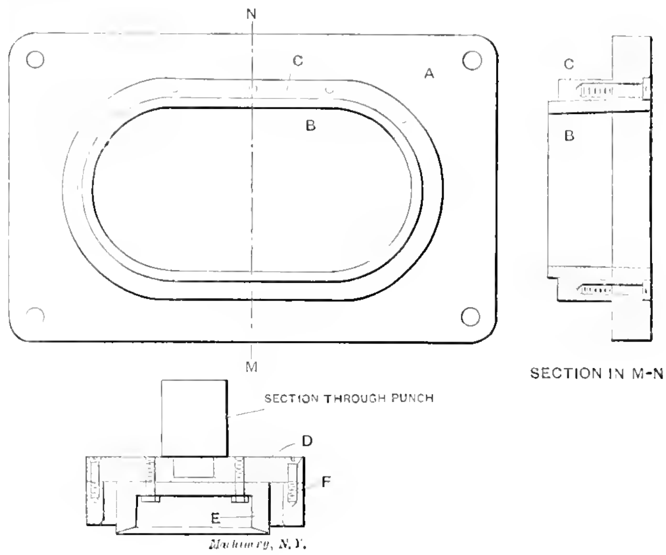
Fig. 2. Guide provided by Grinding Down Point of Twist Drill.

a pilot to fit the holes is not only better adapted for doing this work, but it is cheaper as well. In the second place, when the twist drill is ground down to a square face, it does not retain its efficient cutting edge, the twist drill being fluted so that its cutting edge is correct and most efficient only when the drill is ground to the usual angle of 59 degrees with the center line of the drill. For this reason, while the method itself of drilling the holes is recommendable, it would be best to substitute a counterbore for the ground down twist drill.—Editor.]

A COMBINATION CUTTING AND EDGING DIE.

The idea of cutting a hole and turning the edge up around it is old, and most die-makers are familiar with it, and with the usual methods of making such dies. It may still be that there is something new in the construction of the die shown in the accompanying cut. This die was made for cutting and edging the stove-pipe hole in range tops. The material which the die had to cut and edge was gage No. 18 soft steel. In the cut is shown a plan view of the die and a section through the center of it, and also a section of the punch. Referring first to the die, *A* is a cast iron die bed with a suitable hole cast through it for the punchings to fall through. At *B* is shown a tool steel ring which is planed at the top and bottom, and the inside hole at the top of which is the same as the size of the punched hole of the stove plate. This ring is tapered on the outside 10 degrees toward the bottom. The ring *C*, which is of machine steel, is finished to fit the outside of ring *B*. The ring *C* is about 3/8-inch lower than ring *B*. The inside of ring *B* is machined to have a taper of 1 1/2 degree toward the bottom for clearance, and is then hardened and driven into ring *C*. The die bed *A* is provided with screw holes and dowel holes, and the ring *C* is fastened to it.

The punch consists of a cast iron punch plate *D* with a punch shank screwed or riveted to it. The cutting punch *E* is made of tool steel and fastened to the punch plate. The punch, of course, fits closely to the ring *B* in the die, and should be provided with a slight taper on the outside, after which it is hardened and drawn. The forming ring *F* is made of hardened steel, and the inside is made to fit the outside of the cutting ring *B*, permitting, however, a space for the material, the edges of which are to be bent over. The inside corners of this forming ring are slightly rounded. This ring should be about 3/8-inch lower than the cutting punch *E*. It is screwed and dowelled to the punch plate. The punch plate with ring *E* is put onto the die with a strip of material of proper thickness between the forming edges of the punch and die. The cutting punch *E* is then put into the die and located, and is then drilled and tapped and fastened in place.



Combination Cutting and Edging Die.

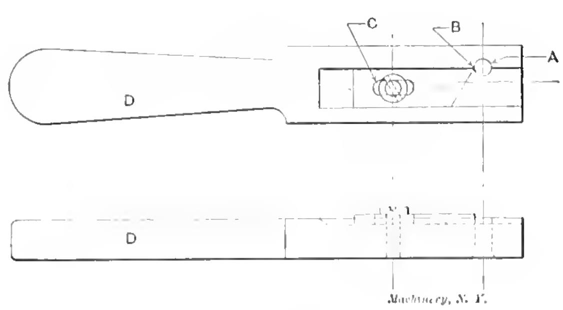
If the die is made in the above manner it will prove to be much stronger than if cutting ring *B* and ring *C* were made in one piece. The ring *B* will not have the same tendency to crack in hardening, as it sometimes does when made in one piece. If after long use the ring *B* is worn down, the machine steel ring *C* may be planed lower to make the cutting ring high enough. This applies to the punch also. In our shop we have made several of these dies, and they have given very good satisfaction.

Julius F. A. Vogt.

Buffalo, N. Y.

WIRE-TURNING TOOL.

I noticed a cut and description of a method for turning down very small diameter stock in the September issue of Machinery. In the accompanying cut is shown another device which answers the same purpose and has been used in our shops with entire satisfaction. This fixture can be put in the tool-post of a lathe, or may have a handle as



Wire-turning Tool.

shown at *D* for feeding along the work by hand on very small diameter rods. The hole *A* is of the same size as that of the stock before turning, and the tool *B*, adjustable at *C*, is set to turn the stock down to the required size; the work, of course, is chucked and revolved in the lathe as usual. This fixture is very simple to make and answers the purpose very nicely.

Tool Designer.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

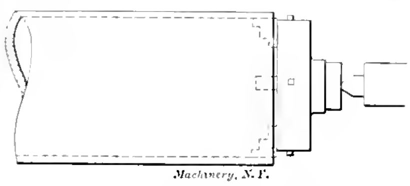
MILLING ON THE LATHE.

Our little shop cannot boast of a milling machine, so we have been accustomed to split the brasses and eccentric straps for the 5x5-inch vertical engines we manufacture on the shaper. This has made an ununiform job, since the parting tool would wear, and often necessitate the truing up of the surfaces after parting. Then, too, the babbitt in the straps would be pushed out in places, making a poor job. We now do this work on the lathe by clamping the pieces to be split on the compound rest, and running a slitting saw on an arbor between centers. This makes a very neat job in a fraction of the time taken by the old method.

Chattanooga, Tenn. E. R. Seiter.

HOLDING LARGE PIPE WHILE THREADING.

Coming in one morning, we had orders to thread a piece of 18-inch pipe several feet long, and a pair of flanges to fit; it

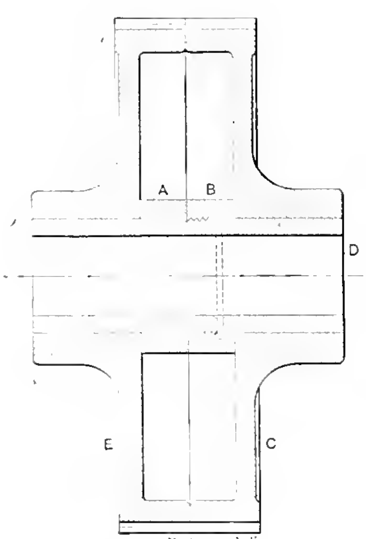


looked like making a spider, as the steady rest was too small, and there was no spider around. My pal, however, said no, and reaching under a certain bench, behind a certain post, brought forth a threaded plug which fitted any one of the three chucks for the lathe. With the plug screwed in, that chuck made an ideal spider, being just small enough to enter the pipe.

Sirius.

A KINK IN GEAR CUTTING.

A number of years ago we adopted a coupling bushing, as shown in the cut, to be used when cutting gears. The design of gears shown here is often used on milling machines, lathes, etc. In order to cut these economically, it is best to cut two at the same time. To do this we had first bushings *A* and *B* made in one piece, but this gave a lot of trouble when trying to get the gears apart. One man would be holding gear *C* on the face while another would be pounding at *D* to drive out the bushing, and thus force gear *E* away from gear *C*. This, however, caused lots of waste of time and sore fingers. The coupling bushing as shown in the cut was then adopted. It is simple and effective. Bushing *A* is put in one gear, and *B* into another; the bushings are then screwed together until the sides of the gears bind against each other. Now the two gears can be put on the gear cutter arbor as one gear, and it is easy to get the gears apart.



Gear Cutter.

FACING WORK ON CENTERS.

I think Mr. Leonard's kink, under the above title, in the August issue of Machinery, on grinding and using a side-tool is good. However, some trouble will be experienced at the extreme point. I have found when a good finish is required, or when facing a number of pieces, an extra lathe center with a recess milled in it to give clearance for the side-tool, to be of great advantage. Fig. 1 shows a top view of the lathe center, side tool, and a section of the work, the dotted lines showing the recess in the lathe center. Fig. 2 shows an end view of the center, with side tool in cutting position in the recess. An old discarded center will do, which after being annealed can be milled, or chipped with a good chisel, within 1/16 inch of the center line. It should then be hard-

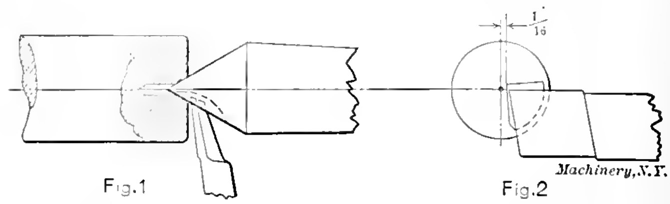


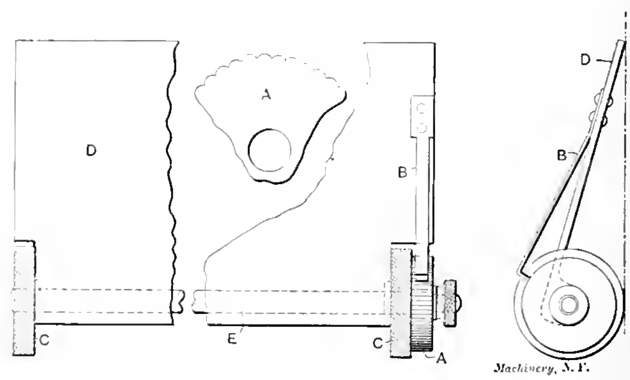
Fig.1 Fig.2

ened and ground the same as an ordinary center. Another advantage in using this tool is that any desired amount of stock can be removed, limited only by the depth of the center-drill hole, by facing close to the point of the lathe center and keeping this pressed into the drilled hole. Of course this center should be used only for facing, the ordinary center being put in for the succeeding operations.

Arthur Nichols.

DRAFTSMAN'S SECTION LINER.

The section liner shown among the Shop Kinks in the January issue made me think that the readers of Machinery might be interested in the device shown herewith, which has given excellent results. It is used on drawing paper entirely independent of a T-square. As seen from the cut, the device consists of a ratchet wheel *A*, a pawl spring *B*, two knurled rollers *C*, and the pen guide or ruler *D*. The teeth of the



ratchet are milled as shown in the detailed view. The ratchet and knurled rollers are fastened to the shaft *E*, and as the device is pulled back across the drawing paper for each line drawn, the ratchet pawl descends into each of the little grooves in the wheel, thus spacing the lines evenly. For different spacing, differently pitched ratchet wheels are used. By using thin rubber bands over the knurled rollers, the device would undoubtedly work well on tracing cloth, but I have not as yet tried it on anything but drawing paper.

Grand Haven, Mich. Charles A. Kelley.

ANNEALING NOVO AND BLUE CHIP STEEL.

The following method of annealing will give good results in the shortest space of time that I know of. Take the piece of steel, put it in a cast iron pot. Fill the pot full of lead, and put it in the fire. Bring it to a good heat, making sure that the steel is heated clear to the center. For the last few minutes before removing, hold the piece of steel down to the bottom of the pot with a piece of wire. Remove the pot from the fire and hold the piece down on the bottom of the pot by a weight on the top of a wire rod, leaning the rod against some support so that it does not fall over. It is important that the wire rod or the pot of lead be not moved while cooling off. When the lead has cooled, remove it from the pot and chop it apart with a cold chisel. It will be found that the piece of steel is well annealed in about two or three hours, according to the size.

P. W. Abbott.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

385. LUBRICANT FOR CUTTING ALUMINUM.

A good lubricant for the cutting of aluminum in the lathe is kerosene oil. It will permit a better finish, and will materially reduce the liability of tearing the surface by the cutting tool. GREGOR.

386. SILVER WHITE BRONZE.

To prepare silver white bronzing powder, melt together one ounce each of bismuth and tin, adding one ounce of mercury. When cool, pulverize into a fine powder. R. P. PERRY.
Hoboken, N. J.

387. IMPREGNATING CAST IRON WITH ZINC.

Use 1 pound of pulverized zinc to each 50 pounds of iron. Scatter the zinc well over the bottom of the ladle, and fill with melted iron. Stir the mixture well with an iron rod, and pour it at once. W. B. STAUFFER.
Scottdale, Pa.

388. LUBRICANT FOR TURNING COPPER.

Referring to receipt No. 359 in the June issue, which says gasoline is a good lubricant for copper, would state that a solution of sal-soda mixed with lard oil is a lubricant I have seen used on copper in turret lathe work with good results.
Bridgeport, Conn. S. H. SWEET.

389. RUST-PREVENTING MIXTURE.

Melt 4 ounces of rosin in 1 quart of linseed oil and mix with 2 gallons of kerosene oil. The mixture is readily applied with a cloth or brush, and can be easily removed. So far as concerns absolute protection of metal surfaces from rust however, it perhaps is no better or worse than many other compounds recommended for the purpose. M. E. CANEK.

390. TO CLEAN RUSTY PIECES OF STEEL.

Put the pieces in a solution of chlorate of tin, not too strong, or it will attack the metal, and let them stay there about 24 hours or less. Take the pieces from the bath, wash them in water, then in ammonia, and then dry them quickly. They will have an appearance almost of silver, but will take the natural color by rubbing them. J. M. MENEGUS.
Los Angeles, Cal.

391. METHOD OF REPAIRING CRACKED WATER JACKETS.

The following method of closing up cracks in castings will be found to produce good results: Prepare a dry mixture of 17 parts of cast-iron filings, 2 parts of sal-ammoniac, and 1 part of flour of sulphur; add twenty times the weight of new iron filings; put in a mortar and add water so as to obtain a paste. This paste is applied to the crack, and in a short time becomes as hard as the metal itself. M. E.

392. TO JOIN TOGETHER TWO PIECES OF IRON THAT CANNOT BE HEATED.

I have used a compound consisting of sulphur, 6 parts; white lead, 6 parts; and borax, 1 part. These substances are dissolved in concentrated sulphuric acid, and the surfaces to be united covered with the mastic, and pressed very hard together. In about six days the two pieces are so well joined that even hammering will not part them. J. M. MENEEUS.
Los Angeles, Cal.

393. TO UNITE METALS OF ANY KIND.

The following mastic may be used to unite metals of any kind. It becomes very hard. First, mix well together 4 parts of iron filings with 4 parts of chloride of ammonia. Then dissolve 100 parts of arabic gum and 20 parts of sugar in 100 parts of water and add 1½ part of nitric acid. Boil this, and put the first mixture into it. When the mastic has to be used, mix one part of it with ten parts of new iron filings and some water, and heat it until a paste is formed, which is applied well heated to the pieces to be united.
Los Angeles, Cal. J. M. MENEGUS.

394. TO COPPER BRASS FOR LAYING OUT WORK.

To apply a copper coating on brass for laying out purposes, apply the ordinary copper solution in the same manner as used on iron or steel. Then, while the brass is still wet with this solution, cover the entire surface with a thin layer of fine cast iron dust from the drill press. Brush off the cast iron dust, and the surface will have a nice copper coating. This works much better than the receipt No. 34, reprinted in the booklet 150 Shop Receipts and Formulas, in which an iron rod is recommended. C. S.

395. TO TEST GALVANIZED WIRE.

The Western Union Telegraph Co. subject their wires to the following test in order to ascertain that they are well galvanized. The wire is plunged into a saturated solution of sulphate of copper (blue vitriol), and permitted to remain in this for one minute, after which it is wiped clean. This process is repeated four times. If the wire appears black after the fourth immersion, it shows that the zinc has not all been removed, and that the galvanizing has been well done; but if it has a copper color, the iron is exposed, showing that the zinc coating is too thin. O. G.

396. INVESTIGATING ADULTERATIONS IN BELTS AND LEATHER.

Some manufacturers make their belts and leather heavier in the following way: The leather is kept in a current of steam at low temperature until its pores are well open. Then it is put in a solution of glucose. The leather absorbs the liquid, and in drying the water evaporates and the pores close, retaining the glucose. To find out whether belts or leather have undergone this operation, put a piece of the suspected leather in some distilled water, and when it is well soaked, half fill a glass tube with some of the water, add a few drops of sulphate of copper, and fill the tube with a solution of caustic potash. Stir the liquid well and let it boil on an alcohol lamp. If the leather is natural, no change will take place in the liquid, but if it contains glucose, a characteristic precipitate of copper will form, due to the action of the glucose on the solution of sulphate of copper and potash.
Los Angelus, Cal. J. M. MENEGUS.

397. CAST IRON BRAZING.

The ingredients for this cast-iron brazing may be had at any first-class drug store and should cost no more than about 50 cents. They consist of 1 pound of boric acid, 4 ounces pulverized chlorate potash, and 3 ounces carbonate of iron. These ingredients should be thoroughly mixed, and kept perfectly dry (a glass jar or bottle answering the purpose), and when wanted for use, a small amount should be taken and mixed with grain spelter. In trying this brazing for the first time, take a piece of cast iron of say one square inch cross section, hold the broken parts together by clamps, and fit the break closely in order to form a strong joint. Use a gas forge if possible, but an ordinary blacksmith's forge will do if no gas forge is available. When a blacksmith's forge is used, use charcoal, and be sure to get a high heat. When the pieces of the casting are in place, heat the joint to a good bright red before applying the flux. Then apply it liberally with an iron rod, flattened on the end, and work along the fracture, gradually raising the heat to almost a white heat. Then shut off the heat and allow the casting to cool slowly. If this work is done carefully, the joint will be as strong or stronger than the original casting.

Another formula is: 1 pound of boric acid, 3 ounces of caustic soda, and 3 ounces of carbonate of iron. This is mixed with spelter in the same way as in the first formula, and must also be kept dry. The main points to keep in mind when brazing cast iron are to have the metal clean and free from grease; not to apply the flux until a bright red is reached; and then be sure to raise the heat high enough to make the mixture flow nicely. ETHAN VIALL.
Decatur, Ill.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

BROWN & SHARPE NO. 3 VERTICAL MILLING MACHINE.

This description and the accompanying cuts relate to a new vertical milling machine made by the Brown & Sharpe Mfg. Co. of Providence, R. I. In describing it, it is not necessary to call attention to the advantages which the vertical miller possesses over the horizontal machine for a large class of work, since these advantages have in recent years come to be well recognized, so that the use of the vertical miller has become standard practice. Of the general construction of the machine it only needs to be said that it has been designed and made with the three cardinal points of accuracy, rigidity and convenience in mind. The following detailed description will tend to show that these three features have been realized to a high degree, without requiring that any one of them should be sacrified for the sake of the others.

General Features of the Design.

The front elevation, Fig. 1, and the sectional line drawing, Fig. 2, will serve to give an idea of the general arrangement of the tool. The power is delivered to the machine through a single speed shaft, *C*, driven either by a pulley, or from a direct-connected constant-speed motor, as in Fig. 1. The spindle motion is transmitted through a gear mechanism giving eight changes of speed to the bevel gears and reversing clutch shown at *B*. From here a vertical driving shaft leads to a train of gearing at the top of the column, where another change of speed is provided, giving sixteen in all. The feed gearing, also having sixteen positive geared changes, is driven by a Renold chain from the constant speed shaft; from the feed gearing the motion is carried to the knee, where it can be applied to either the vertical, cross or longitudinal feeds, automatic and positive stops being provided for all of these in either direction, as well as fixed automatic stops to prevent over-running. This variable feed can also be applied to the axial movement of the spindle, as well as to the circular milling attachment shown in Fig. 6, when the latter is furnished.

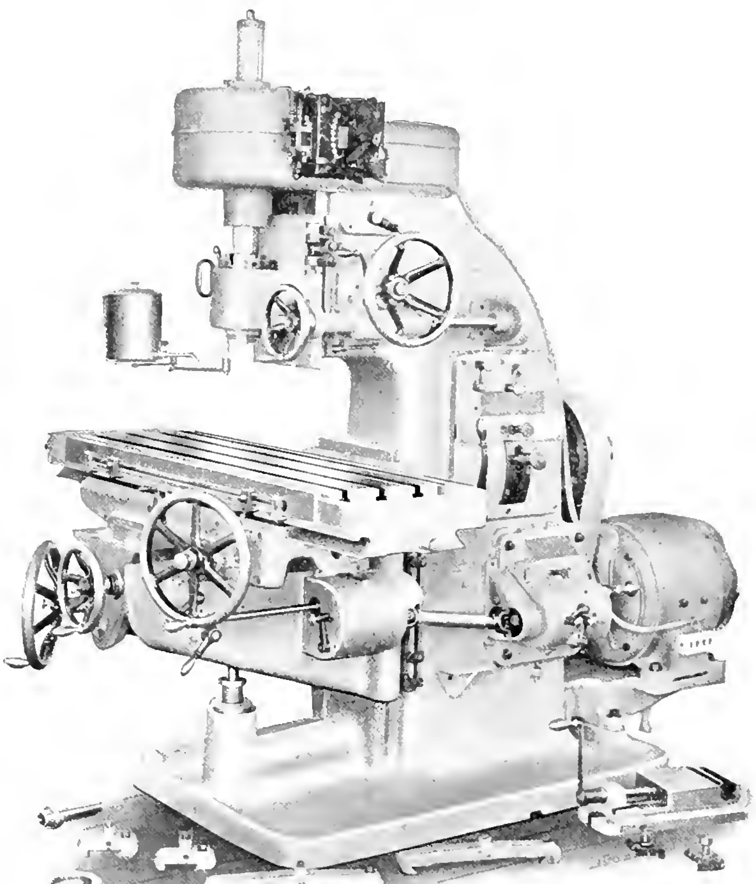


Fig. 1. The Brown & Sharpe No. 3 Vertical Milling Machine.

Spindle Speed Change Gearing.

A driving pulley of the plain flanged type as shown in Fig. 2 (or a wide-faced sprocket wheel, if the machine is motor-driven, as in Fig. 1) runs loosely on the driving shaft, and may be clutched to it or released from it at will by operating the vertical lever shown at the side of the column in Fig. 1, and connected to reach rod *A* in the line drawing. This serves regularly to start and stop the machine. In the case of a belt drive, no countershaft is needed or ordinarily furnished, the belt leading directly to the main line shafting. The spindle speed change mechanism (also shown removed from the machine in Fig. 3) operates very simply, giving four changes by the shifting of an idler from the driving pinion on *C* to mesh with either of the gears in cone of four gears. This number of changes is multiplied by two, by shifting a double gear on the sleeve on the upper shaft. This mechanism is similar to that used in varying the feed, which will be explained more in detail later, the only difference in design between the two being the different arrangement of the handles necessitated by the location of the shafts. As shown in Fig. 3, a speed plate is provided, giving definitely the revolutions per minute obtained by shifting the various handles to either of the sixteen combinations it is possible for them to take, ranging in geometrical progression from 17 to 374 revolutions per minute. The lever for operating the reversing mechanism *B* is shown just at the left of the speed plate.

The vertical shaft *E*, Fig. 2, leading to the top of the column, carries a gear *F* meshing with the wide face gear *G*. A sliding gear *H*, with an attached pinion, may be shifted along the face of *G* so that either the gear or the pinion may be connected with the corresponding diameters of the double spindle gear *I*. This change is effected by a lever seen in Fig. 1 over the hand-wheel for the spindle feed. The spindle is of crucible steel with ground bearings, running in bronze boxes. The lower end is threaded and has a No. 11 taper hole, with a recess milled across the end for driving an arbor or collet with a clutch collar.

Feed Change Mechanism.

The feed change gearing is driven from the constant speed shaft *C* by the sprocket pinion *J* on its end, Fig. 2, through a "silent" chain to the driving sprocket *A* shown in Fig. 4. The same mechanism is shown in the half-tone Fig. 3 separated from the machine. Through the keyed hub on this sprocket *A* passes the shaft *B*, carrying gears *C* and *D*; by the shifting of the lower lever seen in the feed box in Fig. 3, either of gears *C* or *D* may be shifted to engage with the corresponding ones on pinion shaft *E*, opposite them. Two speed changes are thus provided for. Pinion teeth are formed on *E*, as shown. Meshing with this is an intermediate gear which does not appear in the cut. This intermediate gear may be shifted to engage either one of the four gears on shaft *F*. Lever *G* at the side of the gear box serves to adjust the intermediate about the axis of *E* to suit the different diameters of the gears on shaft *F*, while the knob shown just under the feed plate in Fig. 3 shifts it to the proper station on the cone of gears for the speed desired. A further doubling of the eight feeds thus obtained is effected by the shifting of double gear *H* on the delivery shaft *J*. This is effected by the movement of the upper of the two short levers on the front of the gear box, which may be shifted to either of two positions. The sixteen feeds desired are thus provided for.

Arrangement of Automatic Feeds.

The telescope shaft carries the motion to a gear box on the side of the knee, in which the feed may be reversed to act in either direction as desired. This reversing box is shown removed from the machine in Fig. 3. From here the feed movement is either led through splined shafts and gearing to the table screw or to the cross and vertical feed mechanisms, as required. The latter two are operated by the handles and clutches encased in the cross and vertical feed box, shown removed from the machine in Fig. 3. It will be seen attached to the machine in Fig. 1 at the side of the knee. The table feed is operated in either direction by the lever at the front of the saddle, the reversing box at the side of the knee not being used for this purpose. Either a slow feed or a quick hand feed may be given by the hand-wheel, or this may be disconnected from the mechanism entirely, the clutch on the center of the hub being used to make these changes. All the movements of the table, saddle and knee are controlled by fixed hand-wheels which may be disengaged so as to hang free on their shafts, thus preventing accidental disturbances of the settings. Graduated dials reading to 0.001 of an inch are provided for all these movements. The hand-wheels do not interfere under any circumstances, and can be used simultaneously without difficulty.

The vertical feed of the spindle head is operated from the same change gear mechanism as the table, saddle and knee feeds. In Fig. 4 a gear K will be seen on the hub of the fork of the universal joint. By operating the knob provided, gear L may be brought into mesh with K, thus driving sprocket M. A chain runs from sprocket M back into the column over two pairs of idlers and out again to a sprocket at N in Figs. 3 and 5. A lever O operates a clutch for connecting this sprocket with the worm shaft on which hand-wheel P is keyed. This clutch is also operated by the automatic stops, adjustably clamped in the T-slot at the side of the spindle head. A worm on the hand-wheel shaft meshes with worm-wheel Q on the pinion shaft R. Q may be connected to it, or disconnected from it at will, by the lever S. Hand-wheel T, when Q is disconnected, may then be used for a rapid hand movement of the spindle head; at other times, hand-wheel P gives a slow movement. The pinion on the inner end of R meshes with a rack on the spindle head. This pinion also meshes with a gear U on the hub of a disk V, to which is connected a chain which runs over an idler W and down through the column to a counterweight shown in Fig. 2. A channel walled in on all sides is provided for this, preventing it from swinging against other parts of the mechanism, and stiffening the frame of the machine as well. The connection of the counterweight of the head through the gearing described makes it possible to use a lighter counterweight having a greater movement than would be the case otherwise.

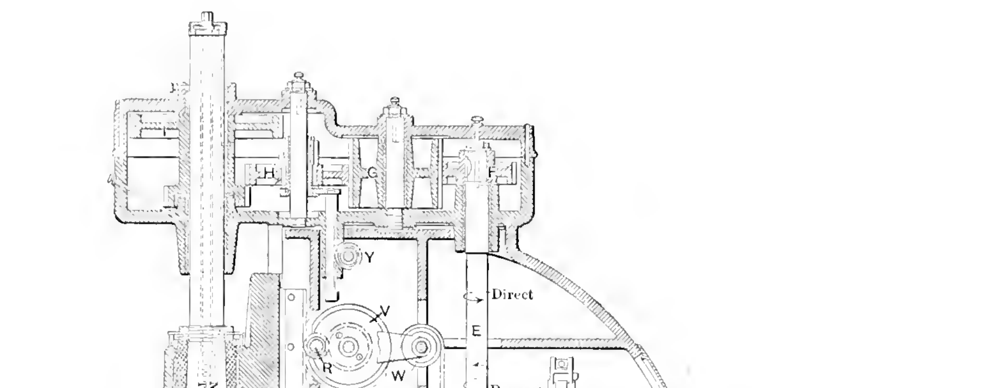


Fig. 2. Vertical Section through Spindle-head and Column, showing Spindle Driving Mechanism.

Circular Milling Attachment.

The circular milling attachment shown in Fig. 6 is furnished for work requiring the finishing of parts on the arc of a circle. The feed for it is taken from the splined shaft which drives the longitudinal feed screw of the table. For this purpose this screw is disconnected from the splined shaft by the simple means provided, so that the table feed applies to the circular table only. For making longitudinal adjustments of the table under these conditions, a crank is applied to the squared end of the table screw at the left end of the table. At the back of the table, at the right end, is provided a finished pad to which may be bolted the bracket shown, carrying the sprocket wheels and chain conveying feed motion from the table feed shaft to the circular milling attachment. These connecting parts are made interchangeable, so that the milling attachment may be purchased at any time subsequent to the purchase of the machine, and applied without requiring any fitting.

The automatic stop and feed controlling devices used for the circular table are similar to those used on the main table. The feed is reversed, started and stopped by the same lever. The dogs for the automatic stop are held in a circular T-slot in the periphery of the face-plate. This latter has three T-slots in one direction, and a third crossing in the center of the plate at right angles to the other three. The periphery of the face-plate is divided in degrees so that the table may be used for indexing the work for taking straight cuts, as well as for circular milling pure and simple. By the movement of a small lever, the hand-wheel may be disconnected from the feed motion.

Recurrence of Identical Details of Design.

The large number of line cuts and photographs shown of this machine furnishes a good opportunity for studying the methods of design followed by a firm which has a high reputation in this regard. One of the things that is noticeable is the recurrence throughout the machine of certain details of design, wherever similar movements have to be performed. For instance, note the use made of the rack and pinion principle in operating the various sliding gears, clutches, etc., in the feed and spindle feed mechanisms. Examples of this occur twice in Fig. 2, once at X, where the double gear of

the spindle speed changing mechanism is shifted, and again at Y in the back gear shifting mechanism. In the first case the rack teeth are turned in the lathe on the hub or shell of the double gear, so that they have a circular form. This allows the part to be rotated freely through the teeth of the pinion, which still controls its endwise movements. The pinion is attached to the shank of the operating handle on the outside of the machine.

will show that it accomplishes the movements desired with about as few parts and as little machining as could be obtained in any possible way.

Another feature also noticeable from a study of the photographs is the carefulness with which the design of the main castings have been worked out. Looking at the side of the machine in Fig. 1, it will be seen that a great many separate parts are bolted onto the sides of the column, knee and

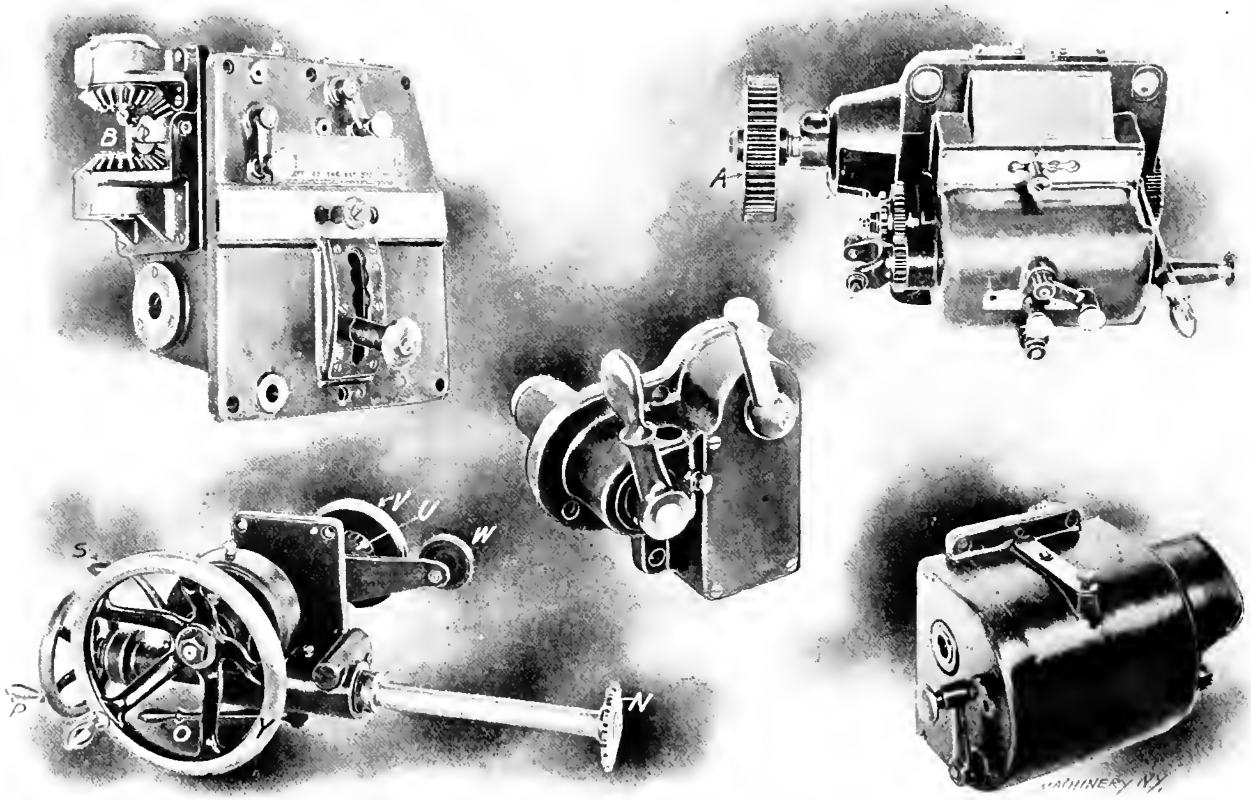


Fig. 3. A Group of Assembled Units of the Brown & Sharpe Vertical Miller.

Spindle Speed Change Mechanism. Feed Change Mechanism.

Cross and Vertical Feed Control.

Vertical Spindle Feeding Mechanism. Feed Reversing Mechanism.

In Fig. 4 the same form of control is used for shifting the double gear H. In Fig. 5, lever O is connected to a pinion actuating a rack, which connects or disconnects the vertical feed clutch. Lever S in the same manner meshes with circular rack teeth in the hub of wheel T, throwing it in or out of engagement with worm-wheel Q. The same device is freely used in the movements controlling the vertical, cross

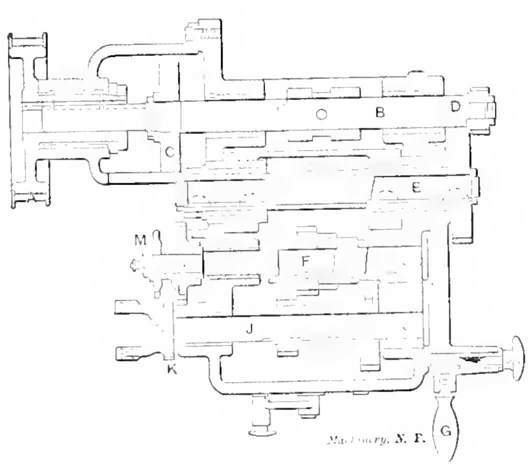


Fig. 4. Arrangement of Gear Feed Changing Device.

and longitudinal feeds. These rack teeth appear to be all of the same pitch, and made of substantially the same form in either of two ways, by being turned in the lathe on the cylindrical surfaces of gears, hand-wheel hubs, etc., or by being milled across the top of round rods seated in drilled holes in the casting. A consideration of this detail of design

saddle. For all of these, however, suitable pads and bosses have been prepared on the main casting, so that to the eye they seem naturally to fit into place, instead of having the appearance of being stuck on afterwards as an after-thought, as is the case with many examples of machine tool design. This requires castings somewhat more elaborate than would otherwise be required, yet it is doubtful if the final cost of producing such work is much, if any, greater than the cost of poorer design.

Unit System of Design.

Perhaps the most noticeable featnre of the machine so far as concerns the matter of design, however, is that best illustrated in Fig. 3. For want of a better name it may be called the "unit system" of grouping the mechanism. It will be seen that the speed changing mechanism, feed mechanism, the feed reversing gearing, and the cross and vertical feed mechanisms, are each grouped in separate independent units, which may be made and assembled as a whole, without reference to the machine in which they are to be used.

This had its advantage, not only as regards manufacture, but from the standpoint of design and use as well. In making changes and improvements in the drafting-room, these mechanisms may often be considered as separate machines, to be altered as occasion may require without affecting the remainder of the structure. This is made possible by the fact that they are so self-contained. Where the different parts are attached to the main frame of the machine at many different points, changes cannot be so easily made. From the standpoint of manufacture there is the advantage of being able to finish much of the assembling at the bench, making the erecting of the machines on the floor a comparatively short and inexpensive process. Not only is it costly to have the erect-

ing space taken up by half-completed machines for weeks at a time, but there is a greater expense as well in fitting small parts to heavy columns and bed castings, remote as they usually are from the tools in which the fitting is done. In addition to all this, the purchaser has the advantage of being able to take the machine apart quickly and easily. The removal of the driving shafts, for instance, allows the spindle speed change mechanism to be removed from the machine in its entirety, so any trouble that may have occurred there may

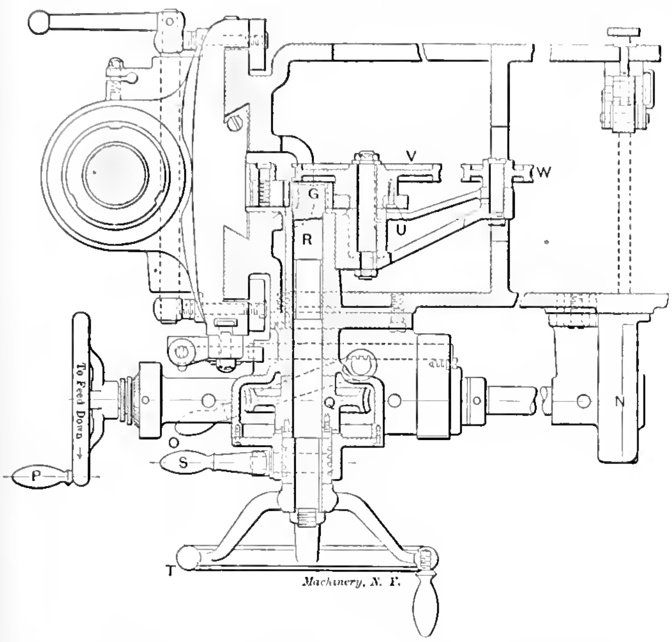


Fig. 5. Arrangement of Hand and Power Feeds for the Spindle.

be easily remedied, the part being carried to the bench or lathe for the purpose. The same thing applies to the other separable units of which the machine is constructed.

It is entirely possible to design machine tools that are commercially and mechanically successful without refinements of the kind we have just been considering, but the fact that wide and insistent markets are found for such machinery as this, where thought and time have gone to the perfecting of the small details, indicates that there are many users who believe that such matters are decidedly worth the time and money spent on them.

Range of Feeds, Dimensions, Etc.

This machine is known as No. 3 in the builders' line of vertical millers. It has a table with a working surface of $49\frac{1}{2}$ by $16\frac{1}{2}$ inches, having three T-slots, $\frac{3}{4}$ inch wide. The longitudinal feed is 34 inches, the transverse feed $13\frac{1}{2}$ inches,

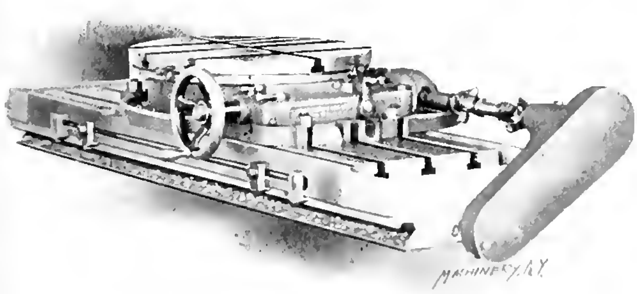


Fig. 6. Circular Milling Attachment.

the vertical feed of the knee 15 inches, and of the spindle head 8 inches. The distance from the center of the spindle to the column is 18 inches, and the maximum distance from the top of the table to the end of the spindle is 23 inches. The net weight of the machine is about 6,100 pounds.

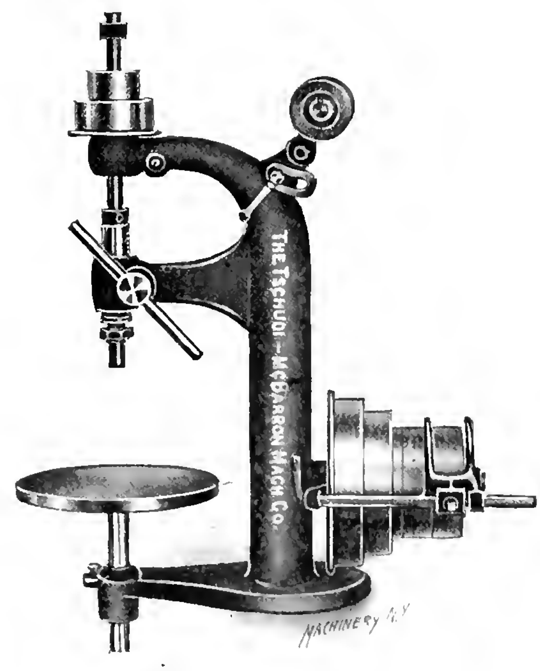
GASOLINE ELECTRIC GENERATING PLANTS.

The Buffalo Mechanical and Electrical Laboratory, Erie County Bank Building, Buffalo, N. Y., furnishes complete gasoline engine and dynamo sets for temporary or permanent electric generating plants. The engines are adapted to either gas, oil, or alcohol, in sizes to carry 10, 20 or 30 lights, according to the candle power and voltage. When operated at a speed of 850 revolutions per minute the engine develops $1\frac{1}{2}$ horsepower, and the dynamo supplies a current of 101 volts pressure. The electrical generator has a capacity of 7.5 amperes at normal load and will carry a maximum load considerably above this amount. For a constant load with a definite number of lights, no regulator is necessary, as the outfit runs at practically constant speed. For a variable load, a storage battery is provided having 50 cells, giving an 8 or 10 ampere hour capacity, this being sufficient to give good regulation and supply a reserve current for night lamps, and extra current during a heavy over-load.

This set is particularly useful for boat lighting, charging automobile batteries, store lighting and other places where isolated plants are required. In places where fire underwriters object to gasoline being used as a fuel in insured buildings, a portable house is provided to protect the engine and dynamos, and the storage batteries as well, if the latter are used. Besides the $1\frac{1}{2}$ horse-power size mentioned, larger sizes are provided, up to double cylinder engines generating 6 horsepower. The latter are especially devised for charging automobiles and similar work. Similar sets have been on the market for some time in Europe, but they are of considerably more costly construction, heavy cast iron bases and complicated governing mechanism being used. These engines are muffled to give results as good as those obtained in the best automobiles.

EXCELSIOR SENSITIVE BENCH DRILL.

The Tschudi-McBarron Machine Co., Dayton, Ohio, is building the bench drill shown in the cut. It is called the "Ex-



Tschudi-McBarron Sensitive Bench Drill.

celsior." As may be seen, the spindle is driven by a 2-step cone, carrying a 1-inch belt. The speed variation thus obtained gives from 1,000 to 2,000 revolutions per minute of the spindle when the driving pulleys are connected to give 800 revolutions per minute. In changing from the large to small diameter on the cone pulleys, the idler shown is swung about its pivot to accommodate the new position of the belt. Bronze bearings are used throughout.

The table is 8 inches in diameter. The front end of the machine is arranged to over-hang the work bench, allowing the stem of the table to drop over the edge as much as is required for the adjustment for height. The distance from the column to the center of the table is $5\frac{1}{8}$ inches, so that the tool may be classed as a 10-inch drill. The vertical travel of the table is $1\frac{1}{2}$ inches and the vertical feed of the spindle is $1\frac{3}{4}$ inch, and the greatest distance from the spindle to the table is $7\frac{1}{2}$ inches. The floor space required is 9 x 7 inches.

STURTEVANT STEAM TURBINE.

The B. F. Sturtevant Co. of Hyde Park, Mass., has been working for some time past on a steam turbine of the impulse type, adapted for direct connection to high-speed machinery, especially for the fans and blowers and electrical apparatus which this firm manufactures. The experiments have resulted in the machine herein described, and illustrated in the accompanying half-tones. It is the invention of Mr. William E. Snow, of the firm's engineering staff, and is built

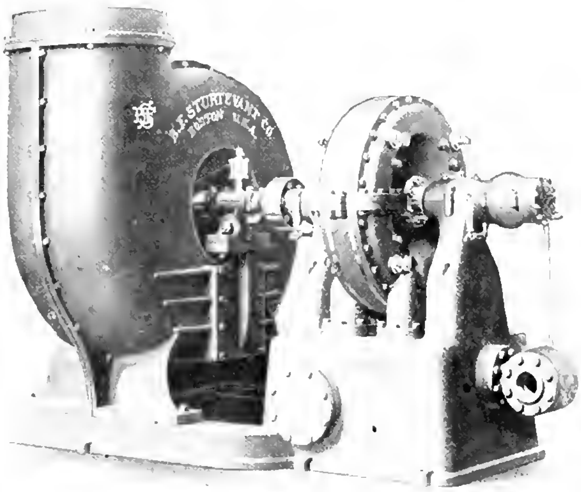


Fig. 1. Sturtevant Steam Turbine, Driving Gas Blower.

under his patents. The experimental work was begun in 1889, soon after the modern practical form of the steam turbine appeared, so that in its present design it is the result of a long period of development.

General Description.

This turbine works entirely on the impulse principle, the steam expanding completely in the stationary member, the rotor only serving to absorb the velocity of the fluid without

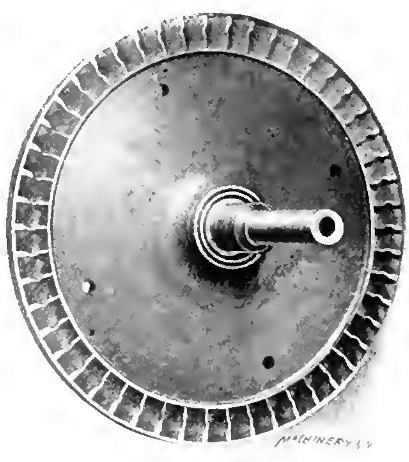


Fig. 2. Runner of the Sturtevant Turbine.

changing its pressure (see article "Impulse and Reaction Turbines Defined," Engineering Edition of MACHINERY, October, 1906). Fig. 1 shows a general view of a 75-horse-power machine attached to a gas blower—a service to which it is particularly adapted. It will be seen, by comparing it with the blower, that it is much more compact than a reciprocating engine for the same purpose, and that it is neat and simple in design. Fig. 2 shows the runner and Fig. 3 the guide plate or stationary member, containing the nozzles and return buckets. One of the side pieces is seen just behind it. So far as can be judged from photographs, the machine is double, the runner having buckets on each side, with two reversing or guide rings, one for each side of the casing. A guide ring and casing are shown assembled in Fig. 4.

As shown in Fig. 1, the diameter of the wheel, as compared with the driven blower, is so small that the base is of considerable size, allowing room for steam passages and a water separator to provide dry steam—a very necessary feature for a steam turbine, if the wear of the blades is to be kept at a minimum. This also reduces the clumsy and complicated outside piping that would otherwise be necessary. The live steam enters the casing through the four small outside ports shown in the base casting in Fig. 5, going up through the side of the frame of the casing into the annular steam chest formed around the side. The passages for this can be traced from the outside contour of the casting in Fig. 1. From this annular steam chest four nozzles lead to the wheel. Samples of these nozzles, disassembled, are shown in Fig. 6. The oval opening which they form in the reverse guide ring will be seen at four points in the face of the ring in Fig. 3.

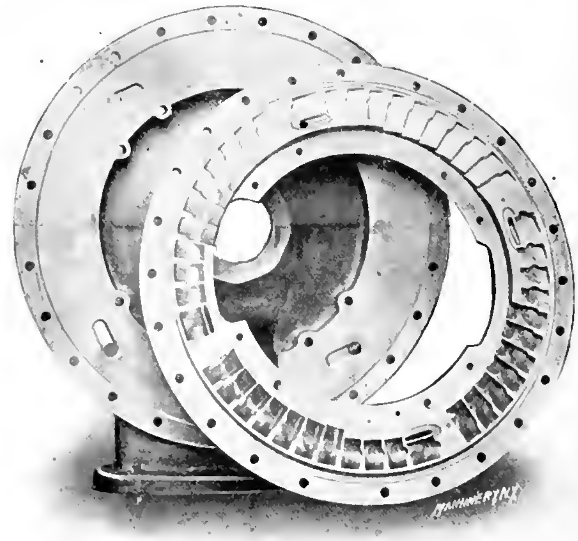


Fig. 3. Guide Plate for Returning the Steam to the Runner.

The steam (having expanded in these nozzles and transformed the dynamic energy, due to its pressure, into kinetic energy, due to velocity) enters one of the side buckets of the runner in Fig. 2. Delivering a portion of this velocity to the runner, and being returned by it to the reverse pocket shown in the guide ring in Fig. 3, opposite each of the nozzles and openings, the curved bottom of this pocket again returns it to the buckets of the runner, where it again gives up another portion of its velocity at a slower rate of speed, and is reverted to the three following guides of the guide plate. This increase in guide area is necessitated by the increase in the volume of the fluid due to its slower velocity.

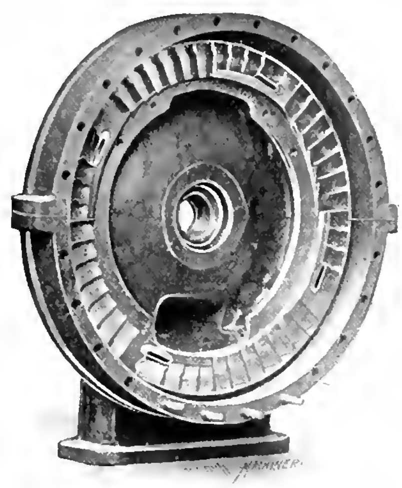


Fig. 4. Guide Plate and Casing Assembled.

From these three pockets the steam again returns to impart its velocity to the runner, which finally carries it around to be discharged into the last seven openings in each of the four series in each guide plate. From here, instead of being returned again to the wheel, it is discharged towards the center through the side openings shown, at a velocity of practically zero, having given up most of its energy to the moving wheel. It is a little difficult to understand just what path the steam takes in traveling through the nozzle to the runner, back to the reverse guide, and so on, until it escapes into the center space of the casing; but it is doubtless done,

so far as can be judged from the photographs, in substantially the manner described. From the center of the casing, the exhaust steam is led down to the center of its support, and through the large central holes of the base in Fig. 5, to the exhaust pipe.

It will be seen from the foregoing that while the Sturtevant turbine shown in Fig. 1 has but one wheel, it is not of the single stage type in the usual accepted meaning of the word, since the steam acts in the buckets over and over again until

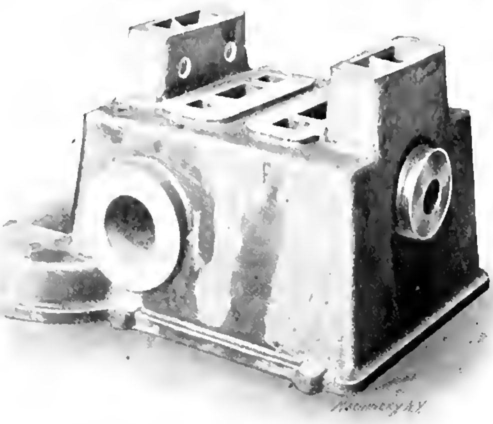


Fig. 5. Base Casting, showing Steam Passages.

all the available energy is extracted. This not only results in a high efficiency, but also permits the use of very moderate speeds of rotation as compared with other types. This speed ranges from 1,600 to 3,000 revolutions per minute, permitting direct connection with blowers and high-speed machinery, and avoiding the use of gears and other reducing devices.

The description shows plainly the simplicity of the machine. It is composed in the form shown of seven principal parts: the bucket wheel, the shaft, the reversing guide rings, casing, bearings, base, and governor. The only parts subjected to actual wearing contact are the two main bearings, and as the load upon these never exceeds four pounds per square inch of bearing surface, they last indefinitely.

Details of Construction.

The bucket wheel is a single forging of the best grade of open-hearth steel, with buckets worked out in the solid

Fig. 6. Steam Nozzles.

metal, as shown in Fig. 7. Here the wheel is mounted in an indexing fixture on the table of the vertical milling machine, having recesses milled out in a way which is obvious from the cut. This process insures a wheel of great strength, and also does away with all possibility of the breaking of the blades of the buckets, as sometimes occurs with wheels of the inserted blade type. If the bucket wheel of the Sturtevant turbine should get out of line and touch the casing, the result would be merely a rubbing together of two steel plates, which could not produce the slightest injury to the guiding surface for the steam. The steam is admitted to the buckets in such a manner that the wheel is always in perfect balance, and end thrust is eliminated. The method of cutting the buckets and the form of the cutter used insures a high degree of accuracy and smoothness of finish. The reverse guide rings are of forged steel, having the buckets milled in them similar to those in the wheel, as described. In the size shown, four steam nozzles are inserted at intervals between the buckets. These nozzles are made of the best phosphor bronze of a shape to give the proper curve for the degree of expansion desired. They are easily removed from the reversing guide rings at any time.

The casing is so made that no packing boxes have to be used on the shaft, steam tightness being secured with a short "labyrinth" or "water" packing. There is no contact between the rotary and stationary parts of this packing, so it requires no adjustment and will wear indefinitely without leakage. The bearings are of self-oiling ring type, with linings of phosphor bronze. Both the governor and the regulating valve are of great simplicity, and the form of the latter does away with all belts, gears and speed-reducing devices. It is

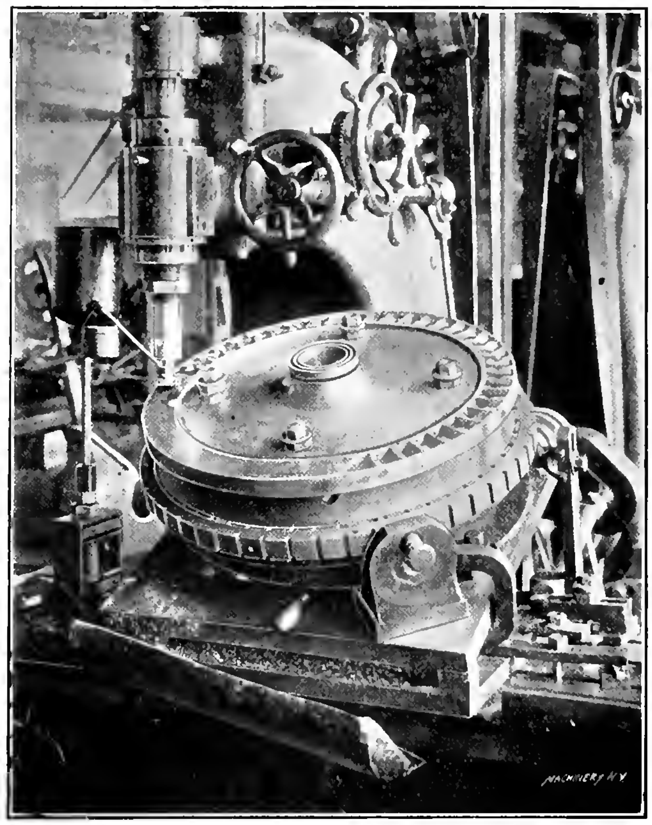


Fig. 7. Cutting the Buckets in the Runner on a Vertical Miller.

composed of but five parts, and is located in the end of the outboard bearing, enclosed in a dust-proof case. The connection between it and the throttle valve is direct, the latter being located directly under the governor.

The extreme simplicity of the turbine makes it comparable to the blower rather than to the engine. The only attention

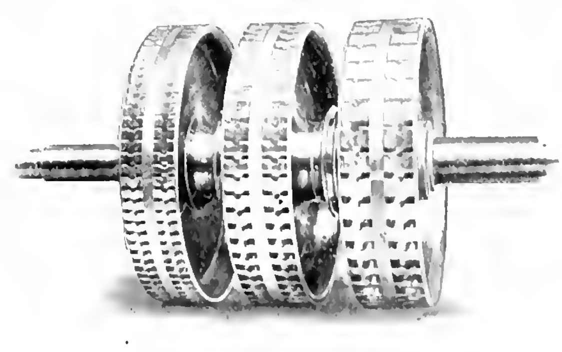


Fig. 8. Multiple Stage Runner, with Peripheral Buckets.

the Sturtevant turbine requires when in continuous operation is a weekly filling of the oil wells in the two main bearings. Since the whole machine is enclosed in a dust-proof case, it is absolutely protected from injury.

Range of Size in the Single and Multiple Stage Forms.

Turbines of the form just described are made in powers ranging from 10 to 200 H.P., and furnished in three sizes, so far as their outside dimensions are concerned. Intermedi-

ate horse-power and speeds range according to the arrangement of the nozzles and buckets. In sizes larger than 200 horse-power, two to four bucket wheels are used, the runner having a somewhat different form, as in Fig. 8, where three of them are shown mounted on a single shaft. This same runner is shown, mounted in its bearings, and placed in the lower half of its casing in Fig. 9, this machine being a 250-horse-power, 3-stage turbine. In this case the steam is directed from nozzles into the first row of buckets on the left-hand wheel, from which it escapes into the pockets in the reversing guide ring shown surrounding it in Fig. 9. These

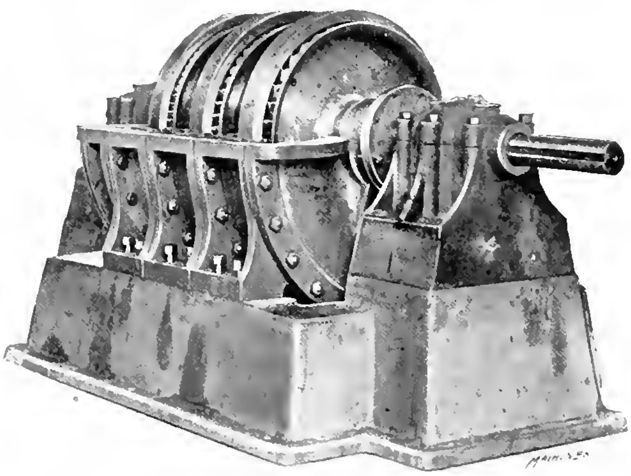


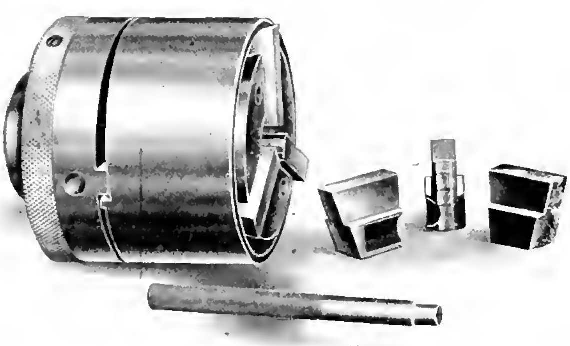
Fig. 9. Multiple Stage Turbine with Runner Exposed.

direct it into the second row on the same wheel, from which the steam is led to the second wheel, where the same operations are repeated. Following as above through the third wheel, it escapes, having given up all its velocity in the meantime. It will be noted that the buckets are progressively larger from the first to the third wheel, thus giving the larger space required by the decreasing velocity of the steam.

The advantages claimed for the Sturtevant turbine over the reciprocating engine for the same work are: greater simplicity; decreased weight; less space; greater reliability; less vibration; decreased cost of maintenance; and noiselessness of operation. As compared with other turbines for the same service, the builders claim for their machine greater durability, greater capacity, lower speed, larger clearance, better balance, less floor space, and higher economy.

QUICK ACTION ADJUSTABLE COLLET CHUCK.

This device is designed to be used in engine lathes, speed lathes, grinding machines, gear cutters, etc., in fact, in any



Quick Action Adjustable Chuck of Wide Range.

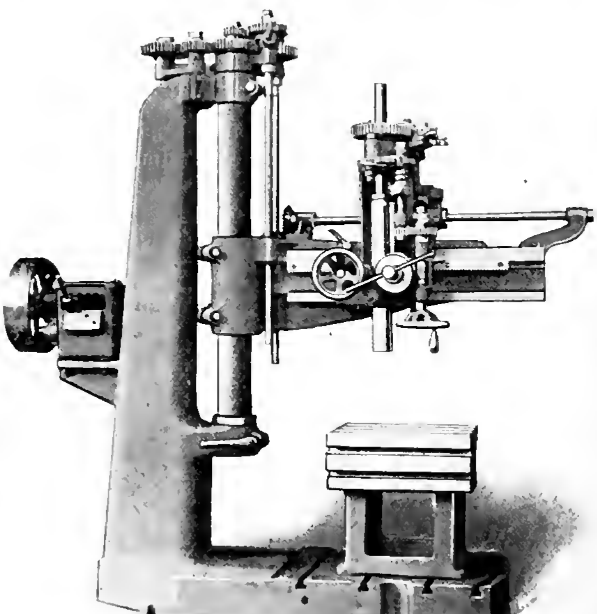
machine having a rotating spindle in which it is desired to hold work or tools of comparatively small diameter. It replaces a full set of draw-in collets, draw-in bar and hand-wheel on the lathe at less than half the cost.

As may be seen, it consists of a solid body, slotted to receive the jaws, which may be either plain (as shown in place in the device) or stepped (as shown dismounted). These jaws have tapered outer surfaces to match the cone shape inner surface of the outer sleeve. This sleeve may be adjusted forward or back, to suit the diameter of the work to be held, by rotating the knurled nut, threaded to the rear end of the body. When this adjustment has been made, the jaws can be quickly opened or closed by inserting the pin, shown in the cut, in the cam ring located between the nut and the sleeve. This latter has cam surfaces engaging projections on the cam ring in such a way that it is forced to move outward or inward, in accordance with the movement given the cam ring by the operator. All working surfaces are hardened and ground.

This device is made in four sizes: for bar stock with plain jaws from 1/4 to 1 inch, or from 1/2 inch to 1 1/2 inch; and with extra capacity stepped jaws (as shown in the cut) to give from 1 to 3 inches or from 1 1/2 to 4 inches capacity. The chuck is made with 2, 3 or 4 jaws as required, and will also be furnished with jaws for stock of special shape. Chucks of the same design for larger capacity will be made to order. The Adjustable Collet Co., Cleveland, Ohio, are the makers.

THE HILBERT 2 1-2 FOOT RADIAL DRILL.

The Hilbert Machine Co., 2116 Colerain Avenue, Cincinnati, Ohio, are placing on the market the radial drill shown in the accompanying half-tone. This machine will do the work of a radial drill of its capacity, but is arranged in addition to have such quick handling and operating features as to allow it to do the work of the ordinary drill press. The driving mech-



Hilbert 2 1-2 Foot Radial Drill.

anism consists of a speed box, having four changes, which, with the addition of the back gear on the spindle, gives eight spindle speeds. The back gear can be thrown in and out while running. All the changes in the speed box are controlled by one lever. The spindle is made from high carbon steel, has four changes of feed, an automatic stop, and a counterbalance weight. A tapping attachment is provided for the head, operated by a lever within convenient reach of the workman. The head can be securely locked in any position.

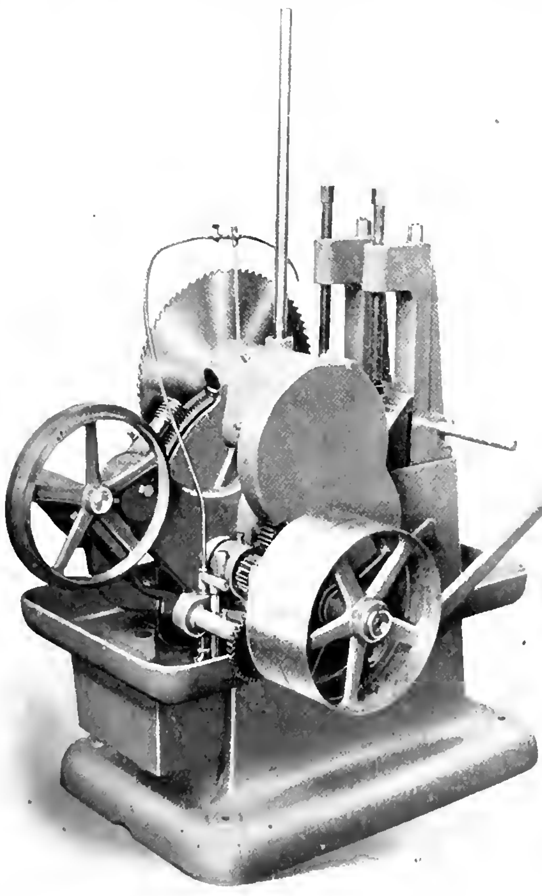
The arm is of rigid design, and is raised and lowered by power. For extra heavy and accurate drilling, a tie-rod arrangement is used to connect the outer end of the arm to the base of the machine, a circular slot being provided in the base for the T-head of the tie-rod. This may be seen in the cut. The maximum distance of the spindle from the base is 49 inches and the minimum extension of the spindle from the column is 11 inches. The rail has a vertical adjustment of 30 inches. The movement of the head on the arm is 24 inches. The machine will drill work on the base to the center of an 82-inch circle, or on the table to the center of a 70-inch circle. The total height of the machine is 80 1/2 inches, and the weight is 2,600 pounds. It will drill 2 1/2 inches diameter in cast iron, 2 1/4 in steel, and drive a 2-inch pipe tap in cast iron.

COCHRANE-BLY METAL SAWING MACHINE.

This tool, made by the Cochrane-Bly Co., Rochester, N. Y., is known as their No. 4 machine, and is designed for cutting rapidly and accurately bar stock in all sizes up to 6 inches round, 5 inches square, and I-beams, channels, etc., up to 12 inches wide.

The saw arbor is carried in a swinging frame, pivoted directly below the axis of the saw. The feed is accomplished by swinging the saw inward about this pivot, a segment of a worm gear being formed on the frame for that purpose, engaged by a feed worm. This feed worm is itself driven by a worm gear receiving its motion from a large cone pulley belted to a cone pulley on the driving shaft, giving two feeds. It is thrown into mesh with the worm-wheel segment by a hand lever, and is held in place by a pawl, which is thrown out by an adjustable automatic stop when the cut is finished.

The spindle is hardened and ground and fitted into a solid bearing on the carriage. It is driven by accurately cut spur gears, mounted on round shafts, insuring a high degree of durability. The vise for holding the work is adapted for either round or square stock, and the large table on which it is mounted may be used with movable clamps for making angular cuts on structural steel, etc. An oil pump supplies the blade with oil from the reservoir, and a large drip pan surrounding the bed provides for chips and oil drainage.



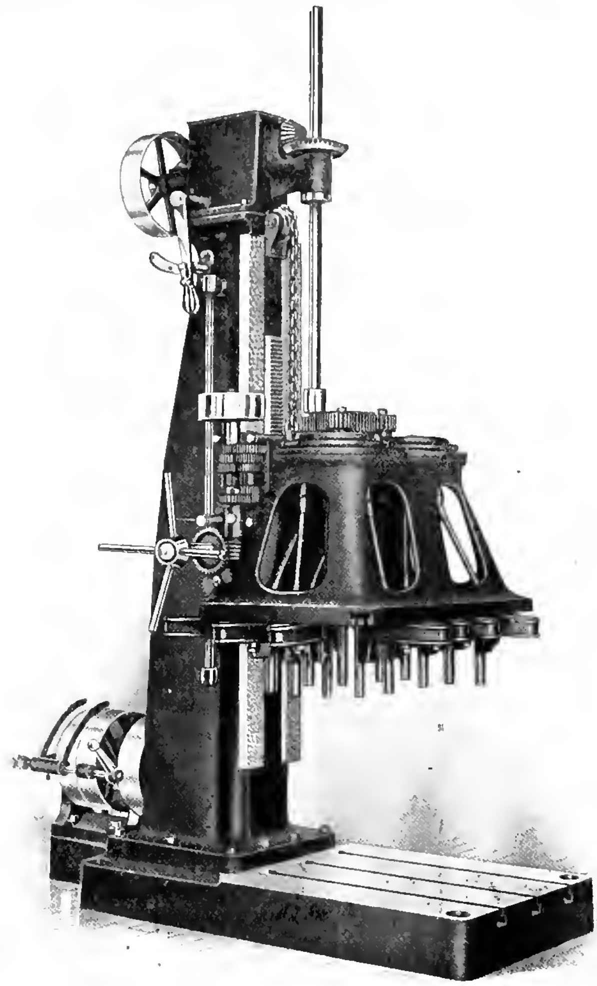
Cold Saw for Bar Stock and Structural Shapes.

This machine takes a saw 18 inches in diameter and 5/32 inch thick. The work table is 15 x 18 inches in area, with a vise having a capacity for stock 6 inches by 12 inches. The floor space occupied is 30 x 43 inches, and the net weight of the machine is 1,150 pounds.

WESTERN HIGH-SPEED MULTIPLE SPINDLE DRILL.

This machine, as may be inferred from the half-tone shown herewith, is built with massive proportions and strong drive, to adapt it to the use of high speed drills. So well has this been done that it will drill simultaneously any number of ½-inch holes up to 20, in a circle, square, or any irregular lay-out within the capacity of the head. If ⅝-inch drills are used, 16 of them may be driven, or twelve ¾-inch drills.

The head is provided with both hand and power feed, with quick advance and return and automatic stop, there being three changes of feed for each of the spindle speeds. It is also counterbalanced by a weight inside the column, through the connecting chain shown. In order to lose as little as possible of the power in transit between the driving pulley and the point of the drill, the spindles have been provided with ball thrust bearings. They are provided with check nuts at the upper ends to take up all end play, and run in bronze bearings which are adjustable vertically to compensate for varying lengths of drills. The arms which carry them are, of course, adjustable horizontally to any desired lay-out.



Heavy Duty Multiple Spindle Drill.

All of the fast running bearings are provided with bronze bushings. The loose pulley and countershaft bearings are chamfered to form reservoirs to hold the oil for their automatic lubrication. The speed gears mounted in the box at the top of the column are submerged continuously in a bath of oil. The driving pinions on the gear box, and the intermediate gear on the head are made of raw-hide, thus insuring a quiet running drive. The size of the head and the number of the spindles can be varied in building the machine to order. In the size shown in the cut, the largest lay-out for the centers of the spindles is 16 x 30 inches. The machine weighs, net, about 6,800 pounds. It is built by the Western Machine Tool Works, Holland, Mich.

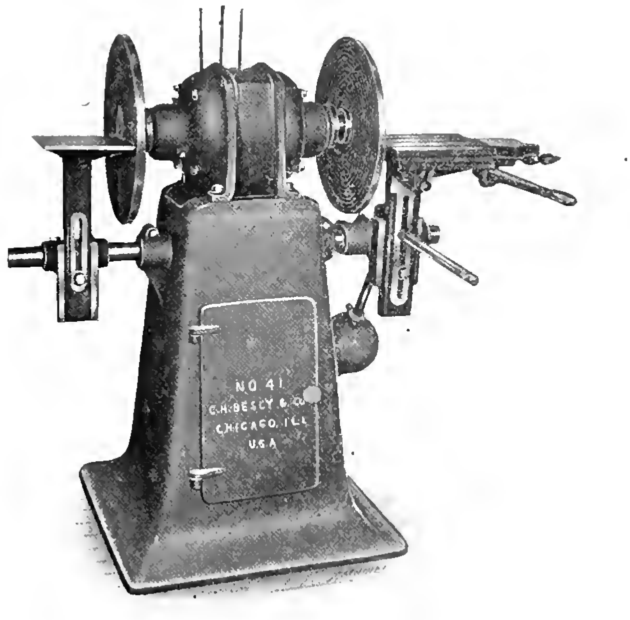
NEW BESLY SPIRAL DISK GRINDER.

Charles H. Besly & Co., of 15-17-19-21 So. Clinton St., Chicago, Ill., have added two new designs to their line of spiral disk grinders, one of them belt-driven and the other motor-driven. The general arrangement of the work holding and feed mechanism is the same in each case. The motor-driven machine, known as the No. 11, is shown in the cut. This tool is intended for general manufacturing purposes on a variety of work.

This machine has one tilting table and one geared level feed table, the latter having T-slots and a keyway for attaching angle plates or other work holders. The disks are 18 inches in diameter and are driven by a 5 horse-power al-

ternating current motor, wound for either two- or three-phase current with voltages of 110, 220, 440, or 550. The spindle, which is of crucible machinery steel, runs at 1,800 revolutions per minute. The journals are 5 inches long and 1⅝ inch in diameter, running in boxes of phosphor bronze, lubricated by the ring oiling method.

The machine covers a floor space of 28 x 28 inches. The length of the spindle over all is 23¾ inches. The height to



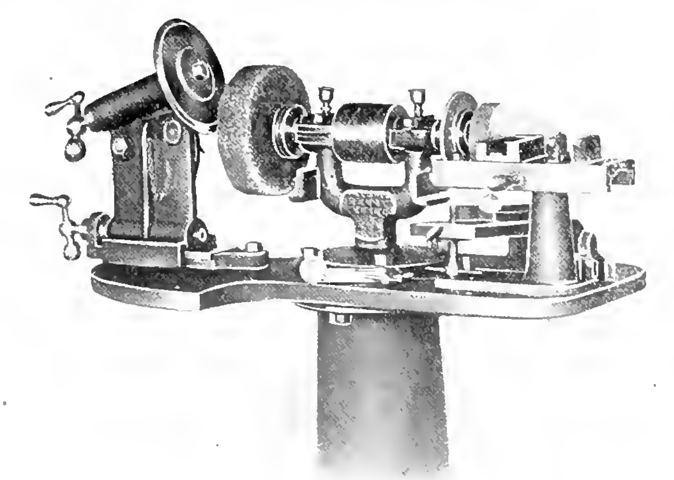
No. 41 Besly Disk Grinder.

the center of the spindle is 40 inches. The net weight of the machine as described, with two extra disks, is 1,400 pounds. All necessary accessories are provided, such as setting up press, cement, lubricating oil, glue pot and brush, wrenches, etc., and a large assortment of "Helmet" spiral paper and cloth circles.

SPECIAL GRINDER FOR PIPE THREADING DIES AND CUTTER DISKS.

This device has been built to fill a need found by the makers, the Murchey Machine & Tool Co., Detroit, Mich., for grinding the tools used in pipe cutting and threading machinery.

The grinder shown in the cut is particularly useful for grinding the disks used in rotary pipe cutters, and the chasers used in pipe threading machines. In the illustration, a cutter



Grinder Specially Designed for Sharpening Thread Chasers and Cutting Rolls.

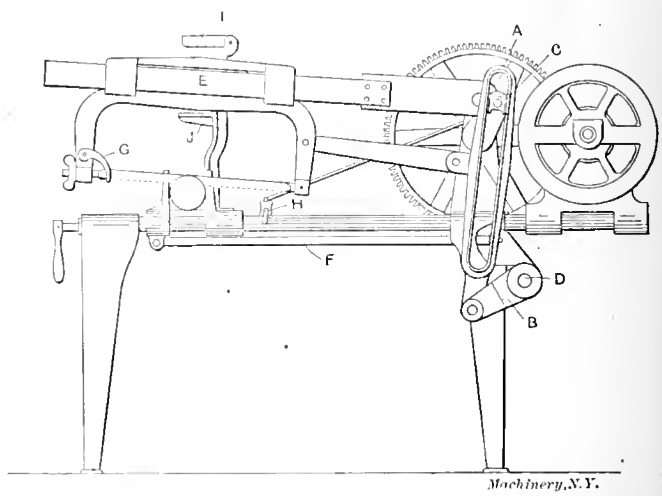
disk is shown in position for grinding on the left-hand side of the machine. It is fed against the side of the cup emery wheel by the movement of the lower screw of the fixture. The upper crank is then used to revolve the roller until its edge has been brought to the proper degree of sharpness. The fixture is then swung around out of the way, the emery wheel removed, and replaced with a felt wheel coated with emery. This gives a fine finish, and is said to increase the strength of the cutting edge.

The chasers are ground on special cone-shaped wheels shown in place at the right-hand end of the spindle. They are held in a suitable holder having stops to locate it squarely, and at the right position in relation to the grinding wheel. The purpose of the cone-shaped emery wheel is to grind the throat of the chasers to the required diameter to agree with the diameter of the pipe or hole it is to thread. After the throats of the chasers have been ground, the holder in which they are mounted is removed to the lower slide, where the face of the thread is sharpened by passing it under the small emery wheel in back of the cone wheel. These operations are all done quickly without removing the individual chaser from the holder. Suitable adjustments are provided to compensate for the wear of the wheels. An emery dresser is furnished attached to a moving slide, to dress the cone-shaped wheel to the proper angle.

VARIABLE STROKE QUICK RETURN HACK-SAW.

It is generally rather difficult to say anything of startling interest in describing a new hack-saw. The movements involved are so simple that no great scope is allowed the designer for the exercise of ingenuity in design. In the machine shown in the cut, however, two features are added which we have not seen before applied to this machine tool.

One of the novelties of the machine lies in the mechanism by which the saw is reciprocated. The crankpin block *C* enters the groove of slotted link *A*, which is pivoted to bell crank arm *B* at the bottom as shown. The other end of this arm is connected to a rod *F*, running back under the machine



Variable Stroke Quick Return Hack-saw.

to a connection with the front vise jaw. By this means the whole link is bodily raised or lowered with the closing or opening of the vise. To the side of link *A* is pivoted the connecting rod by which the saw is driven. By following the action of the mechanism through, it will be seen that when the jaws are adjusted for a large piece of stock, the stroke will be shortened to correspond, and when a small piece of stock is in place, the stroke is lengthened to the proper degree, so that the full length of the saw blade is always in use, without any danger of the saw frame striking the vise jaws.

The arrangement of slotted link *A* pivoted in *B*, and crank pin *C*, forms a quick return motion which gives the saw a back stroke occupying only about one-third of the time taken by the cutting movement. This is owing to the fact that the crankpin is at the lower end of its travel nearest the fulcrum when the saw is returned, so that the motion is very rapid. The quick return movement is a valuable feature. In fact it allows about ten strokes more per minute than would otherwise be the case, without increasing the cutting speed.

An automatic device is furnished for stopping the machine when the stock has been cut in two. A friction drive is used which is disconnected at *H* by the dropping of the saw carrier and the arm. The saw carrier slides in babbitted bearings on the machined rectangular surface of the arm *E*. This gives a guiding surface which will wear for a long time without

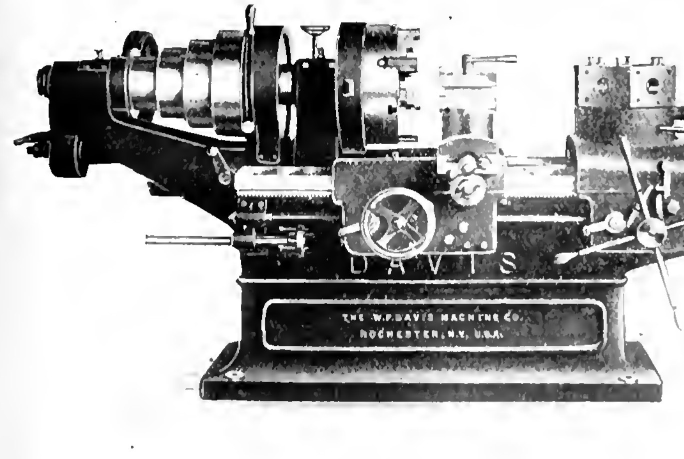
becoming worn or roughed up. The makers of this machine, E. C. Atkins & Co., Indianapolis, Ind., furnish it in three sizes, to cut stock 4 x 4 inches, 5 x 5 inches, and 8 x 8 inches.

DAVIS TURRET LATHE FOR BORING, FORMING AND TURNING.

This tool, built by the W. P. Davis Machine Co., Rochester, N. Y., will be found useful for work done in the large quantities required for the making of duplicate parts for interchangeable manufacture. Six or more operations may be performed on a piece without removing it from the chuck.

As may be seen from the half-tone, the lathe has an unusually strong and massive bed, with the head-stock cast in one piece with it. The spindle is driven directly, or through a quick acting triple back gear mechanism, from a 4-step cone. The front spindle bearing is 4$\frac{1}{2}$ inches in diameter and 7 inches long; the hole through the spindle is 2 inches in diameter. The cone pulley has steps of suitable width for a 4-inch belt. The back gear arrangement provides for a friction drive for connecting the cone directly with the spindle, and a positive clutch drive for engaging the back gears. The triple gear connection provided is not shown plainly in the cut, owing to the fact that the faceplate gears are covered with a guard. With the 2-speed countershaft provided, this gives 24 speeds to the spindle.

The feed connections for the carriage and turret slide are located inside the bed. A shaft is carried in the head-stock, connected with the spindle through the gearing shown at the left-hand end of the machine. A sliding key may be shifted by means of the lever shown at the end of the head-stock to give two changes of speed. The lever shown beneath the large step of the cone operates a sliding key controlling three speed changes given by a cone of gears beneath the main bearing. Six changes in all are thus provided for. The feed rod runs through the center of the machine to change gearing at the rear end of the bed, which may be set to give threads from 2 to 32 per inch, with the gears provided. These gears connect the central shaft with the splined leadscrew at the front of the machine. Either a screw feed or a rod feed may be used, for either the carriage or turret slide. The movement of the screw feed or rod



Turret Lathe of Rigid Design.

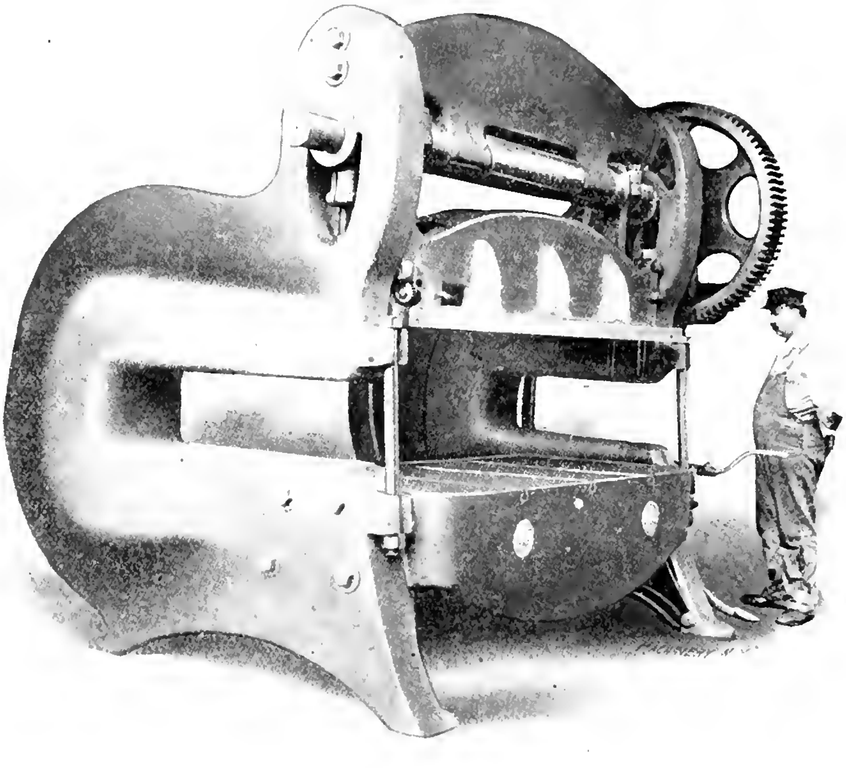
feed is reversed by bevel gears and clutches operated by the lever shown projecting from beneath the bed at the right of the apron. A later design provides for a foot treadle to control this movement at the front of the machine.

The turret has an open center, so that a mandrel can be passed entirely through it. The separate stops provided in the bed for each of the six faces of the turret act automatically, so that the feed may be tripped at any desired point. The carriage, which may be operated independently of the turret slide, has a 4-sided turret for carrying tools, which may thus be used for either turning, forming or facing. Separate stops for each face are provided on the rotating stop carrier on the front of the bed beneath the head stock.

This machine is regularly provided with a special heavy 4-jawed independent chuck, and with a friction countershaft having self-oiling pulleys lined with bronze bushings. The machine swings 26 inches, and its net weight is 7,000 pounds.

FERRACUTE PRESS FOR HEAVY CUTTING.

The heavy cutting press shown in the accompanying halftone was built by the Ferracute Machine Co., of Bridgeton, N. J., from designs of Mr. Oberlin Smith, president and mechanical engineer of the company. This machine is used for



Cutting Press of Great Capacity.

cutting shoe sole blanks from the largest and heaviest sole leather hides, 32 soles being cut at each stroke of the press. As it is run from 20 to 30 strokes per minute, the great capacity of the machine is apparent. It has a width of 7 feet between the columns, and a depth in the center of the ram to the throat of 3 feet, so it is adapted for work of large area.

The columns are well proportioned and calculated to withstand all ordinary stresses, the tie-rods at the front of the press being used only for exceptional work, where extra stiffness is required. The press is capable of safely exerting a pressure of 84 tons. All machines of this type now being built by the Ferracute Machine Co. are fitted with a multiple-disk friction clutch of new design, the result of much study and experience.

The dimensions of the press are as follows: Height, bed to ram when up, 14$\frac{1}{2}$ inches; stroke of ram, 2 inches; adjustment of ram, 3 inches; fly-wheel, 40 inches diameter and 7 inches face, weighing about 1,100 pounds. The total height is 9 feet. The floor space occupied is 11$\frac{1}{4}$ feet right to left, and 8 feet front to back. The total weight of this machine is about 20 tons.

The design of the press can be adapted, of course, to any line of manufacture requiring the cutting of heavy sheet material.

GOULD & EBERHARDT GEAR HOBBING MACHINE.

The accompanying half-tone and line cut illustrate a new machine designed by Gould & Eberhardt, Newark, N. J., for cutting spur, spiral and worm gears by the hob-generating process. In this process a hob is employed whose teeth have a normal section corresponding in outline to the rack of the interchangeable series of the gears which are to be cut. This hob is mounted in a swiveling head on a slide which can be fed downward along the face of the column of the machine. In cutting spur gears, the spindle is inclined to the same angle as that made by the teeth of the hob on the pitch line. This presents the normal section of the hob squarely with the axis of the blank to be cut, with the outline of the interchangeable rack, as previously described. The hob being set to the proper depth, and being connected with the blank by change gearing so as to give the proper speed ratio between the two, the hob and the work are rotated together, and the former is fed gradually down through the latter. When the hob has passed entirely through the work, the teeth will be all cut, of the required number, shape and depth. It will be seen that the continued rotation of the hob with its worm-like series of teeth, as it is gradually fed down through the work, generates the proper shape of teeth in the gear, the same as would be accomplished by meshing a rack of similar shape with a blank of some plastic substance like wax or clay.

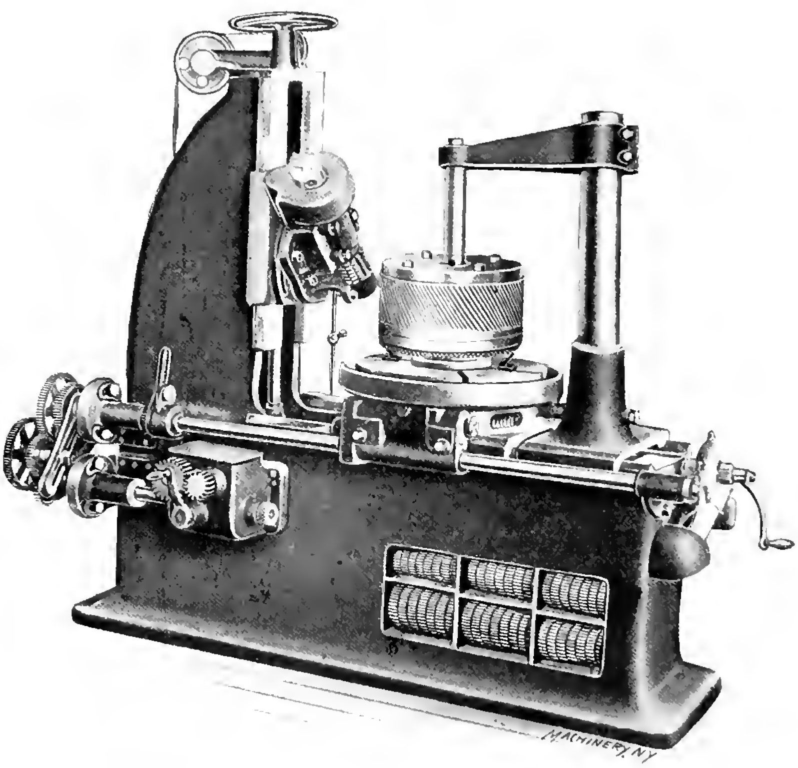


Fig. 1. Automatic Gear Hobbing Machine for Spur, Spiral and Worm Gearing.

The Spindle and Work Table Driving Mechanism.

The mechanism by which this is accomplished will now be described. In Figs. 2 and 3, *A* is the four-step driving cone. This is geared through a reversing mechanism (comprising the usual set of bevel gears and toothed clutches) to the vertical shaft which transmits the motion to the cutter head. Handle *B* operates the reversing clutch and gives the desired direction to the spindle *D*. A splined bevel gear carried by the head, and moving with it on the vertical shaft, acts in turn on a train of gears, and drives the spindle. As stated the hob is carried by a head *E*, which can be swiveled on the slide to any desired angle, the arrangement of the driving gears being such as to permit this. The hob can be adjusted endwise to bring any portion of its length central with the work, so that the wear may be evenly distributed along its cutting face.

The driving shaft, on which the cone pulley is keyed, is continued to the gear casing shown in front of Fig. 1, where it is made to drive the lower shaft running to the change gears back of the column. These change gears connect the spindle movement with a long shaft running along the front of the bed as shown, and geared to a worm, driving what may be called the "index" wheel of the work table *F*, although, strictly speaking, there is no "indexing" in this form of machine. These change gears are the ones which are set to give the proper ratio of movement between the hob and the work. If, for instance, the hob is double threaded, and the gear is to have 84 teeth, the ratio of movement between the hob and the work would be $84 : 2 = 42 : 1$, and the proper change gears for giving this ratio will be put in place.

Near the left-hand support of the long shaft driving the index worm in Fig. 1, will be seen a vertical handle operating a pair of tumbler gears, meshing with a larger gear almost concealed in the frame of the machine. This larger gear drives the feed mechanism, and the handle serves to reverse it for feeding in either direction. At the back of the column, not plainly seen in either of the cuts, change gears are provided for varying the feed, which is applied to cutter slide *C* by a vertical screw *G*, running the length of the column and terminating in the horizontal hand-wheel shown at the top. The slide is carefully counterweighted as shown, so that the only strain put on the feed mechanism is that due to the pressure of the cut. The feed screw is arranged to pull the slide when feeding, instead of pushing it, so that it is not at any time in the condition of a long slender column supporting a heavy load. This provision is markedly effectual in giving steadiness of action.

The gear casing with the vertical handle shown at the front of the machine in Fig. 1 provides a rapid traverse of the cutter head either upward or downward, as desired, and in accordance with the movement given to the handle. This rapid movement is directly connected to the driving shaft. At the rear of the machine is a vertical rod carrying an adjustable dog *H* which is struck by an arm on the saddle at the completion of the working travel of the cutter slide. This throws out the automatic feed.

The work table *F* is directly connected with the index worm-wheel instead of having the latter below the bed, as was usual in previous machines of this type. A double bearing is provided for the table and the gear, the latter being located centrally and supported near its rim, while the table itself has a second bearing under its outer periphery and directly below the work. This insures a rigid support to the gear blank. The cutter arbors are forced into place or withdrawn from their tapered seats by a differential screw arrangement, which does away with the necessity for driving them out from beneath. The table is supplied with a central aperture, so that pinions with long hubs can be inserted and held with suitable chucks. The chip guard is stationary and does not rotate with the table. By this means the carrying of the chips around the whole periphery of the work table is avoided. They are discharged, instead, into an opening in the bed directly beneath the cutting point. As in the regular automatic gear cutters made by this firm, the index worm is arranged to be thrown out of mesh with the worm-wheel, when so desired, so that the work may be rotated freely, as well as allowing the wear to be taken up. A fine adjustment of the worm is also provided, which is useful in setting gears accurately with the hob for recutting. The speed ratio between the worm and the worm-wheel is 60 to 1. This gives a strong and durable drive under the pressure to which the gearing is subjected when cutting, and does not require a high rate of speed when cutting small pinions.

Provisions for Hobbing Worm-wheels.

The machine, as so far described, will be seen to be adapted to the cutting of spur gears. To the machine as described, certain additions have to be made to adapt it to the cutting of spiral and worm gears. In cutting worm gears, for instance, the hob is fixed in the same position that the worm will occupy with relation to the finished wheel, and the hob and blank are rotated together with the same ratio that the worm and wheel will have. This ratio is obtained in the same way as in the case of spur gear cutting, by using the proper change gears. The additional mechanism required is for feeding work table *F* along the bed toward the hob. For this purpose, the screw by which the table is adjusted on the bed is provided with a worm-wheel driven by a drop worm, both being concealed in casing *J*. This worm is connected by bevel gears with a shaft running back to the feeding mechanism at the column end of the bed. A stop rod *K*, see Fig. 3, is provided with an adjustable dog which is engaged by the work slide when the desired depth of cut has been reached. This releases the drop-worm and stops the feed. Scale *L* is read by a vernier carried by the work table, and serves to give accurately the center distance between the work spindle and the hob spindle. This is useful in setting for spur and spiral gears as well as for worm gears. When cutting worm-wheels by this method, it is obvious that preliminary nicking of the blank is not necessary, though it may sometimes be advisable.

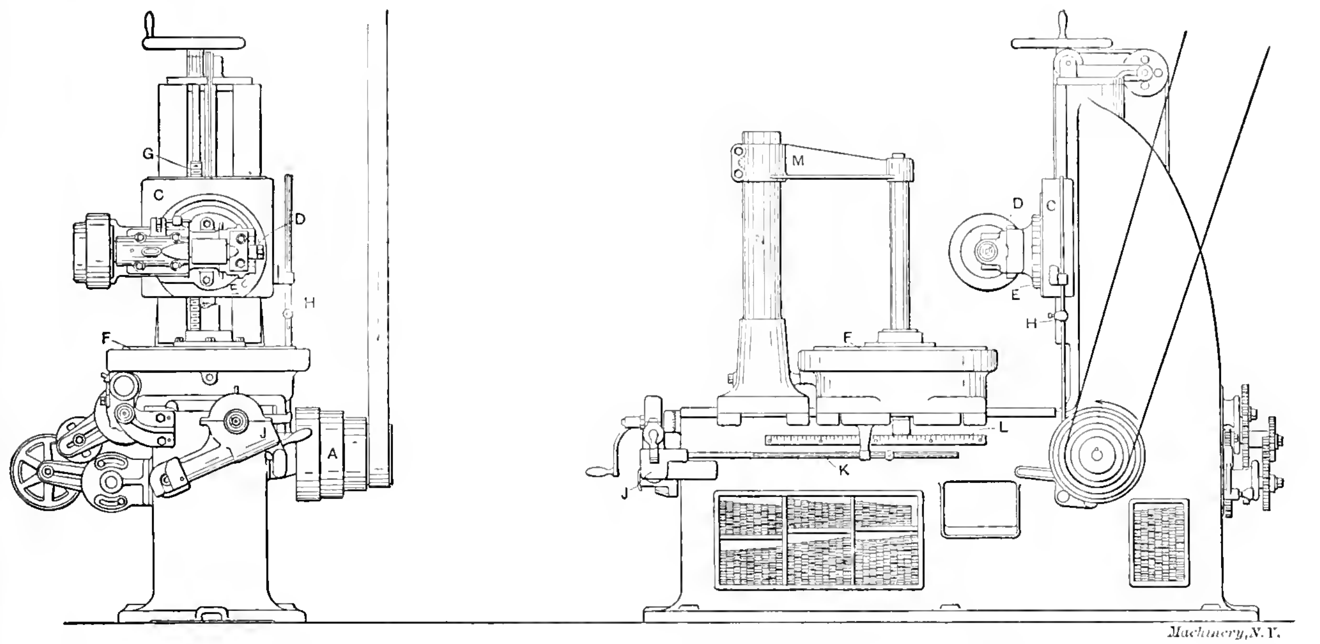
The Spiral Cutting Mechanism.

For cutting spiral gears additional mechanism has to be introduced. In this operation, the head is set so as to bring the teeth of the hob at the same angle as the teeth which are to be cut on the work. A movement of the work relative to the hob, or *vice versa*, is needed, such as would have to be given were the rotation of the spindle stopped, and the hob moved down through the work. It will be seen that in this case, owing to the inclination of the teeth of the work, if the teeth are to clear those of the hob, either the work or the hob would have to be rotated or shifted sideways. The mechanism for taking care of this requirement is not plainly shown in any of the cuts, as it is located at the column end of the bed. It is controlled by a train of change gearing, which is set to agree with the lead of the spiral being cut. With proper change gears for the lead and for the ratio between the hob and the wheel, the machine may be set to work cutting a bank of spiral gears as in Fig. 1, and will make a continuous operation of it, the same as when cutting spur gears.

All the various movements entering into this operation may be reversed at will, to accommodate right- and left-hand spirals, etc. In addition to this, the cutter head *E* may be swung around to the other side, above the horizontal, through an angle of 180 degrees. With this arrangement, the driving gear is always above the center line of the head, so that less clearance is required below the work. This means that the blanks can be held down closer to the table, giving less overhang and greater rigidity.

Rigidity in Design.

This matter of rigidity is of special importance in a machine working on this principle. The number of teeth at work at a given instant is much greater than is the case with a disk cutter in an ordinary automatic machine. This means that the pressure of the cut is much greater, with a corresponding increase of the strain on the machine. Under these circumstances, the number of joints between the cutter, spindle, and work must be reduced to a minimum, and the amount of overhang, as well, must be looked out for. In the present machines, for instance, the column is cast solid with the bed. The cutter is brought as near the face of the column as is possible with the various adjustments required. Mention has been made of the support afforded to the work table immediately beneath its outer rim, and above the worm gear by which it is driven. In addition to this, an outboard support is provided for the upper end of the work arbor. As shown, this support consists of an arm *M*, carried at the upper extremity of a vertical post *N*, which is seated in a base clamped to the ways on the top of the bed. This base may be fastened by a through bolt to the work slide, so that it is adjusted in and out with it.



Figs. 2 and 3. End and Side Elevation of the Gould & Eberhardt Gear Hobbing Machine.

Development and Scope of the Hobbing Process.

This process of cutting spur and spiral gears with a hob is not a new one, as it has been done since about 1850 in various ways, and by different people in Great Britain and continental Europe. The first step taken in this country of which we have any record, was the taking out of a patent by Mr. Geo. B. Grant, about eighteen years ago. This one as well as a number of others relating to this art have been acquired, or have been taken out, by Messrs. Gould & Eberhardt. In spite of the comparative oldness of the idea, however, it is only within the past four or five years that it has been applied commercially. Barring the Grant Lees machine, described in the October, 1907, issue of MACHINERY, there have been but two or three isolated cases of machines acting on this principle, none of them built for the trade. A number of considerations have stood in the way of the development of the idea. Perhaps the most important was the general satisfaction with the work of the automatic machine using a rotary disk cutter. Another factor was the necessity in the hobbing machines for unusual rigidity, only made possible with modern knowledge of machine tool designing

The development of the hobbing machine has also been seriously hampered by a difficulty in giving the proper shape to the teeth of the hobs. It has been found by experience that what would seem to be the theoretically correct tooth will not produce correctly shaped and noiselessly running gears under ordinary conditions. It is commonly found, for instance, that the teeth of such gears are unsymmetrical, even though the hob with which they are cut appears to conform in all particulars with the rack tooth which it is supposed to represent. The builders of this machine have investigated the matter thoroughly, and have arrived at a method of forming the hob which produces in the gear a tooth of the required shape. This feature has been covered by domestic and foreign patents.

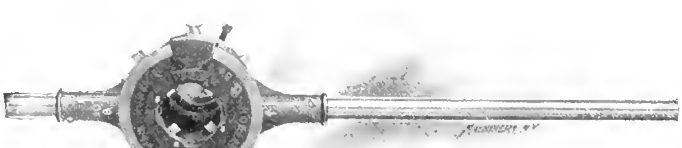
A strong factor tending to develop the hobbing machine in the past few years has been an increased appreciation of the merits of the "twisted-tooth" or "herring-bone" spur gear, for high speeds and smooth action. A largely increased use of this form of gearing has awaited a convenient means of manufacturing it. The making of helical gears in the universal milling machine is a comparatively slow and costly process. Numerous attempts have been made to manufacture them in better ways—such, for instance, as by making an automatic gear cutter, following the lines which have proved so successful for plain spur gearing. This involved the addition of a differential gear mechanism to the indexing parts (somewhat similar to that required on the hobbing machine), and in addition some device for dropping the cutter away from the cut on the backward or quick return movement, to prevent the cutting edge from striking on the finished sides of the tooth spaces. These conditions so complicated the already somewhat complicated machine as to render its commercial success doubtful. In addition to this, it involved the introduction of a number of joints, which tended to reduce the capacity of the machine for taking heavy cuts. A comparatively simple hobbing machine, however, will cut spiral gears as readily as spur gears, and seems to be the correct solution for this problem.

When it comes to the matter of cutting spur gears, its field has not yet been definitely determined. In some work it appears to have certain advantages over the usual type of automatic gear-cutting machine, while in other cases it falls behind. It will doubtless require continued use, with a variety of work, and for a considerable length of time, to determine just what cases are best suited for the hobbing machine, and what for the machine with the rotating disk cutter. It is not probable that in the future either of them will occupy the field to the exclusion of the other.

This machine will cut gears 24 inches diameter and 10 inches face. A larger and smaller size are in preparation.

HOEFER PIPE-THREADING DIE STOCK.

This device, made by the Hoefer Mfg. Co., corner Chicago and Jackson Sts., Freeport, Ill., is believed by its makers to solve all the difficulties connected with the operation of die stocks of ordinary construction. It is so arranged as to require but one set of chasers for a given pitch over a wide range of diameter. In addition to this, a thread may be cut



Improved Die Stock for Pipe Threading.

with this tool with a great deal less exertion than is ordinarily required. The reasons for this will be understood from an examination of the cut and the following description.

The chasers are very narrow instead of being wide and covering several threads. After starting them onto the end of a pipe, they are automatically withdrawn as the cut proceeds, giving the required taper. Owing to their narrowness, the great friction met with in the wide chasers of other dies is obviated, and the cutting is comparatively easy. The first three chasers divide the cut evenly between them, while the fourth takes a thin shaving cut, leaving a smooth thread similar to that which would be produced in a lathe.

The No. 8 size, shown herewith, is instantly adjustable from 1 to 2 inches in diameter. The dies can be set to the desired size by shifting a plate on the stock. This plate is then firmly clamped by a thumb screw which cannot slip, after which the stock is ready for immediate use. By simply relieving the dies, the tool can be taken off the work without fear of injuring the cutting edges of the chasers.

MULTIPLE TOOL BORING HEAD.

This tool, made by Melvin & Hamaker, of Meadville, Pa., embodies a number of novelties in its construction. Six blades, presenting six cutting edges, are used; and owing to

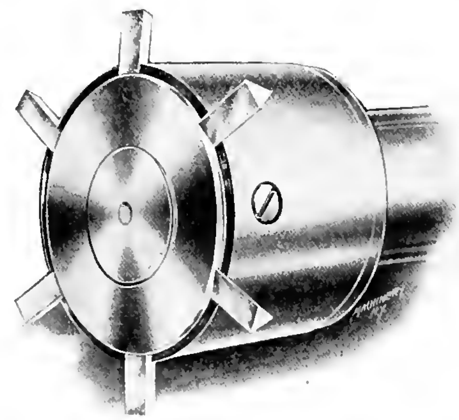


Fig. 1. Melvin-Hamaker Adjustable Boring Head.

the triangular shape of these blades, they may be reset in different positions to give new cutting edges when the old ones are worn. The tool is made in either of two styles, with blades adjustable for diameter, or fixed.

The blades are formed from steel having an equilateral triangular section, and are seated in grooves of corresponding shape in the body of the tool, which presents them to the work at the required cutting angle and with the required clearance. When one cutting edge is dull, the blade may be turned in its seat to present a new one. Three cutting edges are thus provided for each end of the tool, so that reversing it gives six cutting edges in all at one grinding. When the point of the tool is rounded to give a smooth finishing cut, four positions are provided for.

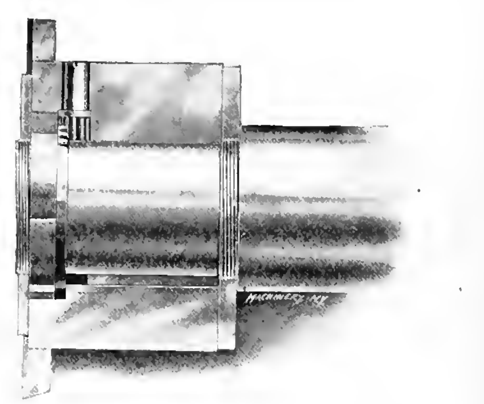
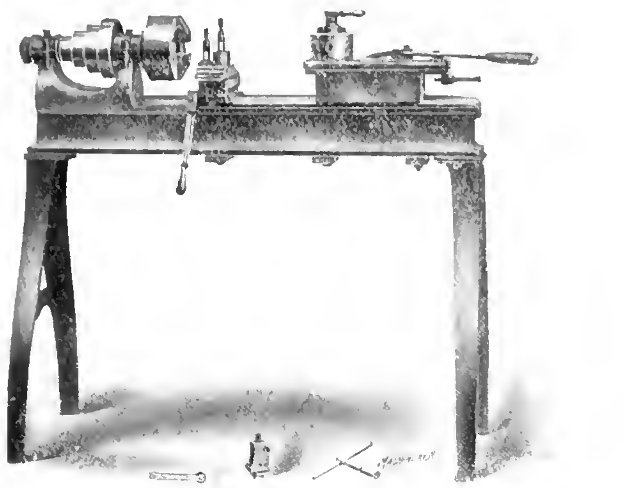


Fig. 2. Section of Adjustable Head, showing Construction.

The adjustable form of the tool is shown in cross section in Fig. 2. The bottoms of the blades seat against the corresponding faces of a cam. This cam is rotated by teeth on its left side, engaging with an adjusting pinion, operated by a screw driver slot in its upper end. A nut, threaded to the front of the shank, has to be loosened to make this adjustment, and is tightened down again after the required size has been reached, as determined by calipering over the outside diameter of the blades. This adjustment is furnished in the shell form of the boring head in sizes above 6 inches, and in the solid or machine type of head in sizes above 4 inches in diameter.

WELLS CHUCKING LATHE.

This chucking lathe is one of a line of turret machines which F. E. Wells & Son Co., of Greenfield, Mass., has recently designed. Like the other machines of the line, the head-stock and bed are cast in one piece, this being a distinctive feature of the machines made by this firm. This chucking lathe is intended for doing the machine work on small brass and iron castings, being adapted for doing work



Simple and Inexpensive Chucking Lathe.

which is generally done on much more expensive machines. The lathe is ordinarily furnished with a 4-hole hand-operated turret, but either a 4-hole or 6-hole automatic turret can be furnished if desired. Any kind of a 2-jaw scroll or geared chuck can be used, and if the customers work requires it, a 3-step cone for a 2-inch belt, or a 2-step cone for a 3-inch belt can be furnished in place of the 4-step cone shown. The bed is made in 3½, 4 and 5 foot lengths.

DOWN-FEED FOR STOCKBRIDGE SHAPER.

The advantage of the automatic down-feed on the shaper for work for which it can be used, is obvious. It enables

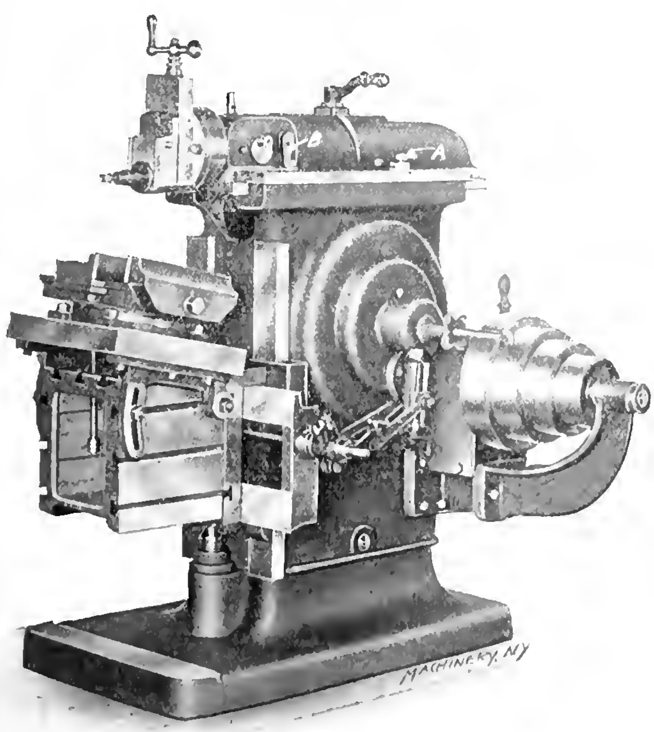


Fig. 1. Stockbridge Shaper with Patented Automatic Down-feed.

the operator to attend to other matters while the actual cutting is in progress, and it enables the tool to be used at its maximum efficiency, by giving it, uniformly, the heaviest cut it is capable of standing safely, at each stroke. With hand feed, this latter requirement is especially not met, since the amount which the handle is turned is bound to vary more or less with each stroke.

The attachment is shown applied to the machine in Fig. 1, and separated from it in Fig. 2. An adjustable dog A, is mounted in a T-slot on the upper surface of the holding-down gib for the right side of the ram. This dog engages with the lever B on the ram at the end of the return stroke, giving B a greater or less movement depending on the position in the slot at which dog A has been clamped. If, by mistake, it has been set too far toward the front, so that the backward movement carries lever B entirely over it, no harm results on the forward movement, owing to the fact that the acting portion of the dog is formed by a catch, pivoted and held in position by a spring. As the lever is going back over it under the circumstances just described, it is forced to one side, snapping back into place again ready for action as soon as the ram again returns.

Fig. 2. Mechanism of the Automatic Down-feed

Lever B, which receives an adjustable swinging motion by the means just described, is keyed to a short shaft having a bearing in the plate, and carrying at its inner end the disk D, having teeth cut in a portion of its periphery. This latter mechanism is best seen in Fig. 2. Disk D meshes with a similar one E, located on the stud C. An internal ratchet in E engages teeth on gear F, so that the positive movement given to lever B by the dog is transmitted through to this latter gear. A coiled spring about the axis of lever B and disk D returns these parts to their original position as the ram starts its forward stroke. It will be seen that this action gives to gear F an intermittent rotation, continuous in direction. By the pinion and bevel gears shown, gear F is connected to G, the down-feed screw of the machine. The ratchet connecting E and F may be engaged or released by a knob on the outside of the machine.

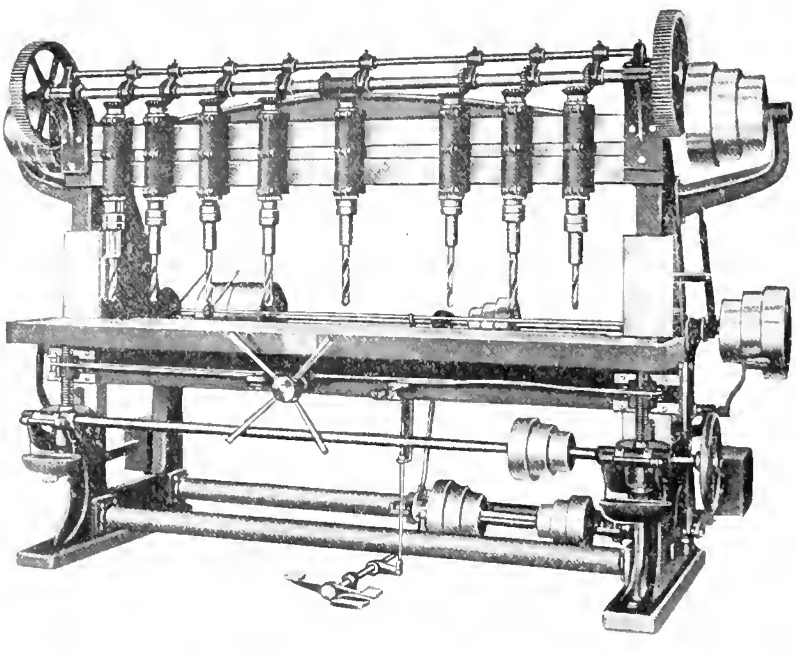
This machine will be seen to be practically fool-proof, positive in action, and simple and compact in construction. It is built by the Stockbridge Machine Co., Worcester, Mass.

ANDREW MULTIPLE DRILLING MACHINE.

This tool, as may be seen from the accompanying half-tone, is of the type in which the drill spindle heads are adjustably mounted on a long cross rail, and are spaced the distance apart required by the work in hand. The work is supported by a table, which is raised by a power feed to perform the operation of drilling.

This machine has been given unusual strength and rigidity by the judicious use of cast iron in the uprights, cross rail and table. The rail, in particular, is so designed as to prevent any

springing or twisting from the thrust of the drills, thus insuring true and accurate work. The spindles are driven from both ends of the machine by large 3-step cone pulleys, driving raw-hide pinions meshing into large spur gears, fitted to the main driving shaft. From this shaft cut steel miter gears transfer the movement to the vertical drill spindles. These spindles, mounted in heads adjustable along the rail, have each four inches vertical adjustment to allow the use of different lengths of drills, and to accommodate off-sets in bars and irregular work. This adjustment is made with a screw sleeve, which may be securely locked when set to the proper length. All the spindles are fitted with ball thrust bearings to reduce the power required to drive the machine. This is



Heavy Duty Multiple Drilling Machine.

especially important when it is being worked to its full capacity with eight 1¼-inch drills.

The table is carefully counterbalanced with levers and adjustable weights, and has a rapid movement by means of a steel rack and pinion which is operated from the pilot wheel shown in the front. This is independent of the feed movement, which is given to the table by vertical feed screws at each end, acting on split nuts of a construction similar to those used in the lathe apron. These nuts may be opened and closed by the action of a foot lever at the front of the machine. The screw feed is very powerful and also easily operated, ball thrust collar bearings being provided for each feed screw. The makers state that six changes of feed are provided, though the two sets of 3-step cones shown in the cut would lead one to the belief that nine changes are possible. An automatic stop is provided for stopping the feed when the desired depth of hole has been reached.

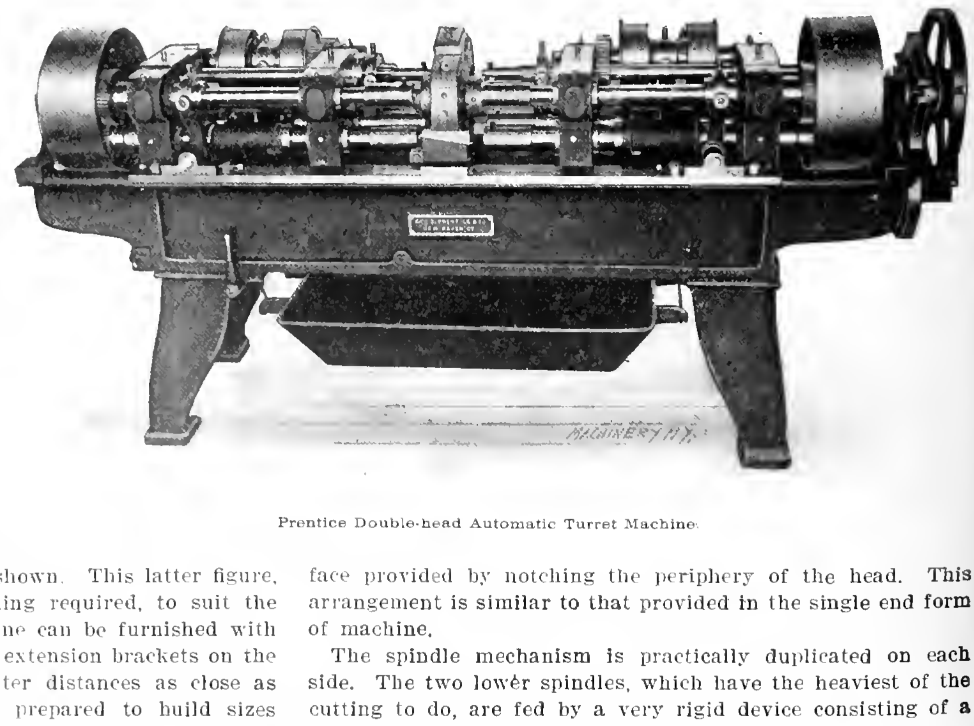
This machine is regularly built with eight spindles, having sufficient power to drill eight 1¼-inch holes in steel at one time. The spindles may be adjusted to a minimum center distance of 4 inches apart and a maximum center distance of 72 inches, in the machine shown. This latter figure, however, may be made most anything required, to suit the needs of the purchaser. The machine can be furnished with a sliding compound table; also with extension brackets on the rail to drill staggered holes at center distances as close as may be desired. The makers are prepared to build sizes both larger and smaller than the machine shown. It is built by M. L. Andrew & Co., 2850-2852 Spring Grove Avenue, Cincinnati, Ohio.

PRENTICE DOUBLE-HEAD MULTIPLE SPINDLE AUTOMATIC TURRET MACHINE.

In the December, 1905, issue of MACHINERY, we illustrated and described an automatic multiple spindle turret machine built by Geo. G. Prentice & Co., of New Haven, Conn. This machine comprised a head, carrying work holding chucks, and arranged to be indexed to as many positions as the design of the machine provided for. Facing each of these positions (except the upper one, which was left blank for inserting and removing the work) were placed rotating spindles, carrying the tools needed to perform the required operations for the work. The feed was effected by cam movements actuating the work carrying head, moving it slowly toward the spindles for the cutting stroke, and returning it rapidly to be indexed for a new position. It will be seen that this design made possible the performance of 3 to 5 operations, depending on the number of spindles, in the time that would ordinarily be taken by the longest of them on an ordinary chucking machine.

In the machine shown in the accompanying half-tone, this idea has been extended to adapt the principle to work requiring machining operations to be performed from each end. To accomplish this, the work holding head is stationary, so far as feeding movement is concerned, and is located in the center of the bed. At the right and left of it are carried the spindles, each opposite a station of the index head. These spindles are operated by cams on the cam shaft in the bed of the machine, for the feed and quick return movements. It will be seen that the principle of the machine is the same as before, except that the spindles have been duplicated at the right-hand side of the head, and that the feed movement is given to the spindles instead of to the work.

In the 5-station form of machine, as shown in the cut, the top position is left open for removing and replacing the work in the head, which latter is shown in the center of the machine. This head is supported against the rotative tendency, given to it by the cutting of the tools, by a wedge-shaped slide, which comes under it from the front, and bears on a surface provided by notching the periphery of the head. This arrangement is similar to that provided in the single end form of machine.



Prentice Double-head Automatic Turret Machine.

The spindle mechanism is practically duplicated on each side. The two lower spindles, which have the heaviest of the cutting to do, are fed by a very rigid device consisting of a yoke connecting each pair on each side of the head, and carry-

ing a cam roll bearing on the cam directly beneath it. This connection is so direct that there is very little side strain or cramping action set up. The first spindle, the upper one at the front of the machine at each side, is fed from the cam by a forked lever arrangement as shown. The fourth and last spindle on the back of the machine is for threading. This is driven separately from the countershaft, tight and loose pulleys with friction clutches being provided for the forward and reverse movements. A cam in the bed of the machine starts the die or tap properly for the first two or three revolutions. The continued forward movement of the threading spindle continues the threading or tapping operation until the proper depth has been reached, when the reversing clutch is thrown by the cam, and the die or tap is backed off or out.

The plan of the mechanism of the machine is simple. The first four spindles on each side are connected together by gearing, each side being driven by a separate pulley. The cam shaft of the machine is driven by a worm and worm-wheel operated by a pulley at the back of the machine, separately driven from the countershaft. Change gears are provided to give different rates of feed, depending on the material and length of cut on the work to be handled. A fast and slow movement for this cam shaft is provided, similar to that used in automatic screw machines of some makes. The right-hand end of the cam shaft carries the roll member of a Geneva stop motion, which is used to index the work-carrying head, whose spindle extends through the machine to the right and carries the slotted disk member of the mechanism. An index wheel of large diameter provided with a locking lever, also operated by the cam shaft, is used for definitely locating the head in position.

This machine is made in 6- and 8-spindle forms, both of which are furnished in three sizes—one for light work, one for ¾-inch pipe size threads and smaller, and one for work having pipe threads from ¾ to 2 inches. These machines vary in weight from 2,300 to 7,500 pounds. The machine is obviously useful in the finishing of pipe fittings, valve bodies, injector parts, etc., as well as in the general run of manufacturing work involving chucking operations, such as bicycle hubs and other work of a similar nature. Manning, Maxwell & Moore, Inc., New York, are selling agents.

THE BICKFORD UNIVERSAL RADIAL DRILL.

The machine illustrated in the half-tone, and described in the following paragraphs, represents a radical departure in design from the standard universal radial drill. The greatest novelty lies in the construction of the arm and the saddle. The changes introduced in the construction of these parts give the machine a rigidity of structure and power of driving mechanism which its builders, the Bickford Drill & Tool Co., Cincinnati, Ohio, believe have not been hitherto attained in any radial drilling machine.

A cross section of the arm is shown in the line cut, Fig. 2. As may be seen, it is composed of a double pipe section, each entirely enclosed, and thus capable of resisting great torsional stresses. The saddle has a bearing on the inner side, the front and outer angular face of a way on each member of the double arm. When the two handles *M* and *N* are tightened, gibs *X* and *Y* are drawn in, clamping the saddle firmly and independently to each of the two sections, and tying them and the saddle together in one solid structure. It will be readily seen that this construction offers possibilities in the way of rigidity not attainable with the older form of arm, usually made in U-form, as shown in Fig. 3, with an opening at the front through which the short intermediate shaft *D* passes, to lead the power from the arm shaft to the spindle. The cutting of this opening in an otherwise circular arm practically nullifies the ability of the circular section to resist torsion.

As is most clearly seen in Fig. 2, the back gearing and the reversing mechanism are located behind the arm. This allows the use of much stronger driving parts, and permits placing the back gears close to the spindle. The tapping attachment, also, is not subjected to so much strain, since the back gears can be located between it and the spindle, so that it is running at a comparatively high speed and transmitting a small turning movement. Besides this, the shafts can be made long enough to provide adequate bearings for them, insuring long life. This point will be particularly noticed in com-

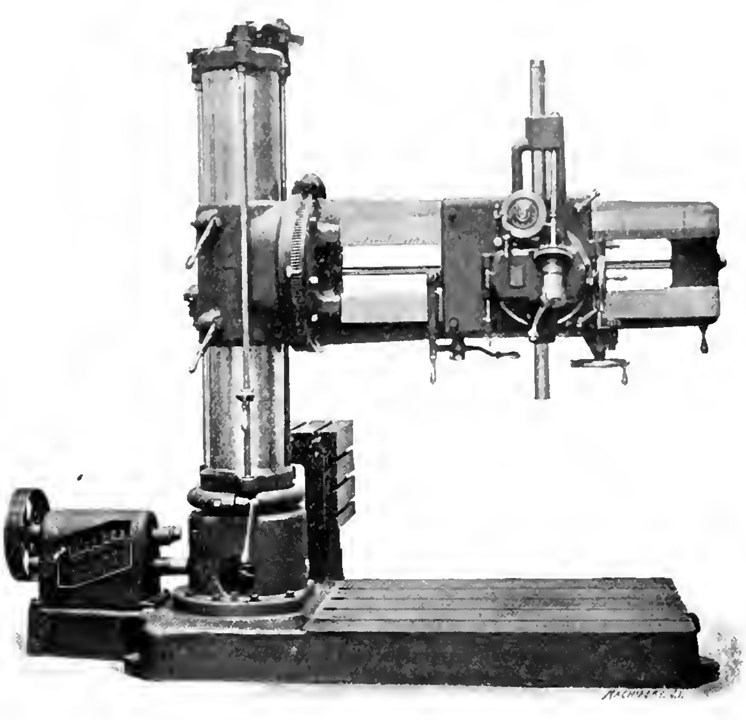
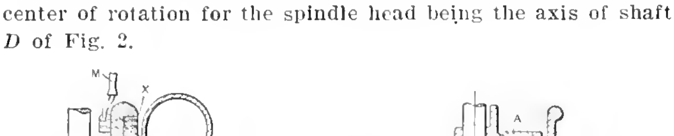


Fig. 1. Universal Radial Drill, with New Design of Arm and Other Features.

paring the new and old constructions in Figs. 2 and 3. The short shaft *D* in Fig. 3, as used in the old construction, will be seen to be very poorly fitted to perform its function continuously under severe duty for long periods of time. This is replaced, in Fig. 2, by shaft *D* working under conditions which could scarcely be bettered. The removal of the heavy back gearing and reversing mechanism from the top of the spindle makes the swiveling part very much lighter and less top heavy. It will be seen that the gear frame work does not revolve when the spindle is adjusted for angular position, the center of rotation for the spindle head being the axis of shaft *D* of Fig. 2.



Figs. 2 to 5. Improvements in Detail. Figs 2 and 4 show New Designs, Figs. 3 and 5 the Usual Construction.

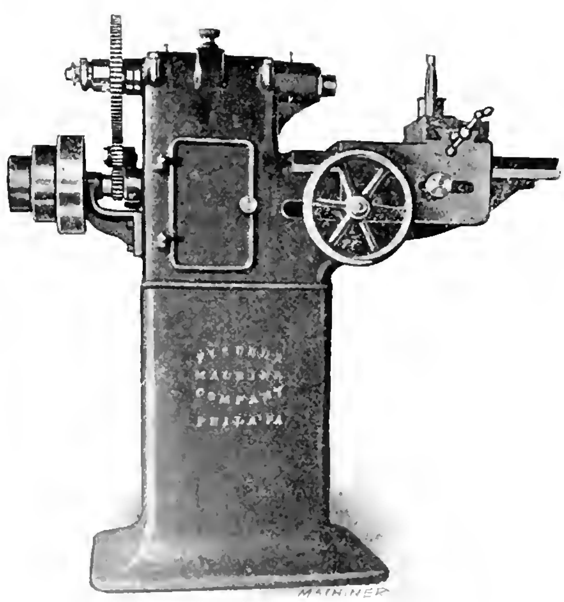
Improvements have also been made in the manner of leading the drive from the vertical shaft at the back of the column to the driving shaft in the arm. These are shown in Figs. 4 and 5, the former being the new arrangement, and the latter that previously used. In Fig. 5 conditions were such that the arm shaft *H* could not be located in the axis around which the arm was adjusted for the angular position. This necessitated the use of an extra shaft with gears *J* and *K*, to

bring the movement down to the axis. From J, an intermediate idler I on a stud completed the connection to the shaft carrying the bevel gear which meshes with the vertical shaft G at the back of the column sleeve. A glance at Fig. 4 will show the simplification effected. The intermediate shaft and gears I, J and K of Fig. 5 have been eliminated, by bringing the arm shaft and the axis of rotation of the arm to coincident positions, and the new design of arm permits this without destroying its balance.

Aside from the points mentioned, this tool appears to follow in its details the general practice of its builders. The facilities for handling the spindle movements, for instance, are retained. A depth gage is provided which enables the operator to read all depths of holes from a datum point at zero, doing away with the usual delays attending the operations of scaling or calipering. This also supplies a convenient means for setting the automatic trip provided, since the graduations show exactly where each dog should be located in order to disengage the feed at the required points. The automatic trip operates at as many different points as there are depths to be drilled at one setting of the work. In addition, it leaves the spindle free after any intermediate tripping to be advanced, raised or traversed its full length, without disturbing the setting of the dogs. It also automatically throws out the feed when the spindle reaches its limit of movement. Eight rates of feed are provided, ranging in geometrical progression from 0.007 to 0.640 inch per revolution of spindle. These may be instantly obtained by positive geared changes. The tapping mechanism permits backing out the tap at any speed with which the machine is provided, regardless of the speed used in driving it in. It is operated by a friction clutch, controlled by a lever whose handle extends around under the arm, within convenient reach of the operator, as shown in Fig. 1. The driving mechanism, positive geared spindle speed changing device, etc., are essentially the same as in previous designs. For a description of the speed changing arrangement, see MACHINERY for January, 1906. The speed box of this machine is similar to the one described in that issue, though a greater number of changes are provided for. Twenty-four speeds in all are obtained, each of which is instantly available. This machine is furnished either as a half or full universal, in three different sizes, with 4, 5 or 6 foot reach.

FISCHER OIL GROOVING MACHINE.

This machine is adapted to cut oil grooves automatically in bearing boxes, the lines of the groove forming a double letter O. The design of the machine is simple. The spindle



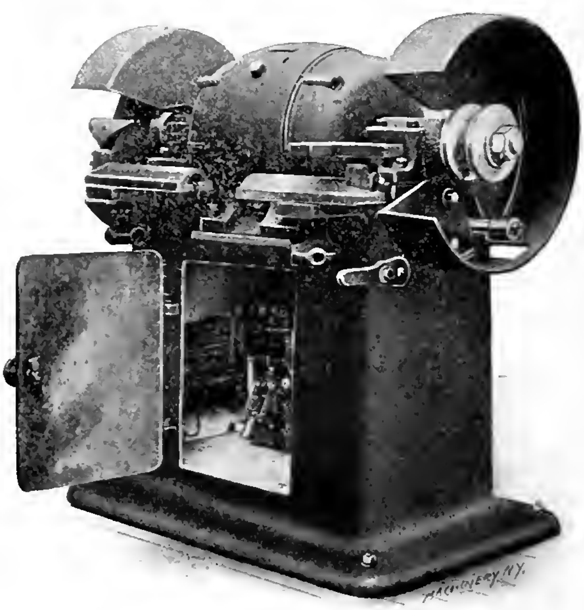
Machine for Cutting Oil Grooves in Journal Boxes.

is geared to the driving pulley, so as to give a slow movement to the work, which is held on a chuck or faceplate on the end of the spindle. The driving pulley is also connected with a crank, inside the column of the machine, whose connecting rod operates the slide. When the work is rotating, a boring tool placed in the tool post in the carriage, and properly adjusted to the work, will automatically cut out an oil groove of the shape desired, the controlling mechanism being such as to give the necessary movement. The resulting groove is made with a clear, clean cut, without the ragged edges and distortion of the soft bearing metal that often result from chipping. The operation is, as well, much more rapid than the hand process, while it can be performed by a "handyman" instead of requiring a skilled mechanic.

The spindle may be locked with a lever provided for the purpose, and the intermediate gear connecting it with the driving pulley disengaged, in which case the machine is adapted for cutting keyways on either side of the bearing. The crank connecting rod and gears driving it are enclosed within the machine, making a dust-proof and compact arrangement. The maximum limit of its adjustment, both as to diameter and length, is for boxes 5 inches in diameter by 5 inches long. This machine is built by Fischer Machine Co., 1217 Race St., Philadelphia, Pa.

SPEED CONTROLLER FOR ELECTRICALLY-DRIVEN GRINDERS.

The Ransom Mfg. Co., of Oshkosh, Wis., has devised a remarkably ingenious device for regulating the speed of elec-



Grinder provided with Device for Graduating the Speed to Suit the Diameter of Wheel.

trically-driven grinders to conform with the requirements for a uniform surface velocity for the wheel as it wears to a smaller diameter.

The device operates on the electrical speed controller, enclosed in the base of the machine. The contact lever for this is connected by link work to a rod passing through the base, parallel with the grinding wheel spindle. This rod carries at either extremity, on the inside of the column, arms having fixed to them studs with rollers extending through slots in the base, bearing on the periphery of the grinding wheel.

The operation of the device is obvious. By means of the handle at the right hand side of the machine, the roller is brought up until it touches or almost touches the grinding wheel. This movement, through the connecting link work, adjusts the speed of the spindle to correspond to the diameter thus gaged. It is evident that with wheels at each end of the spindle varying considerably in size, the speed should be adapted to the requirements of the larger of the two. This is automatically taken care of from the fact that in that case the roller bearing on the larger wheel determines the setting of the controller, it being impossible to bring the other roller into contact with the smaller wheel, since both arms are connected rigidly together.

This device can be attached to any of the motor-driven grinders for direct current made by the builders.

GARVIN AUTOMATIC TAP FLUTER.

This machine, built by the Garvin Machine Co., Spring and Varick Streets, New York, is an example of the way a standard machine tool may be adapted, with comparatively slight changes, to the automatic performance of repetition work, with a great saving of time and cost. As intimated by the name, the purpose of the machine is the milling of straight flutes in small tools, such as taps, reamers, etc. The modifications introduced comprise quick acting work holding apparatus, automatic index, automatic feed with quick return by a spring piston checked by air cushion, and automatic stoppage of the machine when the work is completed.

The machine itself is a No. 11 plain milling machine, with a rack feed. The rack pinion shaft is driven by a clutch on the rear end, from the power shaft inside the column. It is movable endwise, so that the clutch can be disengaged, being normally held in engagement by a spring. The handle shown at the front of the knee in Fig. 1 is clamped on the pinion shaft, and can be set in any position according to the travel desired. Its hub carries a small roller, not plainly shown in the cut, which engages a cam block fastened to the knee. With the handle adjusted to suit the length of feed desired, when this roller reaches the cam block, the rack pinion shaft is withdrawn and the clutch disengaged. A catch holds the clutch in the disengaged position. The table, being now free from the power feed, is returned to the other extreme of its travel by a spring enclosed in a tube shown at the rear of the table in Fig. 2. This rapid motion is checked before the table reaches its fixed stop, by the air cushion shown at the right in Fig. 1. This allows the motion to be reduced to a comparatively slow rate for the last fraction of its travel.

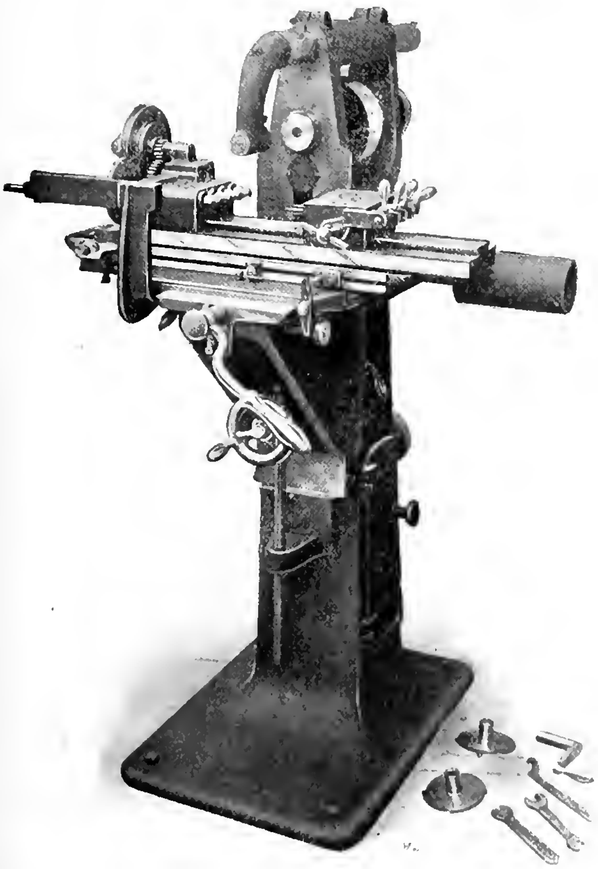


Fig. 1. Small Miller, arranged as an Automatic Tap Fluting Machine.

As the table approaches its extreme return position, the dog shown in the slot at the front engages the horizontal arm of a bell crank lever, whose other arm forms a detent engaging one of the teeth of the indexing ratchet, seen in both cuts. This ratchet is friction driven through the gearing and the pulley shown, a round belt leading to the latter from the countershaft for that purpose. The raising of the detent allows the work to be revolved one step. The attachment shown has four spindles, all geared together to move in unison. The foot stock has a corresponding number of spindles separately adjustable to suit slightly varying lengths of work. They are all clamped by a single handle. Just before reaching the fixed stop formed by the middle of the three dogs in the slot at the front of the table, the dog at the right releases the catch which held the feed clutch out of engagement. The feed is thus thrown in at the same instant that the movement of the table is arrested, so that there is no shock thrown on the clutch. The table again feeds forward and the same cycle of operations takes place.

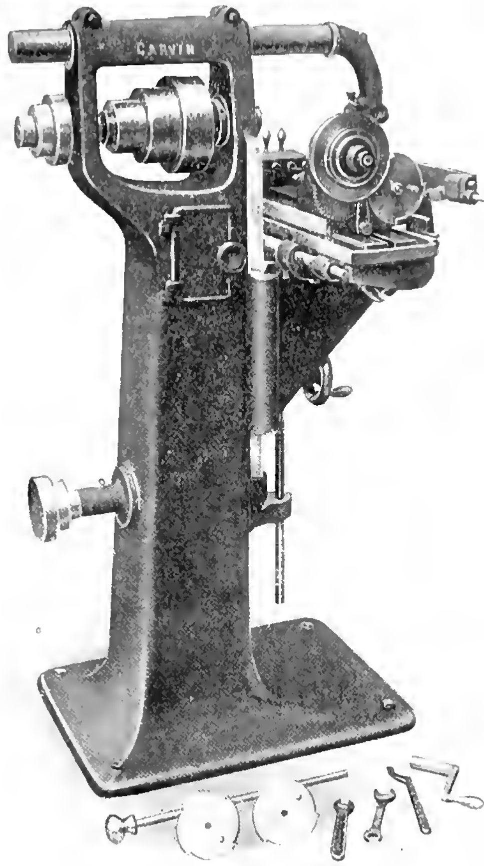


Fig. 2. End View of Tap Fluting Machine, showing Indexing Mechanism, Etc.

The countershaft is shifted by a spring, and a rope controlling this is attached to a pin on the left-hand end of the machine. There is a corresponding pin on the face of the index dial, and when the dial has made one complete rotation, it comes in line with the rope pin on the return stroke, pushes off the rope, and releases the countershaft so that the machine stops. This mechanism is seen mounted on a bracket attached to the left side of the saddle.

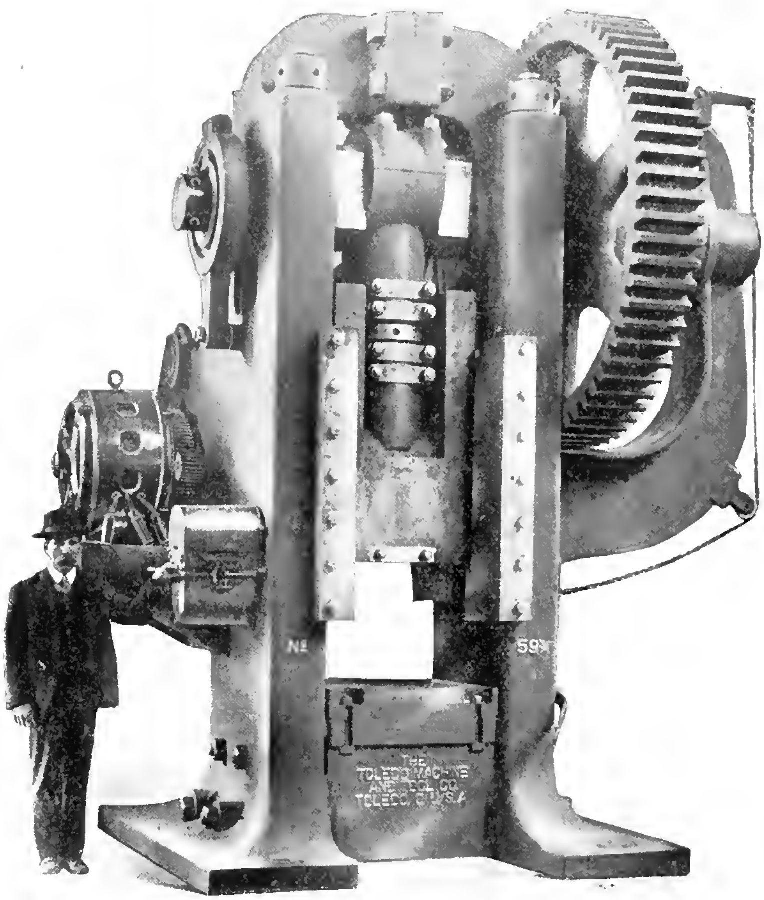
The four spindle centers are set $1\frac{1}{4}$ inches apart. The table has a feed of $3\frac{1}{2}$ inches, adjustable, as described, by dogs. The knee has a micrometer adjustment for depth of cut. The weight of the machine is about 690 pounds.

HEAVY TOLEDO STRAIGHT-SIDED PRESS.

This single pitman straight-sided press is built by the Toledo Machine & Tool Co., Toledo, Ohio. The massive proportions of the frame, connecting rod, and slide at once strike the eye. The construction of the frame is particularly interesting. This frame is made in three pieces, there being two side pieces and a separate bed, which rests on ledges planed on the inner faces of the side pieces, as may be seen in the cut. The bed and side pieces are held together by bolts closely fitted in reamed holes, passing through from side to side. At the top, over the crank, the side pieces are joined together with a tongue and groove fit, carefully made. The side pieces are reinforced for tensile strains by heavy steel rods, passing through from top to bottom inside of the housing and shrunk in position. It will be seen that this whole design is admirably fitted for the taking of heavy strains, the thrust due to the pressure of the die on the work being

transferred from the journals of the heavy crank, down through the straight side piece, to the ledges which support the bed.

The machine is intended for making steel stampings for automobile parts and similar work. Brake drums, ¼-inch plate, and similar flanged automobile parts are made with this machine. It has a capacity for working cold steel plate as heavy as ⅜-inch in thickness. By using cupping and reducing dies constructed to suit the work, the use of blank holders (which are commonly used and necessary on thinner metal) can be entirely avoided, thus doing the work to better advantage than other forms of presses used to make stampings from heavy plates



Heavy Electrically-driven Straight-sided Single Crank Press.

The machine can be furnished with a stroke as great as 24 inches. The one illustrated has a slide movement of 14 inches. It is fitted with a three-contact block clutch having automatic releasing mechanism with gravity control, eliminating entirely the use of spriugs, and giving a safer and more positive action. The motor shown attached to the machine is of 50 horse-power size. A large proportion of heavy tools of this class are now furnished with individual electric drive.

This press is one of a great number of sizes ranging in weight from 2,000 to 110,000 pounds, the latter being the weight of the machine shown. The weight of the flywheel is 2,000 pounds, and it has a diameter of 62 inches. The bed has an area of 38 x 38 inches. The extreme height of the machine is 196 inches.

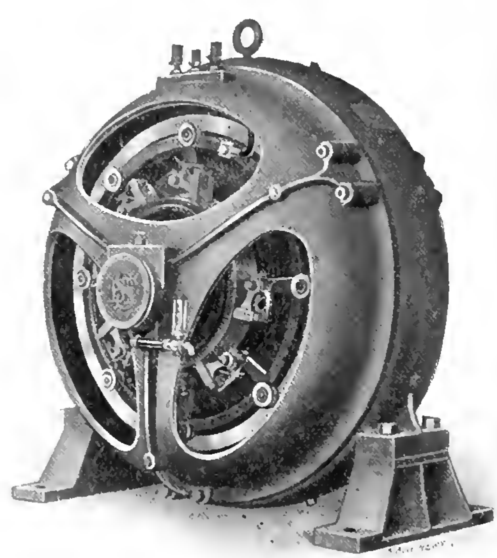
STURTEVANT TWO, FOUR AND EIGHT-POLE MOTORS.

The B. F. Sturtevant Co., Hyde Park, Mass., has recently developed a complete line of 2, 4 and 8-pole motors especially adapted to the driving of machine tools, fans, etc. The bi-polar motors are adapted to the driving of small high-speed machinery, and may be furnished either in the semi-enclosed or enclosed style. The frame (which forms the magnet ring) and the end casings are of cast iron, machine fitted together. The pole pieces are built up of steel plate, energized by field coils of double cotton covered copper wire, well insulated, and made oil and water proof by a special treatment, including baking for 24 hours at a heat of 212 degrees Fahrenheit. The bearings are ring oiling, self aligning, and are cast in the end casings, which are so designed that the motors may be placed on the floor, wall or ceiling.

The armature is of the toothed drum type having a core of thoroughly insulated soft steel plates slotted to receive form-wound coils. It is water-proofed by the same process as used for field coils. The commutator segments are of hard drawn copper, insulated with selected mica. The brushes are of carbon mounted in brush holders of approved form. The starting box provided with these motors is furnished with a "no-voltage release" which serves to automatically open the circuit when the supply of current is interrupted, thereby preventing possible damage when the current is again turned on.

The 4-pole motors are designed for a machine requiring greater output than can be obtained from the bi-polar machines. They are made in the enclosed, semi-enclosed or open type. The enclosed type can be operated continuously at full load, or temporarily at an overload of 50 per cent without undue sparking or heating. The temperature rise does not exceed 90 degrees Fahrenheit. The magnet frame of the 4-pole motors is of special steel with cast field cores having laminated pole shoes. Helical air ducts provided between the laminæ of the armature core act like the arms of a centrifugal fan, cooling and ventilating the windings. The same provision for water-proofing, and the same high grade of commutator construction as in the smaller machines, is used.

The cut shows an 8-pole machine. These have a lower rotative speed than those of the 4-pole type, and are well suited to the driving of large machine tools and for direct connection to blowers and exhausters. For this latter service they may (in the smaller sizes) be supported in a special annular plate bolted to the side plates of the fan, the fan wheel being overhung on the end of the motor shaft. The larger sizes are placed on a suitable steel plate base. They are built in nineteen sizes, having a maximum of 75 horse-power, when the motor rating is based on the horse-power delivered at 100 revolutions per minute. The smaller sizes may be furnished in the



Sturtevant Motor for Direct Driving of Fans, Machine Tools, Etc.

enclosed style by attaching three doors to the end casings. Special attention has been given to ventilation. Air is forced through and about the windings by specially shaped brass

blocks with radial arms, which act like the blades of a centrifugal blower. The air is drawn into the spider and exhausted through the core. For low speeds and high voltage the armatures are wire wound, while bar winding is used for other conditions. The same general methods of water proofing, commutator construction, etc., are followed as with the smaller sizes.

SAFETY SLIPPING DEVICE FOR MACHINERY.

The device shown in the two accompanying half-tones is intended to be used as a safety device in machines of various kinds in which it is required that there be some point in the mechanism which will yield before other parts break. It thus replaces shearing pins, friction slips and similar devices.

The construction is quite evident from Fig. 2, in which the device is shown taken apart. The shaft has keyed to it a body containing four holes, in which are seated springs, contained within hollow bushings which they force outward. These hollow bushings have at their outer ends spherical seats for four corresponding balls, which are thus pressed against the face of the gear mounted on the same shaft. Twelve seats for these balls are formed in the gear. In operation, the shaft will drive the gear or *vice versa*, so long as the force required is not so strong as to force the balls out of their seats in the web of the gear against the pressure of the springs which hold them to their work. This pressure can be regulated by means of the knurled nut shown on the back face of the body, which bears against plungers on which the springs are seated, and increases or decreases the compression which they furnish.

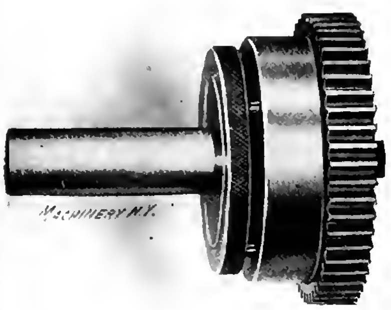


Fig. 1. Safety Slip Gear.

Simplicity and reliability are claimed for this safety device. It has the advantage over the shearing pin of not requiring to be repaired whenever it operates. It has the further advantage of being adjustable, by means just described, so that it may be set to agree with new conditions when conditions change. It is much more reliable than any friction device can be, since it is independent of the condition of the air as to moisture, temperature, etc. It is applicable to any mechanism liable to shock or sudden over-load, such as quick change feed and speed devices for machine tools, automobiles, etc., and will be found useful, as well, for electrically driven and automatic machinery of all kinds. It has been thoroughly tested and experimented with for over a year, in a great variety of uses. It is applicable to any machine without requiring radical change in design, and when once installed, requires no further attention. It is the subject of patents in this country and Europe. The device is made by the Yieldable Gear Company, Springfield, Ohio.

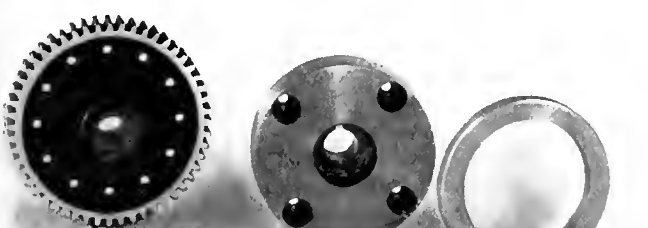
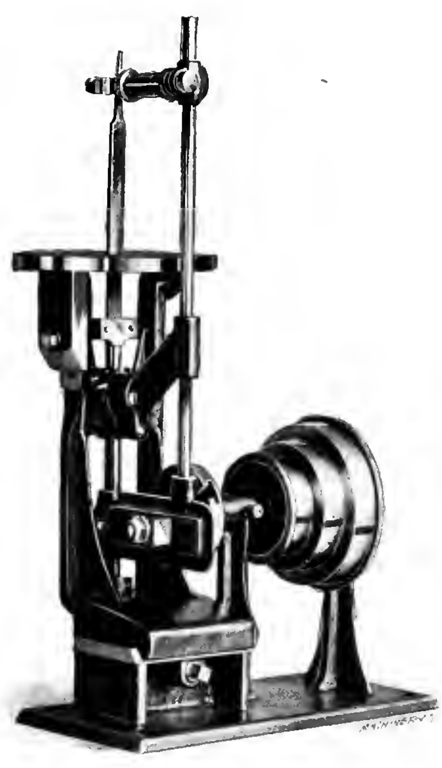


Fig. 2. Slip Gear Disassembled, showing Construction.

HARDINGE FILING MACHINE.

Hardinge Bros., 1034-1036 Lincoln Avenue, Chicago, Ill., are making the neat filing machine shown in the accompanying cut. One novel feature of the design is that the device may be used either as an attachment for the bench lathe, or as a machine by itself in the form shown in the cut.

As here shown, it is mounted on a base and driven from a cone pulley by slotted yoke and adjustable crank-pin. The square block on the crank-pin engages the slot of the yoke attached to the main plunger of the device. It also gives motion to a back rod extending up above the table of the machine and carrying an arm in which the tang of the file is clamped. The lower end of the tool is held by a clamp on the upper end of the plunger. The table is mounted on a pivot, and may be adjusted by graduations provided to swivel 20 degrees either side of the horizontal position. When used as an attachment for the lathe, the table supporting frame, with the plunger, back yoke, etc., is bolted to the ways, instead of to a special base as in the cut. The adjustable crank is mounted on the spindle of the lathe in the same way as the faceplate, and the whole machine is driven from the lathe spindle. In this way it may be used with Cataract, American Watch Tool Co., or Pratt & Whitney bench lathes.



Hardinge Filing Machine.

The table is 6 inches in diameter, and the maximum stroke is 2 inches. The device is made in a substantial manner, with adjustable take-up boxes properly protected from dirt, the same as with the Cataract lathe head. Besides being useful for a filing machine, it may be used with a jig saw in any experimental work with brass, or for jeweler's use with a fine saw, to cut out open gold or silver work.

FLATHER SIXTEEN-INCH GEAR-DRIVEN SHAPER.

This shaper, recently designed by the Mark Flather Planer Co., of Nashua, N. H., has a number of features which make a study of its design worth while. Aside from the quick return mechanism used, which was described in the March, 1907, issue of MACHINERY, other points of interest are the quick change gear device for varying the speed, the novel shape given to the bearing surface of the ram, and the design of the automatic down-feed.

The geared speed changing device will be readily understood from an examination of the half-tones, Figs. 1 and 2. The driving pulley has but a single diameter for a 4-inch belt and is keyed to a driving shaft having at its other end a long 16

tooth pinion. The change gear lever encircles this pinion, and carries an intermediate, meshing with it. By shifting the change gear lever from one to another of the holes provided for its index pin, the intermediate may be made to engage with any one of a cone of five gears, thus giving five speeds. This cone of five gears is connected to the shaft, on which the driving pinion of the crank disk is mounted, by two sets of gears, either of which may be engaged by shifting the lever shown at the top of the gear box. By this means ten changes in all are provided. This is more than ordinarily obtained from back geared machines driven by cone pulleys, and the drive is stronger as well.

All the gears in the gear box are of steel, cut from bar stock, each gear being cut with a cutter made for its exact number of teeth. As ordinarily equipped, the machine can be furnished with tight and loose pulley belted directly from the main line to avoid the necessity of mounting a countershaft on the ceiling. Another advantage of the gear box arrangement is that the machine may be changed to motor drive at any future time by simply attaching a motor to the rear of the column, and connecting it to the driving shaft with the proper chain or spur gearing.

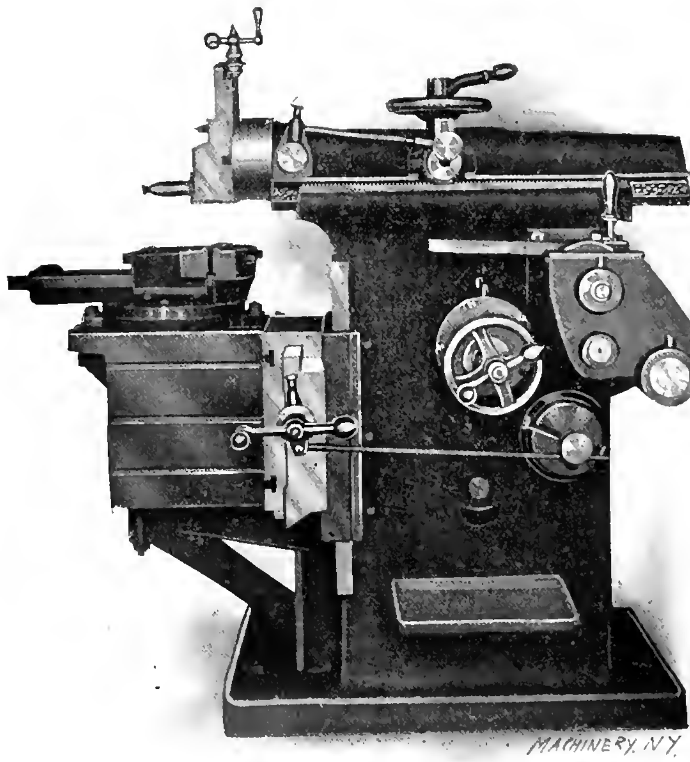


Fig. 1. Flather Quick-change Gear-driven Shaper.

The shape of the ram bearing surfaces is best seen at *A* in line cut, Fig. 3. They are formed to rectangular shape, but set at an angle of 45 degrees, so that the two under surfaces form Vs. The angular straps *B* bear on the third or upper surface, holding the ram down to its work. The advantages of this arrangement are that the alignment is kept by means of the V-way, and that gibs for preventing side motion are entirely eliminated, provision being made for taking up this motion by the simple tightening down of the straps on top. Ample provision has been made for oiling the ways by means of rollers at *C*, similar to those used for oiling the ways of planer tables. These run in oil pockets and are forced against the bearing surface by springs. Wipers are furnished at both ends of the ram bearing.

The automatic down-feed provided is also worthy of note. The strap *B* for holding the ram on the right hand side of the column has rack teeth cut in it, engaging with a pinion *D*, revolving loosely on a stud seated in a recess of the ram. By means of a friction device, held to its work by a spring as shown at *E*, this pinion gives motion to a slotted arm *F*, moving between fixed stops. The movement is given at the beginning and end of the stroke, and in the same way as the regular friction feed for the planer. The adjustment for the feed is also similar to that of the planer, the fulcrum moving in or out from the center to give a less or greater movement. From this fulcrum a rod leads to a ratch lever carrying a pawl, which may be set to give either an upward or downward feed to the head, through connecting gearing not shown in the cuts.

The table support shown in Fig. 1 is peculiar to this shaper. It is always in position and needs no adjustment. This makes it one of the most convenient and satisfactory table supports on the market. It is furnished with each shaper.

BLISS DOUBLE CRANK PRESS.

This press is one of specially massive design, necessitated by the growing needs of the manufacture of articles made from sheet steel. It is one of eight, built for heavy punching, shearing and forming operations. Aside from the magnitude of the press, (which will be appreciated from the dimensions given later) there are a number of details of construction which are worthy of note. The clutch is mounted on the main crank-shaft, and is of the automatic draw type with a positive lock, having three locking faces of hardened

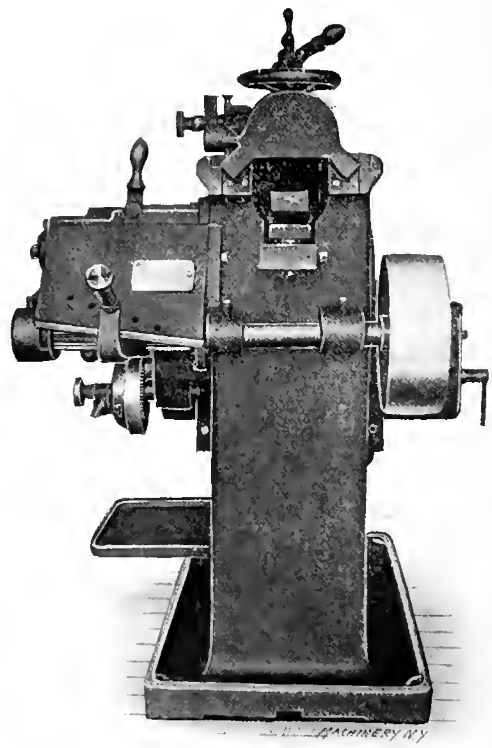


Fig. 2. Rear View, showing Speed Change Mechanism.

tool steel. It is positive in its action, and silent whether engaged or disengaged. The driving pulley is located at the back of the press in such a position as to decrease by a considerable amount the floor space required for the machine. The bottom knock-outs, shown beneath the bed of the press in the cut, are operated from the slide by two connecting rods, screw adjustment being provided for setting them at the proper height. The slide has an unusually long bearing in the frame and is adjusted simultaneously by means of the two threaded connecting rods operated by double pinions on the shaft connecting the two cranks. This insures at all times a perfect alignment of the slide in relation to the bed. A safety coupling, connecting the main driving pinion with its shaft, is provided to prevent the great damage that would ensue in the case of such accidents as the careless leaving of a bar or wrench on top of the die, an improper adjustment of the cross head, or the tripping of the clutch when the work has not been properly placed in the die. These accidents are liable to occur, and without the safety device shown, they would almost certainly result in a broken press body or broken tools.

The crankshaft of this press is 7½ inches diameter, and it gives a stroke of 8 inches. The fly-wheel is 60 inches in

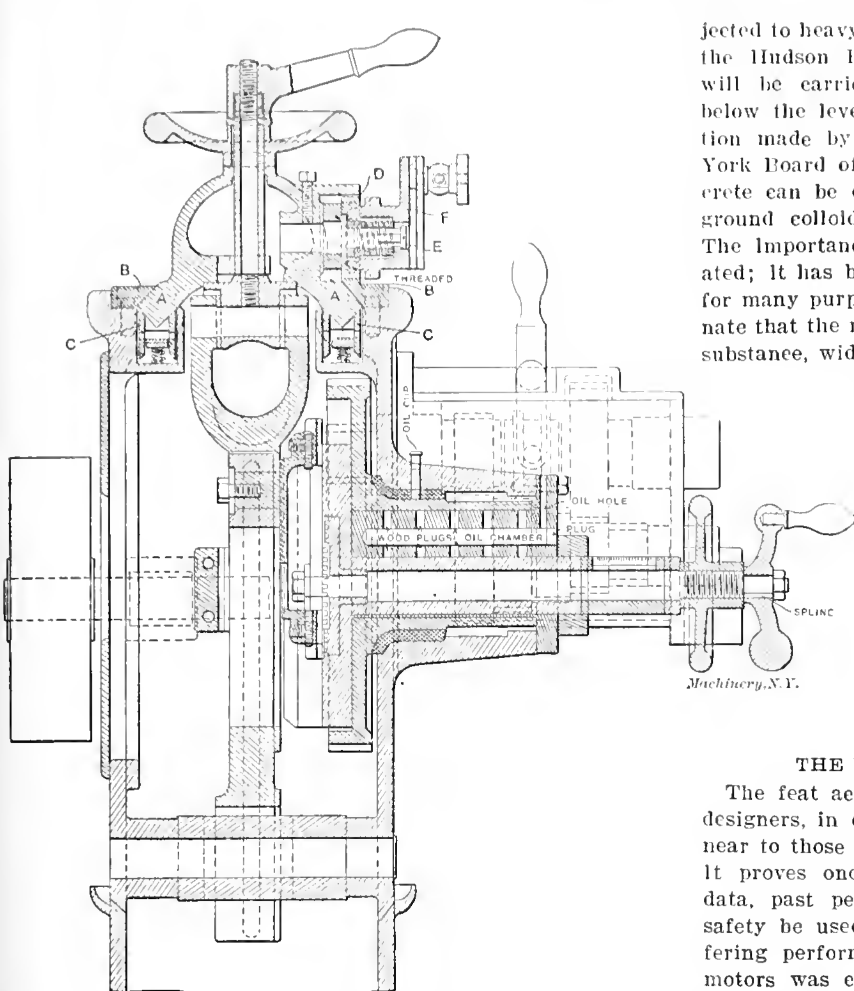


Fig. 3. Section through Ram Driving Mechanism of Flather Shaper.

diameter with an 8-inch face. It weighs about 2,000 pounds, and makes 195 revolutions per minute. The over-all height of the press is 137½ inches, and its total weight is 47,000 pounds. The bed is 24 inches wide by 97 inches long. This press is built by the E. W. Bliss Co., 5 Adams Street, Brooklyn, N. Y.

CARR REVERSIBLE CUTTING-OFF TOOL HOLDER.

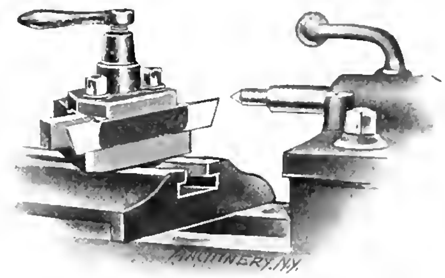
The cutting-off and side-tool holder shown in the cut is made by Carr Bros., Syracuse, N. Y. The construction followed is novel, and provides for holding the blade very rigidly. This is especially necessary in the case of the cutting-off tool.

As may be seen in the cut, the regular tool post of the lathe is used for holding the tool. The ring and rocker are removed, and the body of the holder is dropped down over the post. A key is then inserted through the holder into the slot of the tool post, and the set screw tightened down with a wrench as usual. This clamps the holder firmly in position. The cutting-off tool blade, after being set to project the proper amount for the work in hand, is clamped by a strap held down by two cap screws as shown. In changing from a right- to a left-hand tool, the holder is merely swung around 180 degrees to use the other end of the blade. For a right- or left-hand side-tool, the same device is used, but with the cutting-off tool blade replaced with a side-tool blade.

* * *

WATERPROOFING CONCRETE.

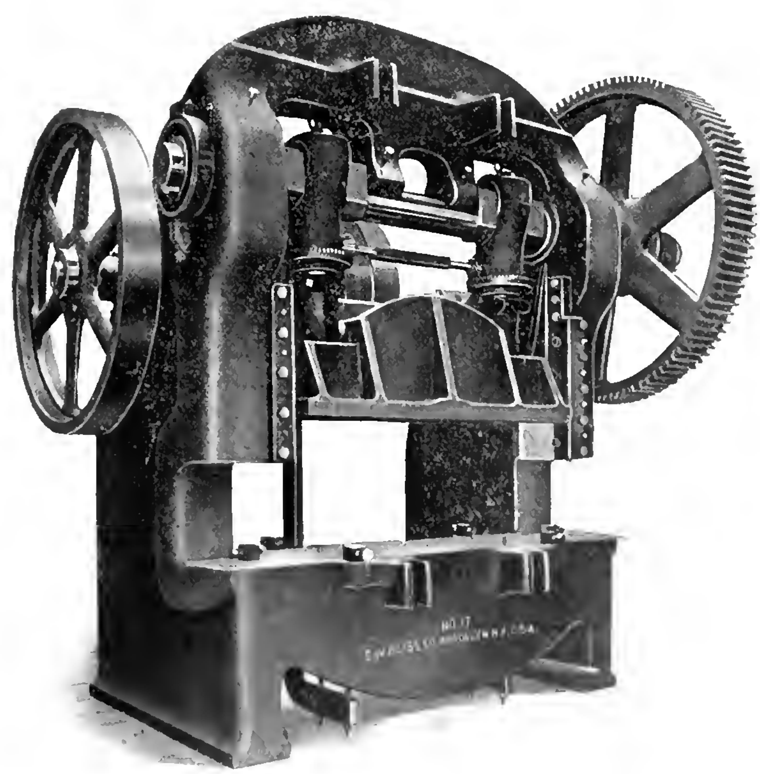
The great water supply system which New York City is constructing in the Catskills will cost about $161,000,000, and it will require years to complete it. Concrete will be used very largely in the construction of the immense dams and aqueduct, and it is highly important that the concrete be made waterproof, especially in the portions which are subjected to heavy pressure, notably in the inverted siphon under the Hudson River at Highland, N. Y. Here the aqueduct will be carried to a depth of something like 1,000 feet below the level of the river. It appears from the investigation made by Mr. Richard H. Gaines, chemist of the New York Board of Water Supply, that the waterproofing of concrete can be done by the use of 5 to 10 per cent of finely ground colloidal clay, intimately mixed with the concrete. The importance of this discovery will be generally appreciated; it has been a serious drawback to the use of concrete for many purposes, that it is permeable to water. It is fortunate that the material required for waterproofing is a common substance, widely distributed.



Cutting-off and Side-tool Holder for the Lathe.

THE PERFORMANCE OF THE LUSITANIA.

The feat accomplished by the *Lusitania*, or rather by her designers, in enabling her to make a speed within limits so near to those calculated, is one of great interest to engineers. It proves once more that, without access to experimental data, past performances of a similar character may with safety be used to accurately determine new and widely differing performances. In the first place, a class of driving motors was chosen for this vessel which had never before been applied to so large a ship, nor had any type of engine



Double Crank Press of Unusual Size.

ever been built with such enormous dimensions for ship propulsion. Notwithstanding the absence of information on the working of these machines, the engineers who designed them were able to determine the horse-power developed, as well as the speed with which this developed power would propel a ship of hitherto unequalled dimensions, within a limit of error, at the trials, of less than 2 per cent, the error being on the side of more, rather than less, power and speed.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

Though, taking the country through, the value of goods imported and exported still increases, in the engineering and allied industries the peak of the upward tendency would appear to have been reached, the present indications pointing to gradual retrogression. For the month of August, 1907, the imports show an increase of $2,037,240 over the corresponding month in 1906, and of $12,199,180 over those of 1905. The exports increased during the same period by $19,312,150 as compared with 1906, and $39,186,040 over that of 1905. Iron and steel, and manufactures directly connected, show, during the month, increased exports to the extent of $2,078,925. Cotton machinery, for which there is an unprecedented demand, contributed considerably to the increase.

Trade Union Activities and Labor Conditions.

As previously mentioned, a prominent topic here, for some time, has been the question of recognition of the official representatives of trade unions in a number of industries. At the moment, a movement is on foot among organized railway servants to insist on negotiations on matters of wages, working conditions, etc., being conducted by their accredited representatives in place of individual application and discussion. The directors of the principal railways are strongly opposed to the suggestion, but apparently this attitude is not to the liking of many shareholders and prominent business men, who have found collective bargaining to answer well in their private business. A ballot is being taken among the men as to whether they will strike as a protest against the refusal of their demands. For the time being, questions of wages or hours are subordinated.

On the other hand, the Shipbuilding Federation has handed notices of a lock-out to about 40,000 shipbuilders and boilermakers, who, as the result of a ballot, decided—against the advice of their officials—not to accept the employers' proposals that all labor disputes should be considered and settled by representatives of employers and workmen, without stoppage of work in the meantime. The employers have suffered considerably in the past through workmen in this branch throwing down their tools and leaving work without consultation with, or authorization from, their trade union executives. It is probable that the men will take another ballot, and, as many men did not vote on the first one, the previous decision will very likely be reversed. In any case, considered simply as a matter of expediency, they will be wise in doing so, as the employers are in a strong position, and have chosen a favorable time for settling the matter. Though just now a larger tonnage of shipbuilding has been placed on the Clyde than during any corresponding period, some time will elapse before it is ready to be dealt with in the yards, and on the East Coast one or two of the largest concerns have scarcely an order on the books, the influence of the depression extending to the drawing office staffs, which have been reduced to a quite unusual extent.

The Shipbuilding Industry.

At Devonport, the *Temeraire* was launched on August 24. Her length and width, like the previously launched *Bellerophon*, are 490 feet and 82 feet, respectively, and her displacement 18,600 tons, or 700 more than the *Dreadnought*. Turbine engines will give a speed of 21 knots. She will carry ten 12-inch guns, as compared with eight on the *Dreadnought*. Orders have just been given at Portsmouth for another *Dreadnought* of 19,300 tons, and a similar vessel is to be built at Devonport. The last two vessels will be armed with 13-inch guns, the heaviest carried in any navy.

The trials of the *Mauretania* are just commencing, and indications point to very satisfactory results. Though built on the general lines of the *Lusitania*, there will be a number of alterations in details.

Cotton Machinery.

As mentioned earlier, textile machine builders are extremely busy, more especially in the cotton section. It is rather surprising that American builders do not make a better show in this connection as regards export business, as the conditions are all in favor of repetitive methods, the various details being mostly made in lots of many thousands. Prices have also been advanced considerably during the last year or so. During average times, however, it is wonderful at how low a cost really good and well-finished machinery in this line is produced and sold. One reason for this possibility is, doubtless, the fact that the population in the districts where cotton goods are manufactured, and the requisite machinery built, is very stable and apt, machinery having been built alongside its manipulation since the commencement of the industry. A considerable proportion of the most modern machine tools has recently been installed in the textile machine shops, and the splitting up of processes into individual operations on very simple machine tools has been carried to a high degree of efficiency. A machine which appears to lend itself to this class of work with excellent results is the Potter & Johnston automatic turret lathe, with magazine attachment, especially on wheel blanks, pulleys, etc. For the manufacture of the rings used on frames for ring spinning, the "Ajax," an American forging machine, turns out a very superior article as regards homogeneity at a wonderfully quick rate, and without waste of material, as the ring is upset to outside diameter from a bar of the same size as the hole afterwards punched in, the ring being forced off its core, which is thus available for the next ring forged. These rings are now made from mild steel bar, and after boring and turning, are case-hardened and highly polished. They were formerly made of malleable iron, but drop or press forgings in mild steel are found superior and cheaper. For hardening the rings after carbonizing, the Brayshaw furnace (see MACHINERY, January, 1905), which utilizes a bath of liquid salts, the temperature of which may be ascertained and varied to a high degree of exactitude, is found very well adapted. Many of the smaller castings used in the business are annealed by packing them, in suitable pots, with cast iron turnings and leaving them over night in a heating furnace. The ease of subsequent manipulation of the castings and the longer life of the tools amply justify the cost of annealing.

Automobile Industry.

The building of motor-cars now appears firmly established in Great Britain, the imports from the Continent having greatly decreased relatively to the total output, coincidentally with a decided increase in British exports in this line. However, there are indications that the facilities for the manufacture of cars built for the luxury trade are now more than sufficient, and the needs of the less wealthy are receiving attention. Continental makers are also making a study of the problem. The Royal Automobile Club is now carrying out a valuable series of trials of commercial vehicles. The various classes travel by a route which tests the characteristic features of each class, and at certain towns the whole of the vehicles are on view a day or two, thus giving prospective users an opportunity of comparing the merits of the different designs. From point to point the routes are so arranged that the heavier types travel the shortest distance, and the lighter ones travel a roundabout journey, so that all have practically the same duty to perform. The report of the trials—the methods employed on which are approved by both builders and users—will be of considerable commercial value.

Iron and Steel Industry.

Mention has previously been made of improvements adopted by British iron and steel works during the last few years. At the large works of Sir Bernard Samuelson, near Middlesboro, two steam turbines, each capable of giving a normal output of 1,350 K.W. at a speed of 2,400 R. P. M., are being installed. They will work from the exhaust steam of blowing engines, which have previously worked non-condensing. Portable machine tools increase in size and adaptability in every tool-using country, and in this connection may be mentioned a portable facing machine for gun turrets, swing bridges, turntables, etc., built by John Hetherington & Sons, Ltd., Manchester, which weighs 33 British tons. An old engineer commenting on this and other recent tools of this class, stated that in his younger days portable tools were mostly represented by ratchet braces, screwing tackle, etc. He could understand Mahomet going to the mountain when

the mountain refused to come to him, but when Mahomet started getting bigger than the mountain, our friend thought it was almost time to give such machines a fresh title.

J. Butler & Co., Halifax, have introduced a line of girder drilling machines for handling work up to 30 inches by 24 inches by 60 feet long. The machine has six heads, and roughly resembles a traveling head shaper with six heads. The machine has been very successful drilling holes in straight or zigzag lines, each head having automatic stop and withdrawal.

In the September, 1904, issue of MACHINERY, there was illustrated and details given of a 12, 14 and 18-inch swing lathe as built by Clark's Machine Tool Co., Ltd., Luton. As may be remembered, these lathes come about halfway between the ordinary lathe and the special turret lathes, lending themselves to both repetitive and general work, the bore of the spindles being quite large relatively to the height of centers. A 20-inch swing lathe recently produced by these makers will pass 4½-inch black bars through the spindle, and has ample power for dealing with this diameter. As in previous examples, the spindle bearings are placed diagonally, with the idea of giving a double adjustment, and relieving the strains on the cap bolts. Detail improvements have also been introduced into the screw cutting arrangements, allowing of specially coarse threads being cut without risk of breakdown. As in the other sizes, the spindle of the loose head is arranged, when desired, for automatic boring. The back rest for carrying cutting-off or forming tools is detachable from the front rest, allowing a larger diameter of work to be turned in the ordinary way, the front four-tool turret rest remaining as before. The weight of the lathe has been increased, and, generally, the lathe appears likely to give a good account of itself. JAMES VOSE.

Manchester, England, September 30, 1907.

MISCELLANEOUS FOREIGN NOTES.

THE EXHIBITION IN TOKIO IN 1912.—The Japanese authorities have now begun in earnest to make arrangements for the great international exhibition to be held in 1912, and they are setting about their work with that thoroughness which has characterized all their performances of late years. The exhibition is primarily intended for the promotion of education and industry, but is expected to be an important link in the good feeling between the Japanese and western nations. The exhibition ought to be the means for furthering the trade of our own nation in Japan.

THE TANGYES, LTD., Birmingham, England, has placed on the market a high-speed motor driven radial drill which embodies several improvements. The spindle is 3 inches in diameter and bored to receive a No. 5 Morse taper. The working radius is from 1 foot 9 inches to 5 feet. The spindle has 16 speeds, varying from 10 to 300 revolutions a minute, and automatic feed with four changes. An automatic stop is provided for the vertical motion of the spindle. The vertical adjustment on the column is 2 feet 8 inches. The base plate of the machine is about 6 feet long by 4 feet wide. There is also a small table placed on the base plate and revolving about the column. This table is 2 feet 6 inches long by 2 feet wide, and is provided with T-slots on the top and sides.

PERMANENT MUSEUM FOR SAFETY APPLIANCES IN BERLIN.—The permanent exposition for safety appliances in Charlottenburg, near Berlin, has now been opened for three and one-half years. As the material of the exposition relating to hygiene and safety appliances for machinery has considerably increased during these years, the German government has appropriated $45,000 for the erection of additional buildings. The constantly increasing interest taken in the matter of safeguarding the life and health of industrial workers in Europe, as well as on this side of the Atlantic, is one that merits attention, and it is gratifying to notice the great change that has taken place in public opinion of late years in regard to this matter.

INDUSTRIAL AWAKENING IN SPAIN.—While the American war on the one hand, and the political changes due to it on the other, dealt a crushing blow to the credit of Spain, and many foreign dealers, in view of existing difficulties, refused to trade with the country, conditions of affairs are now settled, and the prospects are very much different. The government as well as leading individuals in the industrial world are making every effort to regain the economical prosperity of the country. The imports and exports have trebled in the last ten years. There, as in Italy, mechanical industries are commencing to flourish, and while at first exporters may not expect very great trade, it would be well for machine dealers to keep an eye on the future possibilities for their trade in that country. The immense natural richness of the peninsula, which have not yet received the attention that similar natural resources have received elsewhere, are about to be exploited, and Spain no doubt will, within a few years, show an industrial awakening the same as has Italy.

ELECTRIC STEEL FURNACES IN GERMANY.—In our foreign notes of our September issue we mentioned that a Kjellin induction furnace, having a capacity of 24 tons, had been installed at the Rœchling Iron & Steel Works, Voelklingen, Germany. We have been informed by the Gesellschaft für Elektrostahlanlagen, Berlin, which firm possesses the patent rights in Europe of the Kjellin and Rœchling-Rodenhauser induction furnaces, that, while it is possible in the course of time these furnaces may be made with a capacity of 24 tons, the statement that such was the case in the installation mentioned was not correct. At the present time the furnaces have capacities of only 3 and 8 tons, respectively.

MESSRS. THOMAS ROBINSON & SON, LTD., of Roachdale, England (as reported by *Engineering* of London), have recently completed a machine which can be described in no better way than by calling it a gigantic pencil sharpener. Most of us are familiar with the five-cent hollow cone with inserted blade, which is sold for a pencil sharpener in most stationery stores. This machine has a similar hollow cone, revolved by powerful gearing, with a series of inserted blades acting in exactly the same manner as the tool of our schoolboy days. It is of such size, however, as to be able to sharpen a "pencil" 28 inches in diameter, if necessary. Of course, it is not used for pencils. The machine is built for the harbor works of Rotterdam, Holland, and is to be used in sharpening piles, which are afterward shod with iron shoes. The whole tapering head is arranged on a slide, which is moved forward by a belt-driven feed motion. Suitable clamping devices are provided for supporting the end of the pile. A timber 20 inches square can be tapered in about 15 minutes, the diameter left at the point being 5 inches.

GERMAN MACHINE TOOL TRADE.—The Association of German Machine Tool Builders has given out the following statement for the second quarter of this year. The business was on a firm basis, and employment of workers in the machine tool branch was steady. There was and is a lack of skilled labor, which is charged to the desire for young men to try to earn at once more money than can be paid to apprentices in the machine tool business. The automobile business has also deprived the machine tool builders of many of their best men. Wages have either increased, or at least been permanent, during the first part of this year. From 1901 to 1905 there was an increase in wages of 40 per cent in many districts. The ordinary length of the working day is 9½ and 10 hours, but it has been necessary to require the men to work overtime in many cases, in order to be able to keep up with the demand for machine tools. Consul-General Richard Guenther, of Frankfort, Germany, reported some time ago that at a meeting of a committee of the Association of German Machine Tool Builders, the present business conditions were said to be excellent. The works have orders for a long period ahead, and the increases in prices of machines, due to the prevailing conditions, have not met with any difficulties, nor caused any decrease in the sales. The foreign competition, particularly that from the United States, however, is very keen, and the prices, particularly for medium size and small foreign machines, low. There is a strong tendency for greater specialization in the manufacture of machine tools, this being necessary for meeting on an equal basis the American competition. By adopting American methods the Germans consider that they will be fully able to keep up with the competition, although they do not expect to be able to eliminate it in any way.

NATIONAL MACHINE TOOL BUILDERS' CONVENTION.

The sixth annual convention of the National Machine Tool Builders' Association was held on October 15 and 16 at the Hotel Imperial, New York City. The meeting was addressed by President E. M. Woodward, of Woodward & Powell Planer Co., Worcester, Mass. In the course of his address he referred to the benefits resulting to machine tool builders from the existence of the association, which has brought them into close contact, promoted friendly feeling, and made cooperation possible. Secretary P. E. Montanus, of the Springfield Machine Tool Co., of Springfield, Ohio, spoke of freight charges on fractional car loads. He pointed out the injustice of the present regulations, which oblige manufacturers to pay excessive freight charges on fractional car loads, even when they form part of a large shipment to the same consignee. For example, if a machine tool builder has four planers to ship and a car will accommodate only three, a second car is required for the extra machine, and the additional freight bill is out of all proportion to that for the others. Mr. Montanus argued that under such conditions the manufacturer should receive the benefit of the car load rate on the entire shipment, and that he should not pay a high rate on a part when it happened that one car has not sufficient capacity for the entire shipment. A standard apprenticeship agreement known as the "National Machine Tool Builders' Apprenticeship Contract" was adopted, subject to the modifications necessary to conform to various State laws. It was further decided that a standard diploma would be used for apprentices upon the completion of their terms of service. The need of special apprentices or operators trained to do one kind of work was discussed and action taken to provide for them.

The association is in a prosperous condition, eighty-one concerns now being members, eleven new ones having been added at this meeting, as follows: Aurora Tool Works, Aurora, Ind.; Champion Tool Works Co., Cincinnati, Ohio; Cincinnati Lathe & Tool Co., Cincinnati, Ohio; Eberhardt Bros. Machine Co., Newark, N. J.; Fellows Gear Shaper Co., Springfield, Vt.; E. J. Flather Mfg. Co., Nashua, N. H.; Hilbert Machine Co., Cincinnati, Ohio; Lucas Machine Tool Co., Cleveland, Ohio; Mueller Machine Tool Co., Cincinnati, Ohio; Seneca Falls Mfg. Co., Seneca Falls, N. Y.; Western Machine Tool Works, Holland, Mich.

The following officers were chosen for the ensuing year: President, Fred L. Eberhardt, Gould & Eberhardt, Newark, N. J.; first vice-president, C. A. Johnson, Gisholt Machine Co., Madison, Wis.; second vice-president, E. P. Bullard, Jr., Bullard Machine Tool Co., Bridgeport, Conn.; secretary, P. E. Montanus, Springfield Machine Tool Co., Springfield, Ohio; treasurer, W. P. Davis, W. P. Davis Machine Co., Rochester, N. Y.

The next meeting of the association will be held at Atlantic City, N. J., in May. The date of meeting will be announced later.

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MACHINERY'S ANNUAL OUTING.

On October 17 MACHINERY gave its fifth annual outing, the invitations to which were accepted by five hundred machine tool builders, manufacturers, mechanical engineers, superintendents, and others interested in the machine tool business, from all parts of the country and some from Europe—nearly all of whom were able to attend. The steamer *Sagamore* of the Long Island Railroad was chartered for the day, and the start was made from the foot of West 22d Street, the route being laid out so as to give the visitors a comprehensive idea of the great coast defenses of New York City, and incidentally to include some other objects of general interest. The *Lusitania* of the Cunard Line was lying at her dock at the foot of 14th Street, and the *Sagamore* was warped in and lay there for a few minutes to give a close view of this enormous ship which had just broken the transatlantic record. The steamer then rapidly made her way south, through the upper bay, past the Statue of Liberty and Ellis Island, and reached Forts Wadsworth and Hamilton, which constitute the inner defenses on opposite sides of the Narrows. Passing between these, the *Sagamore* circled through the lower bay in view of Sandy Hook, Fort Hancock, Romer's Shoal and Coney Island. The outer defenses to the main entrance were thus included, and the course retraced to the upper bay, past Governor's Island, through the East River by Blackwell's Island, and under the uncompleted cantilever bridge of the same type as the one which recently fell at Quebec; thence through the beautiful scenery of the East River to Fort Totten, where all disembarked. This fort is the headquarters of the submarine artillery for the United States and a school of submarine defense. Through the courtesy of the Commanding Officer, Colonel G. N. Whistler, all the officers of the post were waiting to receive the party, which was divided into groups, and taken through the electrician sergeants' school, the officers' school, the 54th company's barracks, the mortar battery, gun batteries, torpedo store house, and shown the cable tank, range towers, and the method of plotting the position of a ship, which excited general interest. By the observations taken in the range towers, the positions of the ships of an enemy's fleet is plotted, and the angles and elevation of guns determined. The men who fire the guns do not see the enemy's ships at all. The guns are trained entirely by telephone and telautograph directions giving the elevation and angle of fire, these having been determined by the observations taken from the range towers located at Forts Totten and Schuyler, the latter of which is just across the Sound from the former. The return trip was made through the East River to East 24th Street, which was reached promptly at 6 o'clock.

These annual outings, which began in a small way in 1903 with some twenty guests, have gradually increased until they have now become an established feature in the machinery trade, and afford those who attend an opportunity to meet in an informal way, and to greet their business friends as well as to extend their acquaintance.

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TRANSATLANTIC WIRELESS TELEGRAPHY.

An event of much importance was the starting of transatlantic wireless telegraph service by the Marconi Company, October 17. On this date the stations at Glace Bay, Nova Scotia, and Clifden, Galway, Ireland, 2,000 miles apart, were opened to commercial business, and 10,000 words were sent the first day, the messages, of course, being largely of a congratulatory nature, as befitted the initiation of so signal an advance in telegraphy. The establishment of commercial wireless telegraphy across the Atlantic is the culmination of years of patient work by Signor Marconi and his able assistants. The first wireless signals were sent across December 16, 1902, consisting simply of the letter S many times repeated. The simplicity of the signal inclined many critics to question whether the wireless signals were actually received, or whether it was not some electrical disturbance which simulated the simple signals and deceived the operator. But later events showed that the wireless signals were actually sent and received. Since then the work has consisted of improvements in the apparatus to meet the demands of commercial work. The Marconi Company accepts commercial messages at the rate of ten cents per word, and press messages at five cents. The cable rates are twenty-five cents and ten cents.

Marconi is not, by any means, the first discoverer of the ether disturbances employed in wireless telegraphy. These disturbances, commonly called Hertzian waves in honor of Dr. Hertz, an early investigator, who performed many interesting experiments which demonstrated that it was possible to send electric signals through space without the use of wires, were also known to still earlier experimenters. But Marconi's indefatigable work, dating from 1895, in developing wireless telegraphy and putting it upon a commercial basis, will doubtless forever establish his claim as the chief promoter of the art.

* * *

Preparations are being made to furnish the soldiers of the German army with paper kettles, says the *Industrial Magazine*. These paper kettles are a Japanese invention, and although they are made out of pliable paper, they hold water securely. When water is poured into them, they can be hung over a fire, without burning, for a length of time sufficient to boil the water. One kettle can be used about eight times.

FIRST ANNUAL INDUSTRIAL SHOW IN HARTFORD.

A New England exhibition of manufactured goods in the machine tool and kindred products line, known as the Annual Hartford Industrial Show, will be held December 16-21, 1907, in Foot Guard Hall, Hartford, Conn. The leading manufacturers of New England will be represented by their machines, tools, etc., and about 25,000 complimentary tickets will be issued to mechanical men in New England, so that all may see the latest improvements in the mechanical field in which they are represented. Mr. R. B. Jacobs, secretary of the Jacobs Mfg. Co., Hartford, Conn., is promoting the show, and communications should be addressed to him.

* * *

A 5-foot band-wheel in the Waclark Wire Co.'s mill at Elizabeth, N. J., burst October 8, without causing loss of life or injury to any one, which is remarkable, considering the nature of the accident and the surroundings. The pulley had twelve arms, six on each side, and ran at a rim speed of nearly 5,300 feet per minute. One piece weighing about 100 pounds went through the roof and dropped on the opposite pitch of the same roof. Three 10-inch steam mains were in direct line with the plane of the burst pulley, but, strange to say, none was touched. After clearing away the wreckage, one spoke was found in the basement nicely balanced on the edge of an oil filter, where it had fallen without causing damage.

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The 16-spindle drill built by the Crane Co., Chicago, Ill., for its manufacturing plant, and which is illustrated in another part of this issue, is provided with variable speed motors built by the Colonial Fan & Motor Co., Warren, Ohio. The drill spindle motors are wound for 220-volt direct current and are of 5 H. P. each. They have a speed variation of 350 per cent or 3½ to 1. The feed motor is 10 H. P., and has a speed variation of 3 to 1. The drill motors operate in groups of four.

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OBITUARY.

F. B. Duncan, of Hale & Duncan, Cleveland, Ohio, died after a short illness with typhoid fever at his home in Cleveland, September 17.

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PERSONAL.

E. W. Buechling has been made assistant manager of the sales department of the Pittsburg Automatic Vise & Tool Co.

S. H. Bullard, vice-president and sales manager of the Bullard Machine Tool Co., Bridgeport, Conn., sailed on October 3 for an extended business trip in Europe.

E. R. Fellows, president of the Fellows Gear Shaper Co., Springfield, Vt., sailed October 1 on the steamer *Kaiser Wilhelm II* for a six weeks' trip abroad.

Franklin Jones, for the past four years draftsman and outside man with the Guild & Garrison Pump Co., Brooklyn, N. Y., has joined the editorial force of MACHINERY.

T. J. Shanahan, formerly with the Polo Manufacturing Co., Polo, Ill., has been made factory manager of the General Manufacturing Co., Elkhart, Ind. The company will make a specialty of air-cooled gasoline engines.

Lewis H. Morgan, formerly manager of the Ridgway Machine Tool Co., and later superintendent of the Pond plant of the Niles-Bement-Pond Co., is now connected with the Vandyke-Churchill Co., New York.

David B. Carse, of Carse Bros. Co., New York, has resigned from the advisory board of the United States Steel Corporation to again take up active work with his company in the machinery and railroad supply business.

J. W. Bray, who has heretofore represented the Bullard Machine Co. in New England, is now located at No. 1414 South Penn Street, Philadelphia, where he will represent the company in the Philadelphia territory.

Fred H. White, formerly correspondent of the Pope Mfg. Co., Hartford, Conn., will assist Mr. R. B. Jacobs, secretary of the Jacobs Mfg. Co., Hartford, Conn., in promoting the First Annual Hartford Industrial Show.

Walter B. Snow, formerly mechanical engineer and publicity manager with the B. F. Sturtevant Co., Hyde Park, Mass., where he was employed for nearly twenty-five years, has opened an office at 170 Summer St., Boston, where he will undertake any publicity work for manufacturers of machinery and allied products.

Henry M. Lane and Robert I. Clegg, both well-known editors and contributors to the technical press, have started a new monthly journal for the foundry trade, named *Castings*, which will be under their joint editorship. The first issue of the new journal appeared October 15. The publisher is the Gardner Printing Co., Caxton Building, Cleveland, Ohio.

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NEW BOOKS AND PAMPHLETS.

STRIKES AND LOCKOUTS. Twenty-first annual report of the Commissioner of Labor, 1906. 979 pages, 6 x 9 inches. Published by the Government Printing Office, Washington, D. C., for general distribution.

The character of this report is indicated by the title. It gives the results of investigations of strikes and lockouts in the United States from the years 1901 to 1905, together with summaries covering the 25-year period from 1881 to 1905.

POWER STATIONS AND TRANSMISSION. By George C. Shadd. 157 pages, 6¼ x 9¼ inches. Illustrated. Published by the American School of Correspondence, Chicago, Ill. Price $1.00.

The book is divided into two parts, the first being on power stations and the second on power transmission. It is almost needless to say that the work deals almost entirely with electrical equipment, for in fact the rapid growth of electric power development and electrical transmission of power has put all other power systems completely into the background. The book is prepared in the characteristic style adopted for all its text-books by the American School of Correspondence, and, therefore, is marked by clearness and lucidity of style, numerous illustrations and frequent practical examples.

REGULATIONS AND INSTRUCTIONS CONCERNING DENATURED ALCOHOL, CENTRAL DENATURING BONDED WAREHOUSES, AND INDUSTRIAL DISTILLERIES. 169 pages, 6 x 9 inches. Published by the U. S. Treasury Department, Washington, D. C., for free distribution.

This pamphlet giving revised United States internal revenue regulations under act of Congress June 7, 1906, and amendatory act March 2, 1907, is No. 30, revised July 15, 1907. It is of general interest, as its provisions are supposed to permit the general manufacture of denatured alcohol by small producers. That liberal revenue regulations are required to extend the use of denatured alcohol so as to largely displace gasoline and kerosene is generally conceded, and it is to be hoped that the present regulations will be liberally administered. It is our impression, however, that the unwinding of red tape will tend to discourage many who might be inclined to enter into the manufacture of denatured alcohol from farm products.

SYMPOSIUM OF INDUSTRIAL EDUCATION. Bulletin No. 3, issued by the National Society for the Promotion of Industrial Education. Collated by James P. Haney. 58 pages, 6 x 9 inches. Published by the society. Copies supplied free by the secretary, Charles R. Richards, Teachers' College, West 120th St., New York.

The bulletin is a compilation of letters received in answer to a set of categorical questions on industrial education, and it includes letters from President Theodore Roosevelt, representatives of trade unions, and leading manufacturers throughout the country. The sentiments expressed are almost uniformly in favor of improved methods of industrial education, and the pamphlet contains a number of valuable contributions to the literature on the subject. It is quite evident from reading the pamphlet that the general feeling throughout the country is that our public school system needs to be reformed so as to include more practical education which will better fit the boys for learning trades.

THE BLACKSMITH'S GUIDE. By J. F. Sallows. 157 pages, 4½ x 7 inches. Illustrated. Published by the Technical Press, Brattleboro, Vermont. Price, cloth binding, $1.50; leather binding, round corners, $2.00.

The author of this interesting work is not unknown to the readers of MACHINERY, as he has contributed to its columns a number of unique and valuable articles on tool-dressing, case-hardening, etc. Mr. Sallows has had twenty-seven years of experience at blacksmithing, covering a wide range of work in railroad, printing press, marine, automobile and other shops. The arrangement of the work is, by chapters, as follows: Machine Forging; Tool Forging, Hardening and Tempering; High-Speed Steel; Case-hardening and Coloring; Brazing—General Blacksmithing. The general make-up and typographical appearance is excellent, and the same adjective applies to the contents. The chapter on case-hardening is particularly valuable. The author's experience in this line has specially fitted him to write authoritatively on the art of case-hardening for beauty of product as well as for uniform surface hardness. The chapter on tool forging is of practical interest to all machinists.

ENGINEERING WORK SHOP PRACTICE. By Charles C. Allen. 254 pages, 4¾ x 7¼ inches. Illustrated. Published by Methuen & Co., 36 Essex St., W. C., London. Price, $1.00.

The work treats of properties of materials, transmission of power, measuring, gaging, tool steel and its treatment, joining of metals, laying out, chipping, filing and scraping, cutting tools, lathe work, planing, shaping, slotting, drilling, boring, milling, grinding, lapping, screw cutting, gear cutting, etc. Special attention has been given to highly accurate methods of measurement, gages and other measuring instruments being described in detail. The book is of good appearance and is well prepared. It contains a large amount of valuable instruction and information for the machinist and student in workshop practice. The drawings from which the cuts showing machine details were made, were carefully prepared. They are a very creditable addition to the work, and "shine by contrast" when compared with many other books on shop practice. The bad character of the cuts used to illustrate many examples of otherwise excellent engineering books is notorious. It is a pleasure to examine a book having cuts made from well-executed drawings.

TESTS OF INTERNAL-COMBUSTION ENGINES ON ALCOHOL FUEL. By Charles E. Lucke and S. M. Woodward. 89 pages, 6 x 9 inches, Illustrated. Published by the U. S. Department of Agriculture, Washington, D. C., for free distribution.

This report, designated as Bulletin No. 191, contains an account of the tests made by Dr. Lucke of Columbia University and Prof. Woodward, Irrigation engineer, U. S. Government, to determine whether gasoline and kerosene engines at present in general use can run with alcohol as fuel, and to learn what improvements are desirable to adapt such engines especially for alcohol. The conclusions are that any gasoline engine of the ordinary types can be run with alcohol without any material change in construction; that when run with alcohol the operation is less noisy; that alcohol is specially well

adapted for air cooled motors; that the consumption of fuel in pounds per brake-horse-power-hour depends chiefly on the horse-power of the engine; and that with any good gasoline engine as small a consumption as 0.70 pound of gasoline or 1.16 pound of alcohol per brake-horse-power-hour may reasonably be expected under favorable conditions.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES. 16th annual edition. 1,224 pages, 7½ x 10 inches. Published by S. E. Hendricks Co., 74 Lafayette St., corner Franklin St., New York City. Price $10.00.

This comprehensive work is a commercial register of the United States for buyers and sellers, and it is undoubtedly properly designated, as it is one of the most complete works of the kind published. The register is now in the 16th annual edition, the first edition having been published in 1891. That issue contained about 500 pages, while the present issue contains over 1,200 pages and upwards of 350,000 names and addresses classified under 31,212 trade headings. Seventy-six pages alone are required to index its contents. The first edition was devoted solely to the building industry of the country, but the present edition covers not only that but also engineering, mechanical, railroad, electrical, mining, iron, steel, export and kindred industries. It is said to be the only publication of the kind ever issued that is so classified that it can be used either for purchasing or mailing purposes. The publishers assure us that each annual edition is corrected and verified item by item so far as lies in their power, a task which is of no mean order, as any one will concede upon examining this great and valuable work.

CATALOGUES AND CIRCULARS.

THE HILBERT MACHINE CO., 2116 Colerain Ave., Cincinnati, O. Pamphlet illustrating and describing its 2½-foot radial drill.

CHAIN BELT CO., Milwaukee, Wis. Catalogue of elevating, conveying, and power transmission machinery.

MELVIN & HAMAKER, Meadville, Pa. Catalogue descriptive of the Melvin boring head, which s a new tool offered to the trade, made in all sizes up to 18 inches diameter.

PATENT FILE & TOOL CO., 8 White St., Moorfields, London, Eng. Catalogue descriptive of the "Dreadnought" milling or circular cut file, described in MACHINERY, March, 1907.

THE RIDGWAY DYNAMO AND ENGINE CO., Ridgway, Pa. Bulletin No. 18 entitled Power Plants, containing half-tone views of the installations made by this company in the power plants of various concerns.

THE DAVID BELL ENGINEERING WORKS, Buffalo, N. Y. Catalogue No. 806 on Bell's steam hammers, illustrating and giving specifications of the single frame guide type and the open frame type.

FITCHBURG MACHINE WORKS, Fitchburg, Mass. Circular on the Lo-swing lathe describing its various parts, and telling of the special work for which it is built.

JENKINS BROS., 71 John St., New York. Pamphlet on extra heavy valves, giving dimensions of brass globe valves, brass angle valves, brass check valves, blow-off vales, iron body globe valves, etc.

PIKE MFG. CO., Pike, N. H. Catalogue giving dimensions and prices of scythestones, axe stones, oilstones, water stones, razor hones, knife sharpeners, grindstones, corundum wheels, emery wheels, and abrasives.

THE CRESCENT MFG. CO., Scottdale, Pa. Catalogue of small tools and machine shop appliances giving tables of specifications for detachable counterboring and facing tool, reamers of various types, milling cutters, die heads, taps, tool-holders, angle plates, etc.

B. F. STURTEVANT CO., Hyde Park, Mass. Bulletins Nos. 144 and 147 describing eight-pole, bipolar and four-pole electric motors, respectively. The bulletins contain general description, construction details, principal dimensions, etc.

BUCKEYE ENGINE CO., Salem, O. Circular containing another talk by Professor A. C. Tinic, in which he tells of some of the advantages obtained by using the Buckeye electric blue-printing machine, and reproduces a letter from a well-known firm commending this machine.

H. W. JOHNS-MANVILLE CO., 100 William St., New York. Leaflet descriptive of "Leak-No," a peculiar metallic compound in powder form that is mixed with water to stop leaks in steam, water, gas, air, ammonia and brine pipes, to fill cracks in fire-pots, wash basins, bathtubs, etc.

THE GRAHAM MFG. CO., Providence, R. I. Leaflet descriptive of the universal jig vise which may be used as an ordinary drill vise or as a jig drilling vise by the use of attachments. It is universal in its character for all work within its capacity, and often saves the making of expensive drilling jigs.

THE BROWN HOISTING MACHINERY CO., Cleveland, O. Pamphlet illustrating "Brownhoist" locomotive cranes with grab-bucket equipment, showing the cranes handling ore from stock piles, gondola cars, etc. A general description of this equipment and a summary of its advantages are included. Attention is called to the partial list of steel companies using these cranes.

EUGENE DIETZGEN CO., New York. Catalogue of drawing instruments, drawing materials, surveying instruments, etc. This attractive catalogue contains 473 pages, 5½ x 8½ inches (dealer's size), and lists a great variety of drawing supplies, surveying instruments and other materials and devices required by draftsmen, mechanical and civil engineers, architects, etc.

THE R. K. LE BLOND MACHINE TOOL CO., 4605 Eastern Ave., Cincinnati, Ohio. Catalogue of engine lathes, including both standard and quick-change, special turret lathes, motor-driven lathes, etc. The catalogue also lists all lathe attachments. The illustrations are specially attractive, and the catalogue as a whole is of much interest to manufacturers and lathe users.

NORTON CO., Worcester, Mass. Circular of Norton alundum stones which are made of specially prepared alundum by the same process used in the manufacture of Norton grinding wheels. These stones are recommended for glass cutting, lens grinding, etc. The circular is printed in three colors and is an attractive piece of advertising literature.

NILES-BEMENT-POND CO., Trinity Building, 111 Broadway, New York. Catalogue of the Pond rigid turret lathe. This machine was designed for work ordinarily done on engine lathes, and is specially adapted to gear blanks, small fly-wheels, engine cylinders, etc. It is built in two sizes, 21 and 28 inches swing. The catalogue is illustrated with views showing attachments, equipment, and samples of work that can be handled advantageously.

THE HISEY-WOLF MACHINE CO., Cincinnati, Ohio. Catalogue No. 6, illustrating and describing the company's complete line of portable electric drills and grinders which are wound for both direct and alternating current. These electric drills and grinders represent an important advance in the growth of the portable tool idea and the catalogue will be found of much general interest. It is mailed to any one upon application.

WALTER B. SNOW, 170 Summer St., Boston, Mass. "Productive Publicity," a booklet outlining the proposed activities of Mr. Snow as a "publicity engineer." His long experience in engineering and publicity work has specially fitted him for intelligently handling this business—a business that is rapidly growing in complexity and which demands technical training and experience of a high order to satisfy present needs in marketing manufactured products.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4534 on Curtis steam turbines of the horizontal type for driving horizontal shaft generators. Curtis turbine generator sets are built up to 300 K. W. capacity for both direct and alternating current. The bulletin fully describes the construction, and points out the advantages, among which are less floor space required, absence of reciprocating parts and attendant freedom from vibration, etc.

THE RIDGWAY DYNAMO AND ENGINE CO., Ridgway, Pa. Set of templets showing the floor space occupied by the Standard Ridgway generating units in sizes from 10 K. W. to 200 K. W., inclusive. These templets are made to a scale of ¼ inch to the foot, and are seven in number. They should be of great convenience in the laying out of power plants, as the templets may be laid on a drawing scaled ¼ inch to the foot, and shifted to whatever position best suits. The company is sending the templets free to all interested.

A CATALOGUE has been received from the Twenty-third St., New York, Y. M. C. A., giving a synopsis of the courses of study in the night school which began in October and continues until June. The courses include the ordinary common school studies and instruction in industrial chemistry, paper making, leather making, architectural drawing, plan reading and estimating, mechanical drawing, salesmanship, advertising, accountancy, plumbing, railway transportation, electricity, steam engineering, etc.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4530 on mercury arc rectifiers. It describes the simplicity and reliability of these devices for producing direct current for charging storage batteries and for many other commercial purposes. They are inexpensive, flexible and reliable, require small floor space, have remarkably high efficiency at full and light loads, and in operation are the simplest rectifying devices yet produced. A brief outline of the theory of the apparatus is given in the bulletin and various types of rectifying sets are described and illustrated.

GOLDSCHMIDT THERMIT CO., 90 West St., New York. Circular describing applications of thermit in foundry practice. Thermit has proved to be a most valuable means of producing high temperature (5,400 degrees F.) anywhere with very simple apparatus, and for foundry purposes no apparatus is required. It provides means for maintaining or even increasing the temperature of metal poured into the ladle. It is prepared in special cans for foundry use, and is particularly valuable for reviving "dull" iron and for many other purposes described.

THE HENRY & WRIGHT MFG. CO., Hartford, Conn. Catalogue of ball bearing drill presses, illustrating the line of sensitive drills, including single spindle, multiple spindle and radial drills. The great reduction in power required due to the use of ball bearings and the balanced feather system on the spindle enables a 1¼-inch belt to efficiently drive high-speed drills up to ¾-inch diameter, and even larger, and has made possible a production of from 200 to 400 per cent more work, it is claimed, than is possible with the ordinary drill press construction. The catalogue is copiously illustrated and is an attractive piece of advertising literature.

HERMANN BOKER & CO., 101-103 Duane St., New York. Circular descriptive of "Intra" steel, giving working instructions for heating, hardening and tempering. "Intra" steel is *not* a high-speed steel, but closely approaches it in point of cutting speed, having an average of 50 to 75 greater cutting power and durability than the carbon steels hitherto available. The new steel is readily made up into milling cutters, reamers, twist drills, taps, dies, punches, machine knives, etc., and being hardened at a temperature of 1,500 to 1,550 degrees F. there is not the trouble from blistering and scaling common with high-speed steels. It is notably tough, and being far cheaper than high-speed steel, it naturally promises to be a very valuable brand of steel for general purposes.

MANUFACTURERS' NOTES.

CINCINNATI ELECTRICAL TOOL CO., Cincinnati, O., has opened a Western office and salesroom at Eighteenth and Rockwell Sts. Mr. Oscar P. Wodack has been made manager.

SIBLEY MACHINE TOOL CO., South Bend, Ind., manufacturer of upright drills, has recently made a two-story addition to its shop. The addition is 42 x 75 feet, and it will accommodate a fine new office and increase the size of the present work rooms.

AMERICAN LOCOMOTIVE CO., 111 Broadway, New York, reports an order of 125 locomotives for the Harriman lines made up as follows: 30 Mogul type; 10 Atlantic type; 43 consolidation type; 24 ten-wheel type; 18 six-wheel switching locomotives.

NELSON WHEEL CO., 141 E. Ontario St., Chicago, Ill., has lately been incorporated to manufacture automobile wheels and accessories. The company desires to receive catalogues from the various machine tool builders for its files.

AKRON CLUTCH CO., Akron, Ohio, manufacturer of the "Akron" friction clutches, has moved into a new factory which is a two-story fireproof building 32 x 135 feet. The concern has been forced to build the new and larger shop to accommodate the demand for its clutches.

DIAMOND SAW AND STAMPING WORKS, 357-361 Seventh St., Buffalo, N. Y., announces that Mr. Frederick Peters, Pickhuben Huben 4, Hamburg, Germany, is its representative on the Continent for the "Sterling" hack-saw blades, frames and power hack-saw machines.

EDGEMONT MACHINE WORKS, Dayton, Ohio, manufacturers of friction clutches for counter-shafts and line-shafts, has just completed a two-story brick addition, 50 x 75 feet, which will enable the company to more than double its present output.

THE WARNER & SWASEY CO., Cleveland, Ohio, has opened a Chicago office in the Commercial National Bank Building, Adams and Clark Sts. The new office will be under the management of Mr. E. B. Boye, who will supply any information regarding the machine tools built by the company.

THE TECHNICAL PUBLICITY ASSOCIATION, composed of the publicity managers of leading manufacturing concerns, devoted the first meeting of the year (September 26) to a discussion of the "mailing list," its relation to general advertising, etc. The secretary of the Association is Mr. Rodman Gilder, of the Crocker-Wheeler Co., Ampere, N. J.

THE MCCROSKY REAMER CO., Meadville, Pa., was organized October 1 under the laws of Pennsylvania, and has taken over the business of the F. B. McCrosky Mfg. Co. The new company has a paid-up capital of $40,000, and it will continue the manufacture of the patent reamer formerly made by the F. B. McCrosky Mfg. Co.

VANDYCK-CHURCHILL CO., 91-93 Liberty St., New York, has just concluded an agency arrangement with the Cleveland Crane & Car Co. to represent it exclusively in the New York and Philadelphia territory. The new department will be in charge of Mr. Lewis H. Morgan, recently manager of the Ridgway Machine Co.

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., announces that the New York plant of the Wirt Electric Co. of Philadelphia, which business was purchased by the Cutler-Hammer Mfg. Co. some months ago, has been consolidated with the New York plant of the Cutler-Hammer Mfg. Co. at Park Ave. and 130th St.

THE NATIONAL TWIST DRILL AND TOOL CO., Detroit, Mich., is now located in its new factory at the corner of Brush St. and Boulevard. The new building is of concrete 38 x 145 feet, three stories high. It is equipped with up-to-date machinery throughout, and represents the latest type of factory in all details. The company expects to triple its output when in full working order.

Contributions and data suitable for publication in these Data Sh

CREASE HERE

SPECIAL MACHINE SCREW TAPS.—IV.

Approved by A. S. M. E., May, 1907.

Old	New	Outside Diameters			Pitch Diameters			Root Diameters			Tap Drill Diameters
No.	Out. Diam. and Thrds. per Inch	Minimum	Maximum	Difference	Minimum	Maximum	Difference	Minimum	Maximum	Difference	
1	0.073-64	0.0741	0.0768	0.0027	0.0640	0.0651	0.0011	0.0538	0.0559	0.0021	0.0550
2	0.086-56	0.0872	0.0903	0.0031	0.0756	0.0767	0.0011	0.0640	0.0663	0.0023	0.0670
3	0.099-48	0.1003	0.1038	0.0035	0.0868	0.0880	0.0012	0.0732	0.0757	0.0025	0.0760
4	0.112-40	0.1134	0.1175	0.0041	0.0972	0.0986	0.0014	0.0809	0.0837	0.0028	0.0820
	36	0.1135	0.1179	0.0044	0.0955	0.0969	0.0014	0.0774	0.0803	0.0029	0.0810
5	0.125-40	0.1264	0.1305	0.0041	0.1102	0.1116	0.0014	0.0939	0.0967	0.0028	0.0980
	36	0.1265	0.1309	0.0044	0.1085	0.1099	0.0014	0.0904	0.0933	0.0029	0.0935
6	0.138-36	0.1395	0.1439	0.0044	0.1215	0.1229	0.0014	0.1034	0.1063	0.0029	0.1065
	32	0.1396	0.1445	0.0049	0.1193	0.1208	0.0015	0.0990	0.1021	0.0031	0.1015
7	0.151-32	0.1526	0.1575	0.0049	0.1323	0.1338	0.0015	0.1120	0.1151	0.0031	0.1160
	30	0.1526	0.1578	0.0052	0.1310	0.1326	0.0016	0.1093	0.1125	0.0032	0.1130
8	0.164-32	0.1656	0.1705	0.0049	0.1453	0.1468	0.0015	0.1250	0.1281	0.0031	0.1285
	30	0.1656	0.1708	0.0052	0.1440	0.1456	0.0016	0.1223	0.1255	0.0032	0.1285
9	0.177-30	0.1786	0.1838	0.0052	0.1569	0.1585	0.0016	0.1353	0.1385	0.0032	0.1405
	24	0.1788	0.1850	0.0062	0.1517	0.1534	0.0017	0.1247	0.1282	0.0035	0.1285
10	0.190-32	0.1916	0.1965	0.0049	0.1713	0.1728	0.0015	0.1510	0.1541	0.0031	0.1540
	24	0.1918	0.1980	0.0062	0.1647	0.1664	0.0017	0.1377	0.1412	0.0035	0.1405
12	0.216-24	0.2178	0.2240	0.0062	0.1907	0.1924	0.0017	0.1637	0.1672	0.0035	0.1660
14	0.242-20	0.2439	0.2511	0.0072	0.2114	0.2132	0.0018	0.1789	0.1826	0.0037	0.1820
16	0.268-20	0.2699	0.2771	0.0072	0.2374	0.2392	0.0018	0.2049	0.2086	0.0037	0.2090
18	0.294-18	0.2959	0.3039	0.0080	0.2598	0.2618	0.0020	0.2237	0.2276	0.0039	0.2280
20	0.320-18	0.3219	0.3299	0.0080	0.2858	0.2878	0.0020	0.2497	0.2536	0.0039	0.2570
22	0.346-16	0.3480	0.3568	0.0088	0.3074	0.3094	0.0020	0.2668	0.2708	0.0040	0.2720
24	0.372-18	0.3739	0.3819	0.0080	0.3378	0.3398	0.0020	0.3017	0.3056	0.0039	0.3125
26	0.398-14	0.4001	0.4099	0.0098	0.3537	0.3558	0.0021	0.3073	0.3114	0.0041	0.3125
28	0.424-16	0.4260	0.4348	0.0088	0.3854	0.3874	0.0020	0.3448	0.3488	0.0040	0.3480
30	0.450-16	0.4520	0.4608	0.0088	0.4114	0.4134	0.0020	0.3708	0.3748	0.0040	0.3770

CREASE HERE

SPECIAL MACHINE SCREWS.—III.

Approved by A. S. M. E., May, 1907.

Old	New	Outside Diameters			Pitch Diameters			Root Diameters		
No.	Out. Diam. and Thrds. per Inch	Minimum	Maximum	Difference	Minimum	Maximum	Difference	Minimum	Maximum	Difference
1	0.073-64	0.0698	0.073	0.0032	0.0613	0.0629	0.0016	0.0494	0.0527	0.0033
2	0.086-56	0.0825	0.086	0.0035	0.0727	0.0744	0.0017	0.0591	0.0628	0.0037
3	0.099-48	0.0952	0.099	0.0038	0.0836	0.0855	0.0019	0.0677	0.0719	0.0042
4	0.112-40	0.1078	0.112	0.0042	0.0937	0.0958	0.0021	0.0747	0.0795	0.0048
	36	0.1076	0.112	0.0044	0.0918	0.0940	0.0022	0.0707	0.0759	0.0052
5	0.125-40	0.1208	0.125	0.0042	0.1067	0.1088	0.0021	0.0877	0.0925	0.0048
	36	0.1206	0.125	0.0044	0.1048	0.1070	0.0022	0.0837	0.0889	0.0052
6	0.138-36	0.1336	0.138	0.0044	0.1178	0.1200	0.0022	0.0967	0.1019	0.0052
	32	0.1333	0.138	0.0047	0.1154	0.1177	0.0023	0.0917	0.0974	0.0057
7	0.151-32	0.1463	0.151	0.0047	0.1284	0.1307	0.0023	0.1047	0.1104	0.0057
	30	0.1462	0.151	0.0048	0.1270	0.1294	0.0024	0.1017	0.1077	0.0060
8	0.164-32	0.1593	0.164	0.0047	0.1414	0.1437	0.0023	0.1177	0.1234	0.0057
	30	0.1592	0.164	0.0048	0.1400	0.1424	0.0024	0.1147	0.1207	0.0060
9	0.177-30	0.1722	0.177	0.0048	0.1529	0.1553	0.0024	0.1277	0.1337	0.0060
	24	0.1718	0.177	0.0052	0.1473	0.1499	0.0026	0.1158	0.1229	0.0071
10	0.190-32	0.1853	0.190	0.0047	0.1674	0.1697	0.0023	0.1437	0.1494	0.0057
	24	0.1848	0.190	0.0052	0.1603	0.1629	0.0026	0.1288	0.1359	0.0071
12	0.216-24	0.2108	0.216	0.0052	0.1863	0.1889	0.0026	0.1548	0.1619	0.0071
14	0.242-20	0.2364	0.242	0.0056	0.2067	0.2095	0.0028	0.1688	0.1770	0.0082
16	0.268-20	0.2624	0.268	0.0056	0.2327	0.2355	0.0028	0.1948	0.2030	0.0082
18	0.294-18	0.2882	0.294	0.0058	0.2550	0.2579	0.0029	0.2129	0.2218	0.0089
20	0.320-18	0.3142	0.320	0.0058	0.2810	0.2839	0.0029	0.2389	0.2478	0.0089
22	0.346-16	0.3400	0.346	0.0060	0.3024	0.3054	0.0030	0.2550	0.2648	0.0098
24	0.372-18	0.3662	0.372	0.0058	0.3330	0.3359	0.0029	0.2909	0.2998	0.0089
26	0.398-14	0.3918	0.398	0.0062	0.3485	0.3516	0.0031	0.2944	0.3052	0.0108
28	0.424-16	0.4180	0.424	0.0060	0.3804	0.3834	0.0030	0.3330	0.3428	0.0098
30	0.450-16	0.4440	0.450	0.0060	0.4064	0.4094	0.0030	0.3590	0.3688	0.0098

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

CREASE HERE

STANDARD MACHINE SCREWS.—I.

Old	New	Outside Diameters			Pitch Diameters			Root Diameters		
No.	Out. Diam. and Thrds. per Inch	Minimum	Maximum	Difference	Minimum	Maximum	Difference	Minimum	Maximum	Difference
0	0.060-80	0.0572	0.060	0.0028	0.0505	0.0519	0.0014	0.0410	0.0438	0.0028
1	0.073-72	0.0700	0.073	0.0030	0.0625	0.0640	0.0015	0.0520	0.0550	0.0030
2	0.086-64	0.0828	0.086	0.0032	0.0743	0.0759	0.0016	0.0624	0.0657	0.0033
3	0.099-56	0.0955	0.099	0.0035	0.0857	0.0874	0.0017	0.0721	0.0758	0.0037
4	0.112-48	0.1082	0.112	0.0038	0.0966	0.0985	0.0019	0.0807	0.0849	0.0042
5	0.125-44	0.1210	0.125	0.0040	0.1082	0.1102	0.0020	0.0910	0.0955	0.0045
6	0.138-40	0.1338	0.138	0.0042	0.1197	0.1218	0.0021	0.1007	0.1055	0.0048
7	0.151-36	0.1466	0.151	0.0044	0.1308	0.1330	0.0022	0.1097	0.1149	0.0052
8	0.164-36	0.1596	0.164	0.0044	0.1438	0.1460	0.0022	0.1227	0.1279	0.0052
9	0.177-32	0.1723	0.177	0.0047	0.1544	0.1567	0.0023	0.1307	0.1364	0.0057
10	0.190-30	0.1852	0.190	0.0048	0.1660	0.1684	0.0024	0.1407	0.1467	0.0060
12	0.216-28	0.2111	0.216	0.0049	0.1904	0.1928	0.0024	0.1633	0.1696	0.0063
14	0.242-24	0.2368	0.242	0.0052	0.2123	0.2149	0.0026	0.1808	0.1879	0.0071
16	0.268-22	0.2626	0.268	0.0054	0.2358	0.2385	0.0027	0.2014	0.2090	0.0076
18	0.294-20	0.2884	0.294	0.0056	0.2587	0.2615	0.0028	0.2208	0.2290	0.0082
20	0.320-20	0.3144	0.320	0.0056	0.2847	0.2875	0.0028	0.2468	0.2550	0.0082
22	0.346-18	0.3402	0.346	0.0058	0.3070	0.3099	0.0029	0.2649	0.2738	0.0089
24	0.372-16	0.3660	0.372	0.0060	0.3284	0.3314	0.0030	0.2810	0.2908	0.0098
26	0.398-16	0.3920	0.398	0.0060	0.3544	0.3574	0.0030	0.3070	0.3168	0.0098
28	0.424-14	0.4178	0.424	0.0062	0.3745	0.3776	0.0031	0.3204	0.3312	0.0108
30	0.450-14	0.4438	0.450	0.0062	0.4005	0.4036	0.0031	0.3464	0.3572	0.0108

Approved by A. S. M. E., May, 1907.

CREASE HERE

STANDARD MACHINE SCREW TAPS.—II.

Old	New	Outside Diameters			Pitch Diameters			Root Diameters			Tap Drill Diameters
No.	Out. Diam. and Thrds. per Inch	Minimum	Maximum	Difference	Minimum	Maximum	Difference	Minimum	Maximum	Difference	
0	0.060-80	0.0609	0.0632	0.0023	0.0528	0.0538	0.0010	0.0447	0.0466	0.0019	0.0465
1	0.073-72	0.0740	0.0765	0.0025	0.0650	0.0660	0.0010	0.0560	0.0580	0.0020	0.0595
2	0.086-64	0.0871	0.0898	0.0027	0.0770	0.0781	0.0011	0.0668	0.0689	0.0021	0.0700
3	0.099-56	0.1002	0.1033	0.0031	0.0886	0.0897	0.0011	0.0770	0.0793	0.0023	0.0785
4	0.112-48	0.1133	0.1168	0.0035	0.0998	0.1010	0.0012	0.0852	0.0887	0.0025	0.0890
5	0.125-44	0.1263	0.1301	0.0038	0.1116	0.1129	0.0013	0.0968	0.0995	0.0027	0.0995
6	0.138-40	0.1394	0.1435	0.0041	0.1232	0.1246	0.0014	0.1069	0.1097	0.0028	0.1100
7	0.151-36	0.1525	0.1569	0.0044	0.1345	0.1359	0.0014	0.1164	0.1193	0.0029	0.1200
8	0.164-36	0.1655	0.1699	0.0044	0.1475	0.1489	0.0014	0.1294	0.1323	0.0029	0.1360
9	0.177-32	0.1786	0.1835	0.0049	0.1583	0.1598	0.0015	0.1380	0.1411	0.0031	0.1405
10	0.190-30	0.1916	0.1968	0.0052	0.1700	0.1716	0.0016	0.1483	0.1515	0.0032	0.1520
12	0.216-28	0.2176	0.2232	0.0056	0.1944	0.1961	0.0017	0.1712	0.1745	0.0033	0.1730
14	0.242-24	0.2438	0.2500	0.0062	0.2167	0.2184	0.0017	0.1896	0.1931	0.0035	0.1935
16	0.268-22	0.2698	0.2765	0.0067	0.2403	0.2421	0.0018	0.2108	0.2144	0.0036	0.2130
18	0.294-20	0.2959	0.3031	0.0072	0.2634	0.2652	0.0018	0.2309	0.2346	0.0037	0.2340
20	0.320-20	0.3219	0.3291	0.0072	0.2894	0.2912	0.0018	0.2569	0.2606	0.0037	0.2610
22	0.346-18	0.3479	0.3559	0.0080	0.3118	0.3138	0.0020	0.2757	0.2796	0.0039	0.2810
24	0.372-16	0.3740	0.3828	0.0088	0.3334	0.3354	0.0020	0.2928	0.2968	0.0040	0.2968
26	0.398-16	0.4000	0.4088	0.0088	0.3594	0.3614	0.0020	0.3188	0.3228	0.0040	0.3230
28	0.424-14	0.4261	0.4359	0.0098	0.3797	0.3818	0.0021	0.3333	0.3374	0.0041	0.3390
30	0.450-14	0.4521	0.4619	0.0098	0.4057	0.4078	0.0021	0.3593	0.3634	0.0041	0.3680

Approved by A. S. M. E., May, 1907.

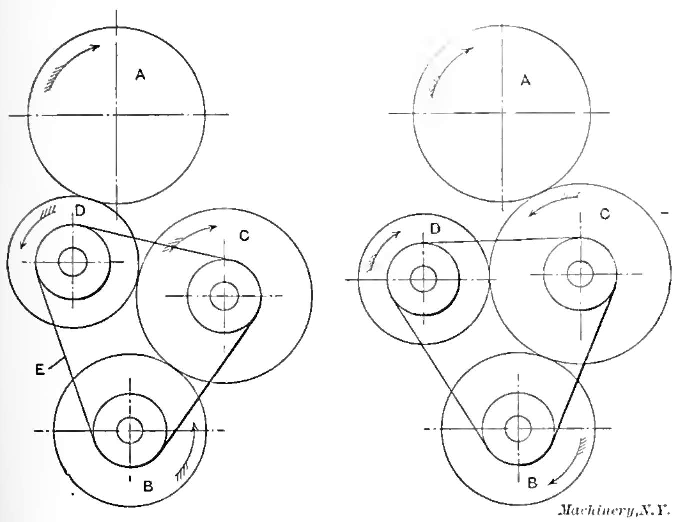
MACHINERY.

December, 1907.

TUMBLER GEAR DESIGN.

JOHN EDGAR.*

OF the different mechanisms that have been used in the machine tools of the past, one—the tumbler gear—could be found in some form or other in almost every machine. Its office, in most cases, was to reverse the direction of the feed. Fig. 1 shows the usual form in which it is found when used for this purpose. The gears *A* and *B* are to be connected so that motion may be transmitted from one, which runs constantly in one direction, to the other, which it is desired to run in either direction. Suppose that *A* is the driver and runs as shown by the arrow. As connected, *A* drives *B* through the intermediate gears *D* and *C*, *B* rotating in an opposite direction to *A*, as shown by the arrows.



Figs. 1 and 2. Examples of Tumbler Gears.

This mechanism is termed the tumbler gear, because the gears *D* and *C* are supported in a frame which swings about the axis of either the driving or the driven gear. In the case in hand, the intermediate gears are carried in the frame *E*, which rotates about the axis of the gear *B*. Some means, not shown, must be provided by which the rocker frame may be changed from one position to the other, and locked. Fig. 2 shows the mechanism shifted so that the motions of *A* and *B* are in the same direction.

The tumbler gear has been used as a reversing gear ever since present forms of machine tools were first invented. While it has always given considerable trouble, it has shown up to disadvantage mostly when applied to the modern machine with positive gear feed, where great power has to be transmitted by it. It is the purpose here to show where this gear may be used to advantage, and also to explain the theory on which the principles of its design are based.

All of us have met with this mechanism in some form or other, and may have formed an unfavorable opinion. The prejudice thus created keeps us from fully appreciating the tumbler gear, even when properly designed, and when used in the right place. It has been placed by many along with the worm drive and the spiral gear as undesirable, and to be avoided unless it is absolutely impossible to get along without it. This opinion has been responsible for the adoption of many combinations used for purposes that rightly belong in the field of the tumbler gear, and many times, in order to avoid using this mechanism, much unnecessary complication has resulted.

What are the faults of the tumbler reversing gear? That one on So-and-So's lathe used to kick furiously when one tried to throw it over. Then, the one used on the milling machine used to go into mesh easily enough, but when any amount of strain was put onto it, the teeth used to crack and growl, showing that the tendency was to drag the gear farther into mesh, causing the teeth to bind on one another and sometimes break. Let us look into the case represented in Fig. 1. Fig. 3 shows the gear *D* just entering into mesh with *A*. An examination of this figure shows that the tendency is for the teeth of gear *A*, when they strike those of gear *D*, to cause the latter to rotate about the axis of the rocker frame, should the gear *B* be locked against turning. This tendency opposes the motion in the opposite direction necessary to bring the gears wholly into mesh. In practice, *B* is not locked, but it is necessary to overcome a certain amount of resistance in order that it may be set in motion, and the presence of this resistance has the same effect as if the gear were locked. The greater this resistance is, the greater is the effort necessary to bring the gears into working position.

Examining the conditions in the case of Fig. 2, we see that the effect would be just the opposite, that is, the gears would come into mesh of their own accord as soon as a contact is produced between the teeth of *A* and *C*. Practically no effort is necessary to bring the gears into mesh, but, in order to withdraw the gear *C* from *A*, considerable effort would be required. When the gears *C* and *A* are in mesh and transmit power, the tendency for gear *C* is to crowd farther into mesh with *A*, which has the effect of binding the teeth. Should the pressure of contact be sufficient, the binding tendency would cause the motion to cease, or would break the teeth.

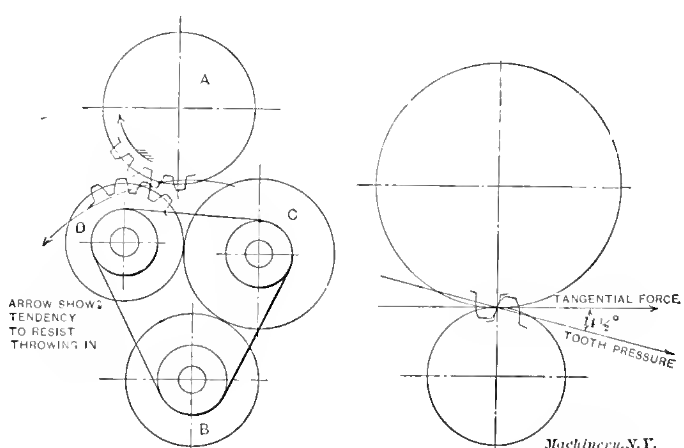


Fig. 3. Illustrating the Tendency to resist Throwing-in of Gear. **Fig. 4. Illustrating the Direction of Line of Pressure.**

This is one of the points on which many have based their verdict against the tumbler gear, and when designed so that such results are obtained, it is not to be wondered at.

Direction of Tooth Pressure in Ordinary Cut Gears.

The first consideration in the design of tumbler gears in any form is that of tooth pressure and its line of application. As all cut gears used in machine tools are made to the $14\frac{1}{2}$-degree involute system, we will confine ourselves to that system. In this, the force tending to revolve the driven gear is not a tangential force, applied as a tangent to the pitch circle, but is a force applied at an angle of $14\frac{1}{2}$ degrees to the tangent of the pitch circle, this $14\frac{1}{2}$-degree line being termed the line of pressure. In case that there may be some confusion as to the above statement regarding the tangential force and the line of pressure on the teeth, the case is graphically shown in Fig. 4. The tangential force is equal to the twisting moment divided by the radius of the pitch circle. This force is equivalent to that which transmits motion between two disks by friction alone, the diameters of the disks being equal to the pitch circles of the gears. This force is,

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in the case of a gear, resolved into two component forces. One component acts perpendicular to the tangential force and tends to force the gears apart; the other acts in the direction of the line of tooth pressure shown in Fig. 4. The tooth pressure thus is somewhat less than the total twisting force, and equals the twisting or tangential force multiplied by the cosine of 14½ degrees.

Influence of Direction of Tooth Pressure on Tumbler Gear Design.

To show what effect the line of pressure has upon the layout of the tumbler gear, we will use the simple case shown in Fig. 5. In this figure, A is the driving gear and B is the driven gear. These gears are connected by means of the intermediate gear C, which is carried in the swing frame E, which, in turn, swings about the axis of A. This mechanism is a simple case of tumbler gear, and while it is little used, it is useful as a means for disconnecting a train of gears when it is desired to stop the motion of the driven section. If we consider the gear B locked in the position shown, and exert a turning effort on the gear A in the direction indicated by the arrow, this effort is transmitted by the teeth of A and C, and a pressure is produced between the teeth of B and C, two of which are shown in the cut. The direction in which this force is applied is shown by the line of pressure $H K$, and is exerted in the direction of H. Since every force is opposed by an equal and opposite force when in a state of equilibrium, we have in this instance a force or reaction opposing the force along the line of pressure referred to. It is this reaction that causes our troubles. In the mechanism shown in Fig. 5, the gear C and the link E are free to rotate about the axis of A, and since the line of pressure does not go through the center of gear A, the force acting along this line tends to rotate the arm E about the axis of A, the direction of rotation being dependent on which side of the center of A the line falls. Thus in Fig. 5, the line falls in a position that produces a tendency for the arm to force the gear C further into mesh with B. The twisting moment thus set up is equal to the tooth pressure multiplied by the normal distance from the axis of A, or $G L$.

If now, instead of trying to turn the gear A in the direction of the arrow, we exert a torque in the other direction, the opposite sides of the teeth would come into contact, and the line of pressure would be located as shown by the dotted

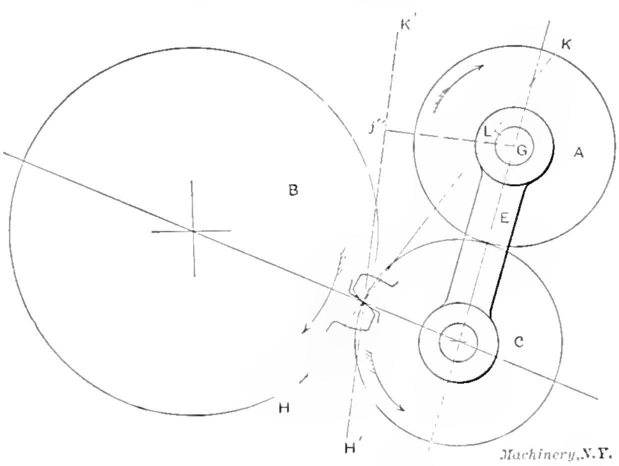

Fig. 5. Objectionable Gear Design.

line $H' K'$. The normal distance of this line from the axis of A is much greater than in the former case; consequently the twisting moment tending to rotate the arm E about the axis is also increased, but the direction in which the torque is applied has changed the direction in which the reacting force along the line of pressure acts, and, since this line falls on the same side of the axis, the tendency of the arm is to rotate in the opposite direction, and to separate the gears C and B. Had the line of pressure gone directly through the axis of the gear A, where E is pivoted, the effect of any force acting along it would have had no rotating influence upon the tumbler gear arm. That this would be the ideal case needs not to be mentioned, and it should be the aim of the designer to approach that condition as nearly as possible.

The tendency for the tumbler to crowd the gears into mesh might be of some advantage were it desirable to throw them into mesh while the gears are in motion; but in cases where any considerable amount of power is being transmitted, a very stiff and rigid design will be necessary for the tumbler frame and the locking device. It is also well in such cases, when setting the locking device, to have the gears mesh with plenty of play or backlash, so that, if there be any give to the frame, the gears will not be likely to bind and cramp. Should B be the driver and run in the direction of the arrow, the line of pressure would be $H' K'$, and the pressure would be in the direction of H'. The arm would then tend to carry the gear C out of mesh with B. Should the direction be reversed, $H K$ would be the line of pressure, and the tendency would be to crowd the gear in.

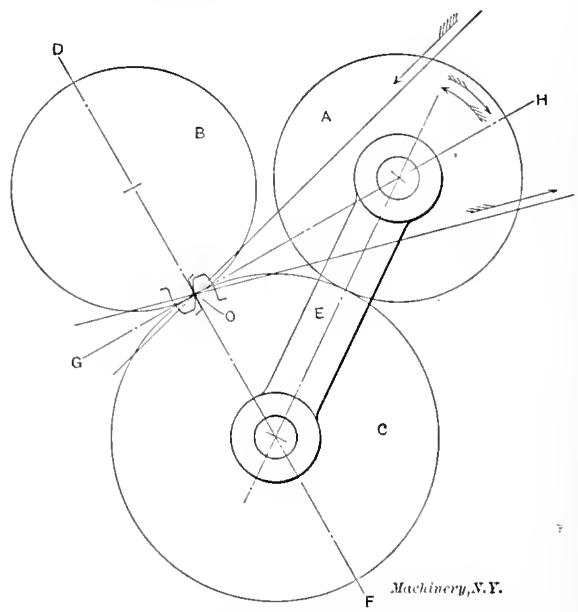

Fig. 6. Correct Tumbler Gear Design to run in Both Directions.

The layout in Fig. 5 has two bad features. In the first place, the gears have a tendency to crowd farther into mesh, which limits the amount of power that can be transmitted, and increases the liability of breakage of the gear teeth and of the tumbler frame should an overload be imposed upon the mechanism. Inaccuracy in the shape and spacing of the teeth aggravates the above conditions. In the second place, the mechanism should be used to transmit motion in but one direction.

In most cases the throwing in or out of the tumbler is a secondary matter as it is done either when the gears are not in motion, or while not under load, if running. In such cases it should be the aim of the designer to overcome the objection of the crowding of the teeth into mesh by having the line of pressure properly located so that the tendency is in the opposite direction. When it is desired to provide a tumbler gear that can be run in either direction, the layout in Fig. 6 is recommended. The object in this case is to have the twisting moment equal in either direction, and such that the gears have no crowding tendency. The arrangement in Fig. 6 is laid out as follows: Draw the pitch circles of the gears B and C and connect their centers by the line $D F$. Through the pitch point O draw a line $G H$ normal to $D F$. Then locate the gear A at some point on $G H$ so that its pitch circle will be tangent with that of C.

The Single Tumbler Gear.

The single tumbler gear is the basis of many of our modern rapid change speed and feed mechanisms, and the principles treated above apply to this as well as to the simple tumbler gear. Take the simple case shown in Fig. 7, which shows the pitch circles of a four-gear cone and the driver A and tumbler gear C. It is evident that only one position of the gear C can be such that the ideal condition prevails, that is, only when in mesh with one gear of the cone can the line of pressure pass through the axis of the tumbler frame. Fig. 7 shows this to be the case when C is in mesh with the gear B'. Each subsequent shifting of the tumbler along the cone brings the line of pressure eccentric to the axis until the position

of extreme eccentricity is reached when C is in mesh with B''''. In mechanisms of this kind, it should always be the aim of the designer to have the line of pressure pass as close to the center of rotation of the tumbler frame as is possible, because the locking devices used with this type of tumbler gear are necessarily of such a design as to be quick in action, and in consequence are not very stiff or rigid. The line of pressure should always be made to fall on that side of the axis where the tendency is to separate the gears rather than to bring them closer together. When the gear C is supported in a swinging frame which does not slide in a lateral direction, but the changes are made by shifting C along an intermediate shaft, the supporting member should be located at the end where the line of pressure has the greatest eccentricity, as the greatest strain comes at that end. Thus, in Fig. 7 the support should be at the same end as B''''. The diameter of the intermediate gear C has an important effect on the location of the line of pressure. It will be found that it should in most cases be as large as B'''', in order that the line of pressure may come right. However, no exact rule can be given by which the diameter of C can be calculated, as it depends greatly on the difference in the diameters of B' and B'''', and also on the diameter of A.

Rules for the Design of Tumbler Gears.

What direct rule can be given that may be used as a guide in laying out the tumbler gear? Referring to Fig. 5, we see that the gear C is revolving in a direction away from the axis of the tumbler at the point of tangency of the pitch circles of C and B, and that the reacting force tends to crowd the gears farther into mesh. Had this line of pressure fallen on the other side of the axis of the tumbler frame, the tendency would have been opposite in effect. When the gear C is revolving so that a point on the pitch circle travels away from the pivot of the tumbler, and the line of pressure falls

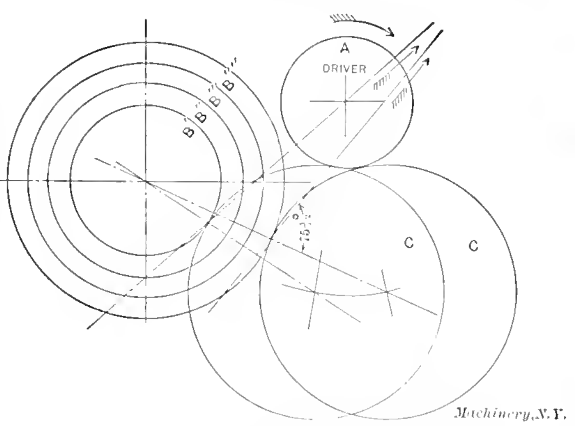

Fig. 7. Single Tumbler Gear in a Feed Box.

somewhere between the pivot point and the axis of the driven gear B, the tendency will be to crowd. From this we therefore may formulate the following rules:

Rule I. When the gear about which the tumbler gear swings is the driver, and the line of pressure falls between the axis of that gear and that of the driven gear, the motion of a point on the pitch circle of the tumbler or intermediate gear, when near the contact point, must be toward the axis of the tumbler frame. Should the direction of a point on the pitch circle be opposite, the line of pressure must fall outside of that area included between the axis of the pivot gear and the driven gear.

Referring again to Fig. 5, it is seen that should the driving gear be B, the above rule does not apply, but may be altered to read thus:

Rule II. When the gear about which the tumbler gear swings is the driven gear, and the line of pressure falls in the space between the axis of this gear and that of the driving gear, the motion of a point on the pitch circle of the intermediate gear at the contact point must be away from the axis of the pivot gear; when the line of pressure falls outside of this space this motion must be reversed.

By following these two rules, more as a precaution than as a compulsory condition, much better success may be expected in the results obtained.

NEW BUILDING FOR THE AMERICAN SCHOOL OF CORRESPONDENCE.

The building recently erected for the American School of Correspondence, Chicago, is of particular interest from both the architectural and the educational point of view. This new home of home study is marked by solidity, dignity and usefulness. In its external, visible lines, it harmonizes with the

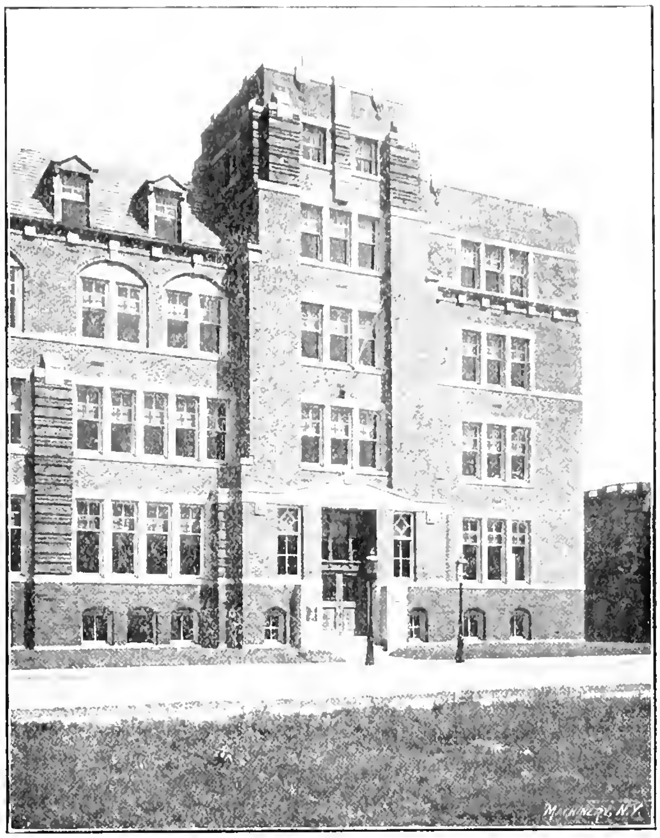

Fig. 1. Detail of Tower, New Building American School of Correspondence.

practical purposes of its design. The structure partakes to some extent of the nature of an office building as well as a school. Its design was, therefore, a complex problem dictated by several different considerations. First, of course, was its intended use as a school and a center of administration; but a factor of almost equal weight was its location. It stands in the immediate vicinity of the magnificent Washington

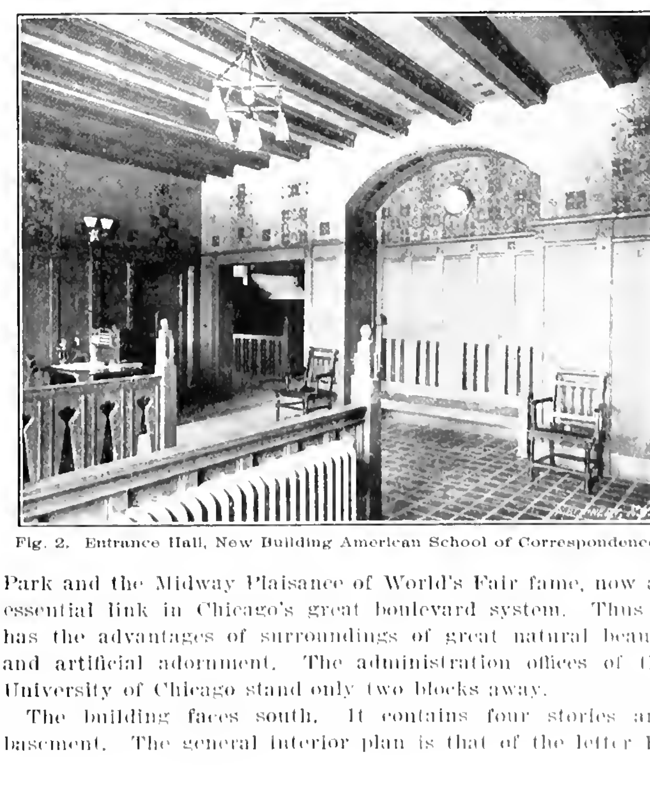

Fig. 2. Entrance Hall, New Building American School of Correspondence.

Park and the Midway Plaisance of World's Fair fame, now an essential link in Chicago's great boulevard system. Thus it has the advantages of surroundings of great natural beauty and artificial adornment. The administration offices of the University of Chicago stand only two blocks away.

The building faces south. It contains four stories and basement. The general interior plan is that of the letter E;

the return of the east and west wings encloses on two sides an open court, 60 feet square, walled in at the rear end and entered through an arched driveway.

The materials of the exterior are paving brick of two shades, with Bedford stone for enrichment, and moss-green tile in the roof. The brick used in the basement and projecting corners of the rustications is of a purplish red, somewhat darker than that used in the body; its depth of tone is strengthened by its being laid with dark joints. The brick in the body of the wall is a medium warm red, variegated enough to have life and pleasing texture; its general contrast to the darker material is emphasized by its being laid with white joints, and by the white finish of the window sash and frames.

The note of green struck in the roof tiling is carried throughout the interior wood finish of the building, which is of quartered oak; the notes of purple and red reappear in the wall decoration, and the red in the polished granite of the entrance steps. Red is also present in the flooring of the vestibule and corridor on the ground floor, which consists of plain red English quarry tile, laid with broad, dark joints, and relieved by occasional mosaics of glazed and varicolored tiling. The general interior color scheme is seen to best advantage in the vestibule. The high oaken wainscoting, the ceiling beams, and the furnishings are tinted a soft green; the walls and ceiling panels a warm buff, relieved with unique, conventional flowered designs in red, green and purple—the whole blending harmoniously and in pleasing contrast with the general darker tinting of the tiled floor.

The administrative offices of the school are on the second floor; the remainder of the building is used for the accommodation of the large staff of instructors, editors, and other employes in charge of the various details of the work of the school. An interior telephone system connects all departments. To facilitate the work of the business office and mailing room, several of the latest electrical appliances have been installed, including adding machines, folding machines, and envelope sealers—all operated by electric power. In the basement are the stock room, the shipping room and the steam-heating plant. The system of heating is known as the "direct-indirect"; the larger radiators are located in juxtaposition to cold-air ducts that lead from the outside through the walls, and that supply an abundance of fresh air at all times. Electricity is used throughout for lighting purposes. The corridors and larger rooms are equipped with Nernst lamps, the other parts of the building with incandescent lamps. Lavatories with hot and cold water are located on each floor.

On the second floor are the lecture room, and the rest room for employes. The lecture room is used as a meeting place for the clubs that have been formed at the works of the Crane Co., the McCormick Harvester Co., and other large manufacturing plants in and near Chicago. At these plants students of the American School of Correspondence have organized, appointed leaders from their own number, and found mutual assistance in studying together. From time to time they meet in the lecture room of the school, where they are provided with instructors, apparatus, and—since most of them come direct from the shop to the school—with a substantial lunch, all for the usual tuition. The school also provides its employes with free coffee and lunch at noontime.

It is the purpose of the American School of Correspondence to take into every home the educational facilities offered by the best resident technical schools; to make it possible for every man, irrespective of age, occupation or condition, to educate himself at home during his spare time; to give the wage earner, the mechanic, the man who has "never had a chance," an opportunity to fit himself for the position in life which he desires to fill.

* * *

It has been estimated that every person in the United States uses, annually, about seven dollars' worth of electricity in some form. Trolley rides lead at $3 per capita; electric light is second with $1.50 per capita. Every man, woman and child buys $1.25 worth of electric apparatus and supplies, uses 75 cents' worth of telephone service, and 50 cents' worth of telegrams and alarms.

BRITISH FILE-TESTING MACHINE.

In the October issue an article on file testing by Mr. Oscar E. Perrigo was published, which gave simple directions for testing files without an apparatus. Presumably this article called forth from Edward G. Herbert, Ltd., Manchester, England, the following description and illustration of that concern's file-testing machine, which was invented in 1905. This machine was designed to give a perfectly reliable mechanical test of hand files and an autographic record of the results produced by each file tested. The machine has revealed an extraordinary difference of quality in files, some files being worn out after filing away less than 1 cubic inch of iron and cutting at the rate of only 1 cubic inch per 10,000 strokes, while the best files (size not given) remove 12½ cubic inches of metal and cut at the rate of 5 cubic inches per 10,000 strokes.

The publication of these results a year or so ago created a sensation in the English file trade, and a public file-testing department was established, and the testing machines were supplied to a number of file makers. The surprising and perhaps, in some cases, painful results obtained by these testing machines at once stimulated file makers to improve their product, and the result has been a general improvement of English files.

The extent of the improvement will be noted from the diagram Fig. 1, being the record of the files tested since the intro-

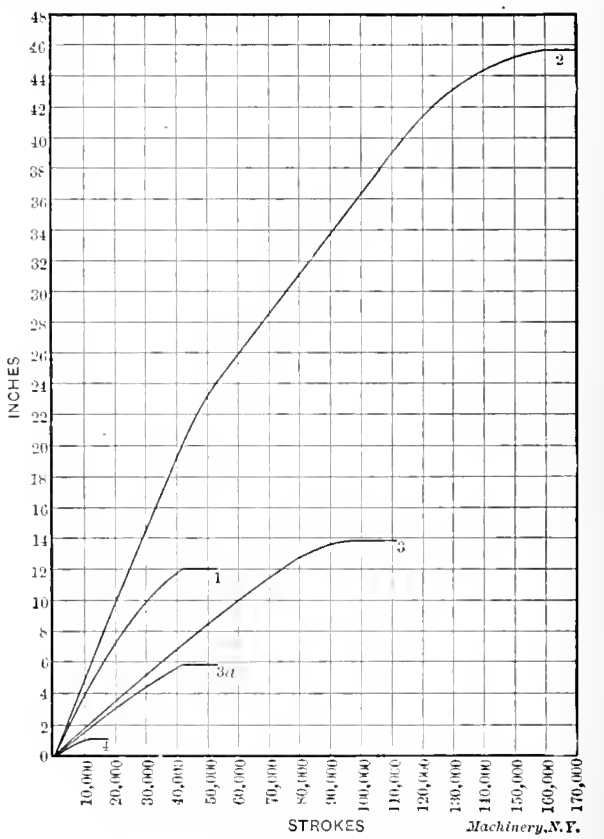

Fig. 1. Records made by File-testing Machine, showing Comparative Life and Cutting Power of Good and Bad Files.

duction of the file-testing machine. Curve 2 indicates that over 45 cubic inches of iron were removed and 160,000 strokes were made before the file ceased to cut. Still better results have been obtained since this sheet was published, files now being made which cut at the rate of 8 cubic inches per 10,000 strokes, and as much as 55 cubic inches have been removed by one side of a single file. Thus, the file-testing machine is directly responsible for an increase of efficiency of very nearly ninefold in the best files, and the end is not yet.

Fig. 2 shows the general construction of the machine. It automatically tests files of any size from 4 to 16 inches and draws a diagram, at the same time indicating the work done in cubic inches. The sharpness of the file is shown by the rate of cutting, and the durability, by the number of strokes taken before the file ceases to cut.

The file A to be tested is held between two head-stocks B B_1, on a reciprocating table C. Head-stock B is provided with a nut and a hollow squared screw D for holding the tang of the

file and exerting end pressure. Head-stock B_1 has a slide and a hand-wheel E, whereby the file may be adjusted with its working face parallel to its direction of motion.

The reciprocating motion of the table is obtained from the pulley and main shaft through a pair of bevel wheels, driving a T-slotted crank disk. A crank-pin, whose position in the T-slot can be varied according to the stroke required, carries a slide block of rectangular form, which slides between two vertical bearing surfaces in an extension of the table C, and serves to drive the latter to-and-fro. The driving mechanism is inside the box frame of the machine and entirely protected from the filings. The machine is started and stopped by a clutch operated by a handle F.

The test bar G is supported in a horizontal position on grooved rollers, and is pressed against the file by a weight H and a chain passing over a pulley and under the bar, to the

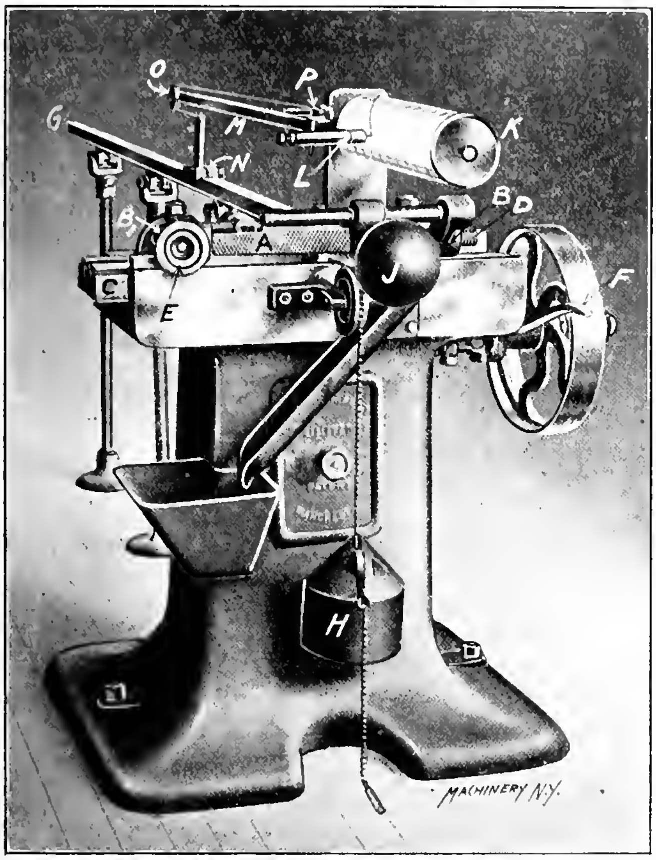

Fig. 2. File-teeting Machine built by Edward G. Herbert, Ltd.

far end of which the chain is attached. The support rollers are grooved to accommodate the chain. The bar is drawn out of contact with the file during the back stroke of the latter, by means of a clutch lever having two hardened jaws embracing the test bar. At the commencement of the back stroke, motion is communicated from a cam on the crank shaft to the outward end of the clutch lever, causing it to tilt and grip the test bar after the manner of a spanner. A slight continuation of the same motion causes it to draw back the test bar, which is again released at the commencement of the forward or cutting stroke. A spherical weight J with a screwed stem, is supported by the head-stock B, and, of course, reciprocates with the file. The end of the stem rests against the back of the file, and the inertia of the weight prevents the chattering and jarring of the file which would otherwise take place. The drum K, round which is wrapped the diagram sheet of squared paper, is driven from a cam on the crank shaft through a pawl and ratchet wheel and a train of reducing gears, so as to make one revolution to 120,000 strokes of the file. A pencil L is pressed against the paper by a light spring, and is carried on a bar M, capable of sliding longitudinally in a fixed bearing. A block N is attached to the test bar, and a fusee chain is attached to this block, and, passing over a pulley O on the pencil bar, is held by a fixed terminal P. It is evident that as the test bar is filed away it is moved forward by the weight H, and a given movement of the test bar causes the pencil to move forward by half that amount. The diagram sheet is graduated in half inches, each of which represents one inch filed off the test bar. The circumference of the drum is 12 inches, and as it revolves under the pencil each inch represents 10,000 strokes of the file. At the commencement of a test, the pencil is set to zero, and, as the drum revolves and the test bar is filed away, a curve is drawn by the compound motion of the drum and pencil. This curve is a complete picture of the life of the file from the commencement of the test until the file is worn out and ceases to cut, the slope of the curve indicating the sharpness or rate of cutting, while the vertical and horizontal ordinates give, respectively, the total amount of work done by the file, and the number of strokes required to do this work and to wear the file out. For example, in Fig. 1, curve 2 shows that the maximum rate of cutting was during the first 15 inches. The efficiency slowly decreased up to 42 cubic inches, when it dropped off rapidly. Cessation of cutting took place at the beginning of the short horizontal line.

On the same diagram, curve 1 was made from a file of good average quality, as usually supplied by the same makers. It cut quickly, but soon wore out, showing that it had sharp teeth, but it was made of poor steel. Curve 3 and 3*a* were made from the two sides of another file. The durability was fair, but the rate of cutting was slow. These diagrams indicate that the file was made of good steel, but had poorly shaped teeth. These diagrams are also interesting in showing the great difference that may exist between two sides of a carelessly made file. Curve 4 was made with a very bad file. It was practically worn out after having removed 1 cubic inch of metal, and 10,000 strokes were required to remove even this small amount.

* * *

DESIGN OF LIGHT STRUCTURAL JIB CRANES.*

W. H. BUTZ.†

In this article, the method of computing the stresses in the various members of the crane in Fig. 1 will be taken up in their proper order. This type of crane is commonly styled

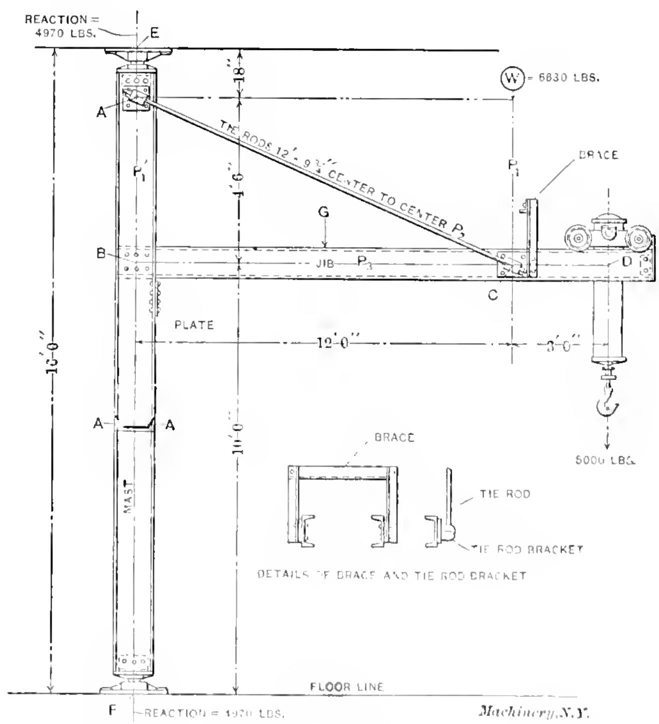

Fig. 1. Outline of the Crane of which Members are to be Calculated.

a jib crane; the radial arm being the jib, and the vertical arm the mast. The tie rods are the adjustable type, the nuts on the end allowing for accurate leveling of the jib when installing crane. A straight lift pneumatic hoist is shown, being the type most familiar to the writer. Assuming the capacity of the hoist as 4,500 pounds, and weight of hoist

* For additional information on cranes and kindred subjects see MACHINERY, November, 1907: Power Required for Cranes and Hoists, and other articles referred to in connection with the article in that issue.

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and carriage as 500 pounds, the total load on the crane will be 5,000 pounds.

Stresses in Jib and Tie Rods.

To arrive at the stresses or loads in the jib and tie rods, the parallelogram of forces is required, see Fig. 2. Draw P_1 to some scale representing the weight of the load, P_2 parallel to the center line of the tie rods, P_3 parallel to the jib, and complete the parallelogram as determined by length of P_1. Now the forces in P_2 and P_3 will be proportional to P_1, when measured to the same scale.

Let W = load,
S_t = tensile stress in the tie rods,
S_c = compressive stress in the jib.

Then we have:

$$S_t = \frac{W P_2}{P_1} \qquad (1)$$

$$S_c = \frac{W P_3}{P_1} \qquad (2)$$

From this it will be seen that the stresses in jib and tie rods are proportional to their length (figured, of course, on the center lines) and the writer would like to say, before going any further, that he has found it the quicker way to use the actual lengths of same in the formulas, making P_1 in Fig. 2 = to distance $A\,B$ on the mast in Fig. 1. All three dimensions (P_1, P_2 and P_3) have to be figured in working up the crane, and after that the slide rule simplifies matters.

Bending Moments and Stresses in Jib.

The first step is to get at the size and weight of beam to use in the jib, as this will add some to the pull exerted in the tie rods by the actual load. It will be seen that $C\,D$ in Fig. 1 equals one-fourth of $B\,C$. This is the most economical location for the tie rod supports, as a glance at the formulas

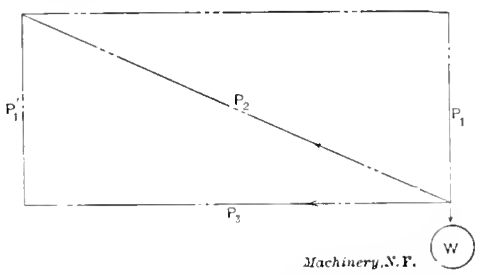

Fig. 2. Force Diagram for the Mast, Jib and Tie Rods.

for bending moments will show. When the load is central between B and C, or at G, we have a beam supported at the ends, and a load in the middle. With the load at D, it is a cantilever, fixed at C, and the load at the end.

Let P = superimposed load (concentrated at one point),
W = total weight of beam,
l = length of beam in inches,
M = bending moment in inch-pounds.

Then for the beam supported at the ends,

$$M = \frac{Pl}{4} + \frac{Wl}{8} \qquad (3)$$

and for the cantilever

$$M = Pl + \frac{Wl}{2} \qquad (4)$$

From this it will be seen that M in a cantilever is four times as great as in a beam of the same length, and the bending moment in either case being proportional to the length of beam, to make the moments equal will require a cantilever one quarter the length of the beam.

When we figure the beam with the load at G, it is also of the proper strength for the load at D. Substituting in formula 3, and assuming that we will use a 10-inch channel, weighing 15 pounds to the foot (remembering that there are two of them), we have:

$$M = \frac{5{,}000 \times 144}{4} + \frac{360 \times 144}{8} = 186{,}480 \text{ inch-pounds.}$$

To get the stress per square inch in the extreme fibers of the beams, we have the formula

$$S = \frac{Mc}{I}. \qquad (5)$$

S = stress in extreme fiber.
M = bending moment in inch-pounds.
c = distance from neutral axis to extreme fiber, in inches.
I = moment of inertia of section, in inches (both beams).

$$S = \frac{186{,}480 \times 5}{66.9 \times 2} = 6{,}958 \text{ pounds per square inch, com-}$$

pression in the upper flange, and tension in the lower.

(NOTE.—The sizes and properties of standard structural shapes can be obtained from any of the steel companies' handbooks.)

In addition to this stress, there is a compressive stress due to the thrust back in the jib. With the load at G, one-half of it, or 2,500 pounds, is supported by the tie rods, together with one-half the weight of the beams between B and C, or 180 pounds, and about 200 pounds additional for the parts outside of C, making a total of 2,880 pounds. Substituting in formula (2), we have:

$$S_c = \frac{2880 \times 144}{54} = 7680 \text{ pounds.}$$

Dividing this by the sectional area of both beams, we have:

$$\frac{7{,}680}{4.46 \times 2} = 861 \text{ pounds per square inch.}$$

Adding this to our stress due to bending moment, we have $6{,}958 + 861 = 7{,}819$ pounds per square inch compressive stress in the upper flange; and deducting $6{,}958 - 861 = 6{,}097$ pounds per square inch tensile stress in the lower flange.

Taking up the allowable stresses in the beam, as compared with stresses obtained above, we find from the handbooks that 12,500 pounds per square inch is the proper working stress (for moving loads) in structural shapes used as beams.

But, we now have to consider an extremely important point. The upper flange is in compression, which makes the same conditions hold as in a column. The longer the column, the lower the allowable working stress, on account of the tendency to buckle in the center, and unless the top flange of our beam can be supported from buckling sideways, the proper reduction must be made to meet this.

Let p = allowable stress in pounds per square inch,
l = length between lateral supports, in inches,
b = width of flange, in inches,

$$p = \frac{18{,}000}{1 + \dfrac{l^2}{3{,}000 b^2}} = \frac{18{,}000}{1 + \dfrac{144^2}{3{,}000 \times 2.6^2}} \qquad (6)$$

$$= 8{,}880 \text{ pounds per square inch.}$$

The allowable stress is 8,880 pounds, and the actual stress is 7,819 pounds, which gives a good margin and insures a stiff crane.

If a 9-inch 13¼-pound channel is looked into, the stress, as calculated from formula 5 (even disregarding the back thrust), will be 8,850 pounds per square inch, while the allowable stress, calculated from formula 6, is only 8,200 pounds, showing that the 10-inch channel is the proper one to use.

The vertical load at C, Fig. 1, with the hoist at D, will be proportional to the lever arms $B\,D$ and $B\,C$.

$$\frac{5{,}000 \times B\,D}{B\,C} = \frac{5{,}000 \times 15}{12} = 6{,}250 \text{ pounds.}$$

Add to this half the weight of beams between B and C, equals 180 pounds, and 200 pounds for structure outside of C, and the total vertical load at $C = 6{,}630$ pounds.

Still another condition to consider is with the load at D. This makes the jib virtually a beam with an upward load at B and downward at C and D, with the added complication of a compressive stress applied at C due to the thrust from the tie rod. Perhaps the best way to calculate the stresses in the part in question, however, will be to consider $C\,B$ as a cantilever fixed at C with the load at D. We may then find the maximum compressive stress due to the flexure at C, and add to it the compressive stresses due to the thrust of the tie rods. Adding together the bending moment due to the 5,000 pounds load, and that due to the weight of the channels and other parts to the right of C, we have

$$M = (5{,}000 \times 36) + (200 \times 18) = 183{,}600 \text{ inch-pounds.}$$

To find the stress per square inch in the extreme fibers of the beams, use formula (5),

$$S = \frac{183{,}600 \times 5}{66.9 \times 2} = 6{,}860 \text{ pounds per square inch.}$$

To this, as before mentioned, we have to add the unit compressive stresses to the thrust on the jib. The total compression is found from formula 2.

$$S_c = \frac{6{,}630 \times 12}{4.5} = 17{,}680 \text{ pounds.}$$

Dividing this thrust by the combined area of the two channels to find the unit compressive stress, we have

$$\frac{17{,}680}{2 \times 4.46} = 1{,}980 \text{ pounds.}$$

The maximum compressive stress immediately to the left of point C is then

$$6{,}860 + 1{,}980 = 8{,}840 \text{ pounds per square inch.}$$

As in the previous case, with the load half-way between B and C, we should examine this condition for safety of the beams as regards failure by buckling. Considering the unstayed length as being that between B and C, as before, we have the same maximum permissible stress of 8,880 pounds per square inch, as given, then, by formula No. 6. It will be seen that our result falls just short of this maximum amount, so we may consider the channels as properly selected.

[In this second case, with the load at D, we would not feel safe in considering the length of the beam as that between B and C when applying formula (6), unless the construction of the brace at C is made differently from that shown, in which case it is possible for the girder to buckle by spreading sidewise at the point where the brace is attached. We would suggest that a cross lattice, or a wide plate, with three or four rivets in each side, be used to connect the two angle uprights shown, rather than to use the single cross angle section with the single riveting, as called for by the sketch.—Editor.]

Size of Tie Rods.

The tie rods must be proportioned to stand the load at D, which is the worst condition. As already figured, the vertical load at $C = 6{,}630$ pounds (with hoist at D).

Substituting in formula (1):

$$S_t = \frac{6{,}630 \times 153.75}{54} = 18{,}875 \text{ pounds.}$$

$$\frac{18{,}875}{2} = 9{,}438 \text{ pounds pull on one rod.}$$

Allowing 10,000 per square inch as a safe working stress,

$$\frac{9{,}438}{10{,}000} = 0.944 \text{ square inches area required at the root of}$$

the thread, giving a 1⅜-inch rod, having an area of 1.053 square inch. A 1¼-inch rod would not be strong enough, having an area at the root of thread of only 0.889 square inch.

Tie Rod Brackets.

These are merely a matter of good design, only making sure that there is sufficient metal to take care of the shearing stress. The rivets for holding the brackets in place must be figured for shear, and for bearing pressure in the channel. We need not discuss the shear, and the safe bearing pressure on rivets in structural work is taken as 20,000 pounds per square inch of projected area in the rivet holes.

One more word with regard to placing the tie-rod brackets at C. The pull of the rods at one side will have a tendency to twist the beams, unless an overhead brace is used as shown. If conditions will not allow this brace, then the rods should be carried very close to the end of the jib.

Stresses in Mast.

This can be arrived at in two ways. Consider the mast as a beam fixed at A, supported at F, and the load at B equal to the greatest back thrust of the jib. A rather complex formula is required for this, and the much simpler method is to figure the reactions on the top and bottom supports, and consider the bottom reaction as a load at the end of a cantilever, fixed at B, and equal to BF in length. The ratio of the reaction on supports to the load at C is proportional to lever arms BC and EF.

$$\frac{6{,}630 \times BC}{EF} = \frac{6{,}630 \times 12}{16} = 4{,}970 \text{ pounds reaction.}$$

M = bending moment in inch-pounds.
P = load = reaction on bearing.
l = length of cantilever in inches = BF.
$M = Pl = 4{,}970 \times 120 = 596{,}400$ inch-pounds.

Substituting in formula 5, and using two 15-inch 33-pound channels, we have:

$$S = \frac{596{,}400 \times 7.5}{312.6 \times 2} = 7{,}155 \text{ pounds per square inch.}$$

The stress for vertical load will add a few hundred pounds to this, but need not be considered in this case, as we have a considerable margin, and the plate shown underneath the jib will prevent side buckling of the compression flange, so that we can figure on the full working stress of 12,500 pounds per square inch. If the stress were very near the limit, then this point would have to be taken up more thoroughly.

A 12-inch channel, 20½ pounds, gives a fiber stress of 14,000, which is too high. A 12-inch channel, 35 pounds, gives only 10,000 per square inch, which would be strong enough, but would not be as economical or as stiff as the 15-inch 33-pound beam, weighing, as it does, 2 pounds more to the foot.

With the hoist at the extreme back of jib, the mast should be considered as a column from B to F. Using formula,

$$P = \frac{50{,}000}{1 + \dfrac{(12L)^2}{24{,}000r^2}},$$

in which

P = ultimate strength, in pounds per square inch.
L = length of column, in feet.
r = least radius of gyration in inches, or about axis AA, in Fig. 1.

We have

$$P = \frac{50{,}000}{1 + \dfrac{(12 \times 10)^2}{24{,}000 \times 0.91^2}} = \frac{50{,}000 \times 19{,}850}{34{,}250} = 29{,}000 \text{ pounds}$$

per square inch, ultimate strength.

Using a safety factor of five for moving loads.

$$\frac{29{,}000}{5} = 5{,}800 \text{ pounds per square inch, safe stress.}$$

Figuring approximately, the load with the hoist at the back is 5,000 pounds, half the weight of jib channels between B and C equals 180 pounds, and the weight of mast parts above B equals 500 pounds, giving a total of 5,680 pounds.

It will be seen from the above that the allowable stress per square inch is greater than the total load on both channels, so that this stress can be ignored entirely in this case, and as a rule, when the mast has been figured for the bending moment, with the load at D, it will be perfectly safe with the load at the back of jib.

Top and Bottom Bearings.

These should be designed with pins amply large to give low bearing pressures, and to take care of shear and bending moments due to the reaction. The bottom plate ought to be large enough to spread the weight over a fairly large area of the foundation. These last points, however, need not be considered here, as this article is intended chiefly to cover the design of the structural portions of the crane.

* * *

Wood Craft calls attention to an important point that is sometimes overlooked by designers who make use of soft rubber as a material for springs. Everyone is familiar with the elasticity of soft rubber. An unconstrained piece of this material, however, acts altogether differently from what it does when it is prevented from changing its shape. Enclosed in a rigid cylinder with an easy fitting cover, it resists pressure solidly and fully, but when free of the cover and allowed to change its form, then it increases in girth exactly as it shortens in length. More than one failure of a rubber spring to do its destined duty has been due to sheer oversight on the part of the machine designer in not giving room for this expansion.

DERIVATION OF THE CROSS-ROLL CURVE.*

ULRICH PETERS.†

The writer offers in the following a practical solution of the mathematical problem known as "the cross-roll curve." This curve is similar to the hyperbola, the curve generating the hyperboloid, but is not the same curve. The cross-roll machine is extensively used for removing the scale on the surface of pipes and round shafts, thereby smoothing, rounding, and to a great extent straightening the work. The angle of the cross-rolls gives rotative and longitudinal motion at the same time to a tube while it is going between the rolls of the machine. The construction of these machines is usually such that on smaller machines there is one cross-roll above and one below, while on larger machines, the cross-rolls are arranged one on each side of the pass. For shaft-

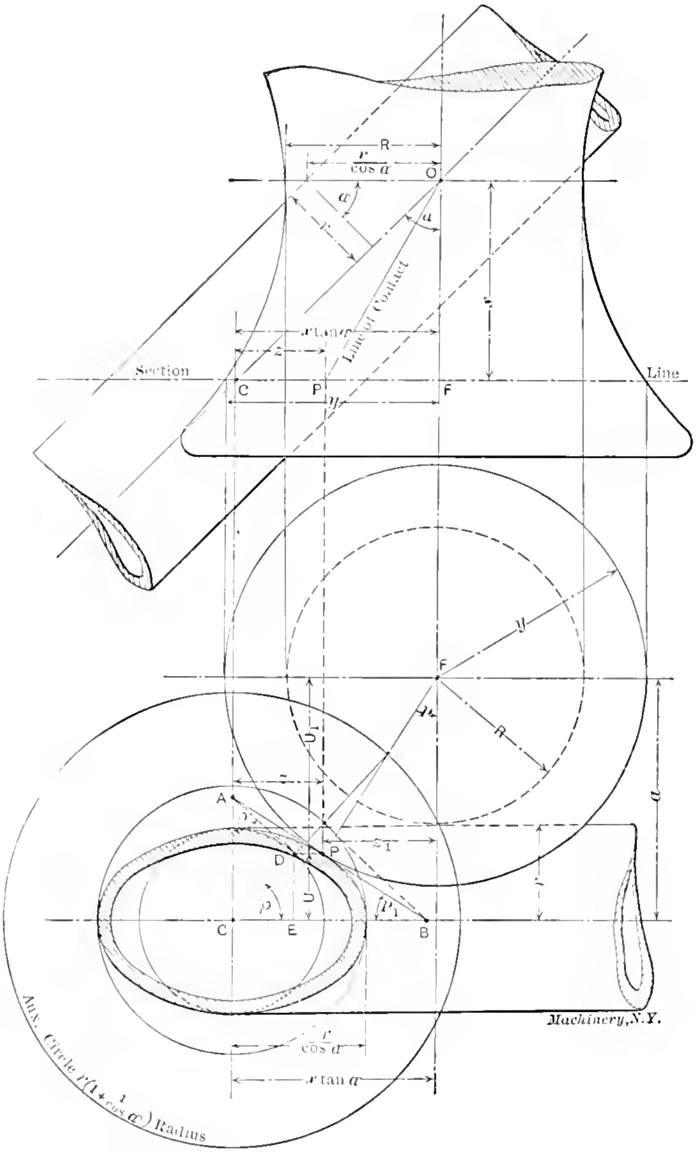

Diagram of Cross-roll Problem.

ing, the best straightening effect is obtained with only one cross-roll working opposite a cylindrical roll, the latter being parallel to the press. The turning of these cross-rolls in the lathe requires considerable skill. The simplest way is to form them to a templet. Of course the work is very much simpler if in connection with this templet an automatic forming lathe attachment is used. The formulas I and II given in the following may be used for determining the true profile of the templet or former.

Let the projected angle of rolls axis on the pipe axis $= \alpha$; the parallel distance of roll axis to billet or pipe axis $= a$ (constant); the middle radius of the cross-roll $= R$; and the outer radius or billet or pipe $= r$.

A section at right angles to the axis of the cross-roll at any distance x from the middle O of the roll (the starting point) will intersect the pipe at an angle. This section when projected, as shown in the lower figure, will show the section of the cross-roll as a true circle of the unknown radius y, and the billet or pipe as an ellipse with half of minor axis $=$ r, and the major axis $= \dfrac{r}{\cos\alpha}$. Both curves touch at a point P where the tangent AB is common to the circle of the cross-roll and at the same time to the ellipse of the pipe, so that $\tan p = \tan p_1$.

By introducing further z, U and z_1, U_1, for abscissæ and ordinates in the ellipse and the circle, respectively, we have according to analysis for the ellipse and circle:

$$z^2\cos^2\alpha + U^2 = r^2 \quad (1) \qquad z_1^2 + U_1^2 = y^2 \quad (2)$$

In the cut it is apparent that $R + r = a$ (3)

$$U + U_1 = a \quad (4) \qquad z + z_1 = x\tan\alpha \quad (5)$$

We also have $\tan p = \tan p_1$, or $\dfrac{z_1}{U_1} = \dfrac{CA}{CB}$, wherein

$$CA = \frac{r}{\sin\beta}, \text{ and } CB = \frac{r}{\cos\alpha\cos\beta}. \text{ Therefore}$$

$$\frac{CA}{CB} = \tan p_1 = \frac{r}{\sin\beta} \times \frac{\cos\alpha\cos\beta}{r} = \cot\beta\cos\alpha.$$

$$\text{Herein } \cot\beta = \frac{CE}{DE} = \frac{\sqrt{r^2 - U^2}}{U}$$

and writing for $\sqrt{r^2 - U^2} = z\cos\alpha$ (taken from formula 1), it follows that for $\tan p = \tan p_1$, can be substituted the following:

$$\frac{z_1}{U_1} = \frac{z}{U}\cos^2\alpha \quad (6)$$

By substituting for $z_1 = \dfrac{U_1 z}{U}\cos^2\alpha$ (from 6) in (2) and (5):

$$y^2 = \left(\frac{U_1 z}{U}\cos^2\alpha\right)^2 + U_1^2 = U_1^2\left(1 + \frac{z^2}{U^2}\cos^4\alpha\right) \quad (2a)$$

$$x\tan\alpha = z + \frac{U_1 z}{U}\cos^2\alpha = z\left(1 + \frac{U_1}{U}\cos^2\alpha\right) \quad (5a)$$

By substituting for $U^2 = r^2 - z^2\cos^2\alpha$, or $U = \sqrt{r^2 - z^2\cos^2\alpha}$ (from equation 1) into (4), (2a) and (5a):

$$a = \sqrt{r^2 - z^2\cos^2\alpha} + U_1 \quad (4a)$$

$$y^2 = U_1^2\left(1 + \frac{z^2\cos^4\alpha}{r^2 - z^2\cos^2\alpha}\right) \quad (2b)$$

$$x\tan\alpha = z\left(1 + \frac{U_1\cos^2\alpha}{\sqrt{r^2 - z^2\cos^2\alpha}}\right) \quad (5b)$$

Finally, substituting from (4a) for $U_1 = a - \sqrt{r^2 - z^2\cos^2\alpha}$ into formulas (2b) and (5b), we obtain:

$$y = \left(a - \sqrt{r^2 - z^2\cos^2\alpha}\right)\sqrt{1 + \frac{z^2\cos^4\alpha}{r^2 - z^2\cos^2\alpha}} \text{ and} \quad (I)$$

$$x = z\cot\alpha\left(\frac{a\cos^2\alpha}{\sqrt{r^2 - z^2\cos^2\alpha}} + \sin^2\alpha\right) \quad (II)$$

Combining formulas (I) and (II) to eliminate the unknown z produces a formula too voluminous for practical application. To solve a given example, it is much better to assume here, by steps, numerical values for z as 0.1, 0.2, etc., inside the limits O and r, and determine the appertaining y and x from above double equations (I) and (II). In this way the cross-roll may be readily plotted and determined.

Mr. Victor Beutner, consulting engineer, Pittsburg, Pa., read a paper before the Engineers' Society of Western Pennsylvania, December 15, 1903, giving a formula:

$$y = \sqrt{x^2\tan^2\alpha + a^2}\left(1 - \frac{r}{\sqrt{x^2\sin^2\alpha + a^2}}\right)$$

which was derived by his assistant, Mr. Edward Hoefer. This formula is not exact and is only approximately correct; in his derivation, the point of contact is incorrectly assumed on the straight line joining C with F, instead of at point P shown in the diagram. Of course the difference would be small for the ordinary cross-roll problem, not exceeding 3/100 inch on the radius y for cross-rolls with small angles of about 5 to 15 degrees.

* See also MACHINERY, June, 1904: The Manufacture of Pipe, engineering edition only, and July, 1904: Rolls for Straightening Pipe.

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SHOP PHOTOGRAPHY.*

CARL S. DOW.†

Carl S. Dow.‡

It is customary for a book to have a preface in which the author states his reasons for adding another publication to an already overcrowded supply in that field, or "makes no apology" for bringing it out. A magazine article seldom has a preface, but there is usually just as good a reason for its appearance. What prompted this article was the editorial in the September issue, in which the editors solicited good photographs for illustrations, and deplored the difficulty of obtaining what they want, namely, sharp "contrasty" photographs that make good half-tone plates.

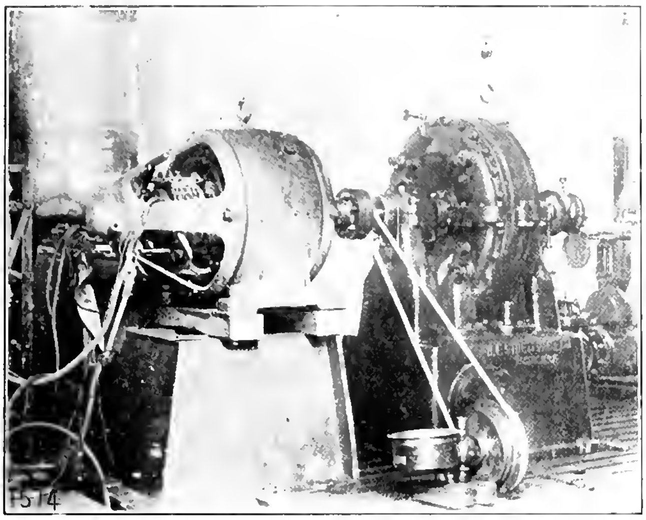

Fig. 1. Photographs taken before Apparatus was Complete. Note the Temporary Base.

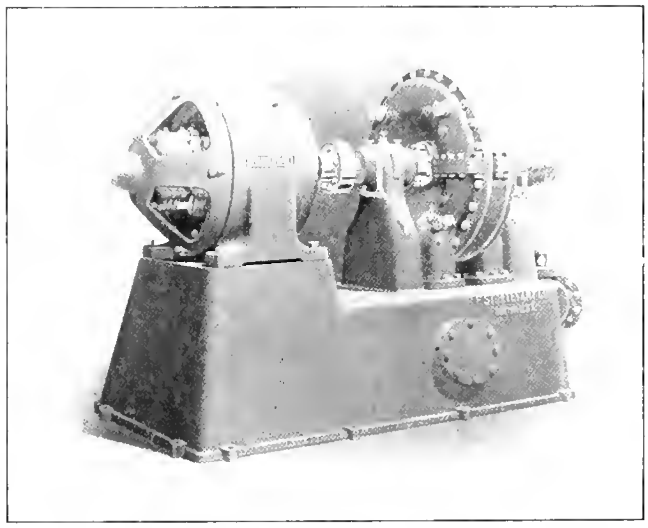

Fig. 1A A Small Generating Set retouched from Fig. 1. An Expensive though Necessary Picture.

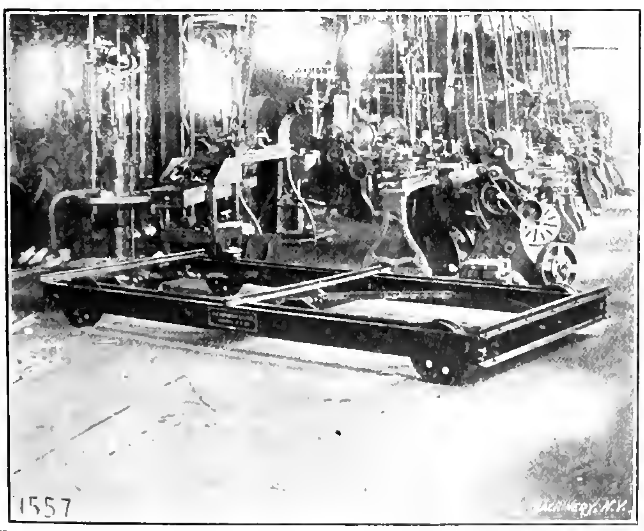

Fig. 2. Lumber Truck photographed without a Background Screen. The Small Stop used brought all Machines into Good Focus.

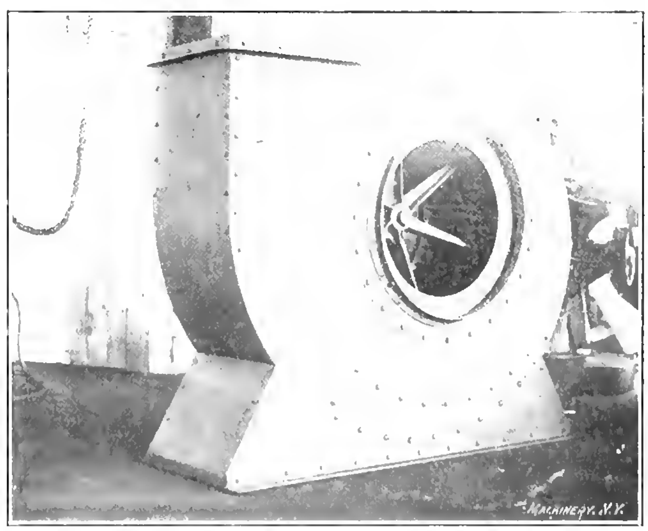

Fig. 3 A Photograph calling for an Opaque Background Screen to prevent Halation from the Windows, and to shut out Surrounding Objects. Otherwise a Good Picture.

It is not for this article to extol the value of photographs as illustrative material, or to tell of the potent influence of good photographs in advertising; but rather to touch upon some of the essential steps in the production of machinery photographs suitable for half toning.

Practically all photographs for technical illustration are made in the shop; this is especially true of large apparatus or machinery in operation, since in the very nature of things, they cannot be taken to a studio. Small parts, gages, valves, and tools, of course, can be moved into good light without difficulty. The three factors which make satisfactory shop photographs of large machines difficult, and necessitate expensive retouching before engraving, are poor light, crowded condition of the shop, and the unpainted or possibly incomplete state of the machine or apparatus.

Poor light cannot be remedied easily, but the manipulation of backgrounds and screens is often an improvement, and flash powders are frequently of service, especially if certain parts are in deep shadow while the major part of the machine is fairly well lighted. Even if a very long exposure is necessary, natural light is usually preferred to a flash-light. A crowded shop makes it necessary to include other machinery and unfinished material, or perhaps renders the best view impossible. When the shop is so crowded that the photograph cannot be taken from a position that will best bring out the desired parts, or if the machine cannot be moved, the

[The photographs used to illustrate this article were reproduced without retouching or change of any kind save in those cases where otherwise stated. This was done to show clearly the points made by the author, but, incidentally, the unretouched views also give the reader a hint of the work ordinarily put on almost all our half tone cuts. Most of the photographs were better than those generally submitted, yet the cuts will not compare well with the average of half tone illustrations used in MACHINERY. We find it necessary to put some retouching on almost all photographs of machinery, shop interiors and similar subjects. If the hints given by Mr. Dow were generally observed the amount of this work would be much reduced and the cuts would gain in snappiness and strength, for a perfect photograph cannot be successfully imitated by the retoucher, although he may be able to greatly improve a poor one. EDITOR.]

* For previous articles on shop photography see "Shop Photography," by H. P. Fairfield, November, 1906, and "Photographs for Illustration," September, 1907.

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‡ Carl S. Dow was born at Woburn, Mass., in 1874. He graduated from the engineering department, Harvard University, in 1897, with the degree of S. B. From 1898 to 1905 he was in charge of the text book department and instruction of the American School of Correspondence at Armour Institute, Chicago, and since up to July, 1907, was in the publicity department of the B. F. Sturtevant Co. He is now advertising manager of that company. Mr. Dow has specialized on engineering publicity and technical editorial work. He has contributed considerably to the engineering press and was editor-in-chief of two volumes on shop work and of three volumes on practical engineering published by a Philadelphia concern.

making of the negative should be postponed until shipment is made, at which time a better position or light can usually be obtained without much trouble. Obviously a machine should not be photographed until completed and painted, otherwise much expense is necessary for retouching; but of course the negative may be necessary before such state of completion is attained. Speaking of paint—it should always be dull finish, and red, black, or slate color will give good results.

Background Screens.

The probable use for the picture should be known to the artist at the outset. If for a catalogue cut or advertising

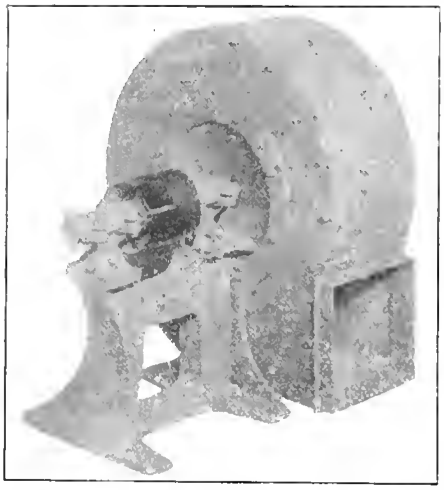


Fig. 4. Made with a Long Focus Lens which was much too High. The Shaft is not Horizontal, the Top and Outlet are Distorted and the Perspective is not Good.

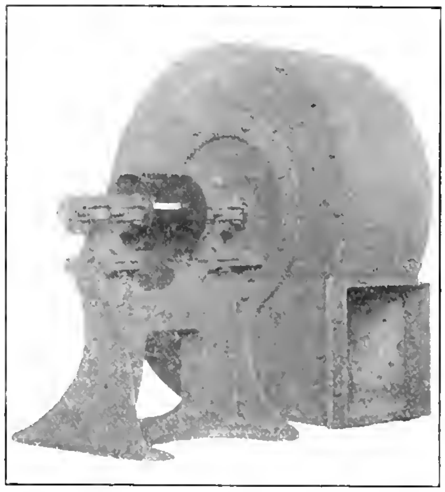


Fig. 4A. Made with Long Focus Lens, with Camera placed at Proper Height. Note the Rectanguler Outlet and General Appearance of Good Proportion without Distortion.

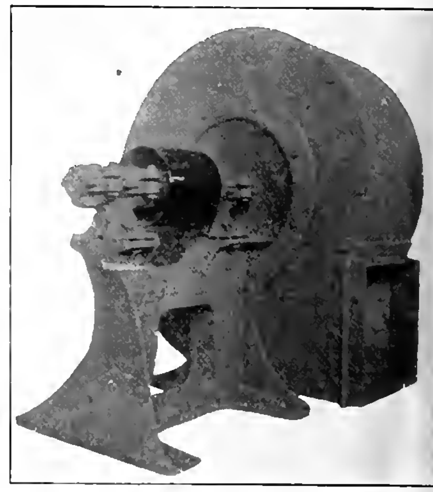


Fig. 4B. Made with a Wide Angle Lens placed at Proper Height. Note the Abnormal Size of the Parts nearest the Camera. The General Effect is Bad.

illustration, the irrelevant machines or material surrounding the object must be obliterated after the negative is made; this is usually done by "painting out" with opaque water color. If the machine has many small parts on the profile, it is often difficult to separate them from the surroundings when painting out. For such conditions a white background

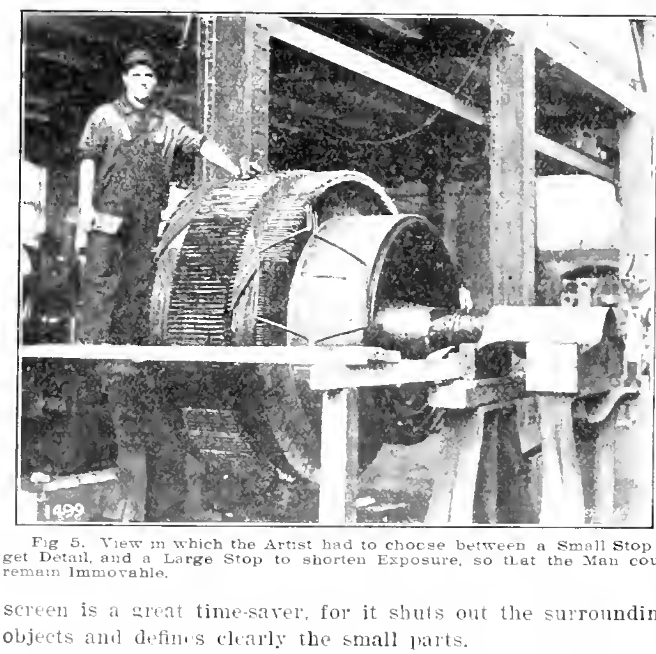


Fig. 5. View in which the Artist had to choose between a Small Stop to get Detail, and a Large Stop to shorten Exposure, so that the Man could remain Immovable.

screen is a great time-saver, for it shuts out the surrounding objects and defines clearly the small parts.

The background screen serves still another purpose. In many shop pictures the desired view necessitates the directing of the camera toward a window, which causes halation around the contour of the machine. An opaque screen will shut off this light which is not only of no assistance in making the photograph but is detrimental. If the background screen is too small to cover the entire machine, it should be placed behind the smallest parts which are the most difficult to paint out. In case no screen is available, the machine should be separated as much as possible from the other apparatus, or placed at some distance in front of it so that the machine only will be in sharp focus. With the light near the floor of less intensity than at a few feet above, white cloth or paper arranged about the bed or frame throws the light upward and brightens up the parts in shadow; it also makes the lower parts more clearly defined.

Position.

In shop photography the features to be brought out are usually those relative to details of construction, or those strongest in selling. The choice of position is one that must sometimes be studied. Shifting the camera a few inches often causes an important detail to become prominent, or, on the other hand, unduly exaggerates a minor or objectionable construction. The writer once had occasion to photograph a blower driven direct-connected by a motor which was large because the air pressure was to be high. Now a good light was easily obtained with the camera in a position that brought the motor into the foreground, but evidently it was not wise to show that the blower required such a large motor because the conditions of pressure might not always be given in connection with the picture. To overcome this, the set was swung around by the electric crane so that the blower came into the foreground, causing the motor to be subordinate to it.

The height of the lens is a point not usually considered with sufficient care, and yet is an important factor in the perspective. One has only to look at two pictures of the same machine to notice the difference. In general, it may

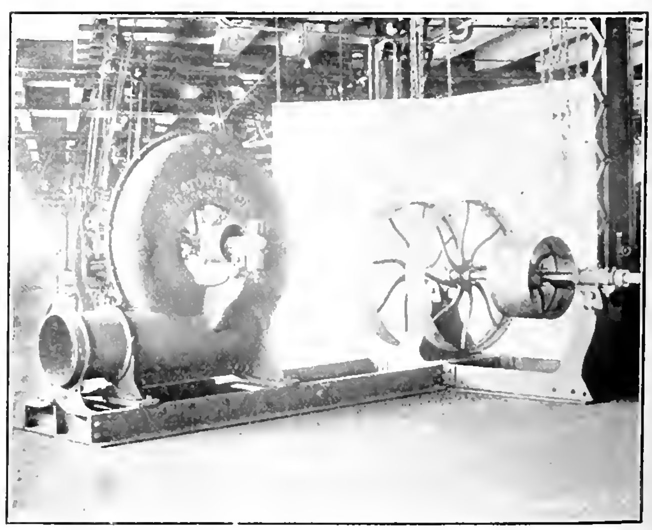


Fig. 6. Showing use of Background Screen too Small to extend over the Entire Apparatus

be said that the lens should be placed at about the middle of the height, and, if the machine has a horizontal shaft, the lens should be placed on that level. With the lens at or below the center, the machine looks large and substantial, which are often desirable features.

As to the lens itself, a long focus lens should be used, if

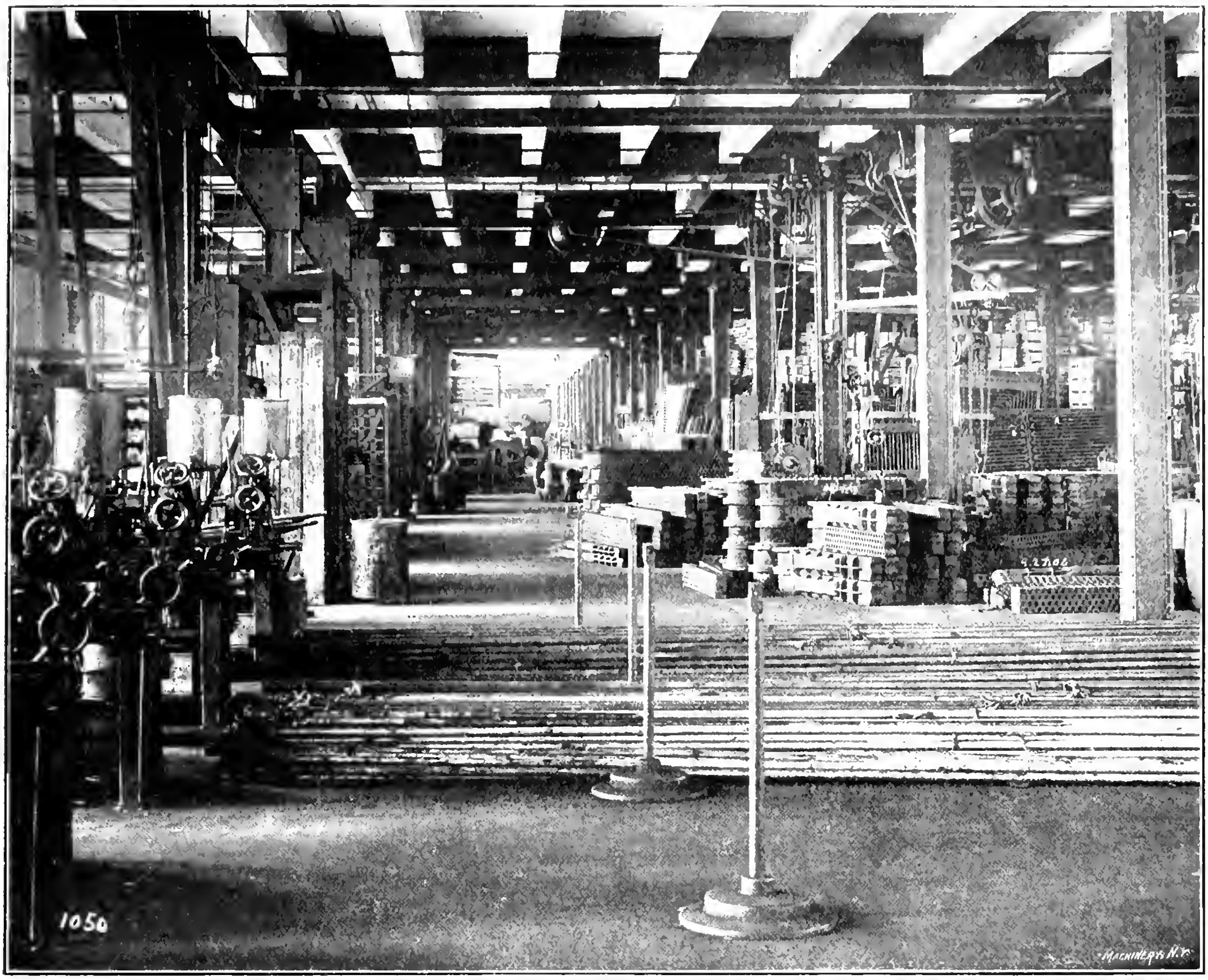


Fig. 7. Well-lighted Shop Interior. The Great Depth required a Small Stop to make all Details Sharp.

possible, when photographing machinery. A wide-angle lens is sure to distort the lines, and make those parts nearest the camera very large; its use should be restricted to cramped places in which it is impossible to get the entire apparatus on the ground glass with a long focus lens.

Focus.

No attempt to focus should be made until the best view has been selected and the camera placed in what is probably the correct position. Focussing is best done with full opening, so that when the opening is reduced the image will be very sharply defined. Curved surfaces are not easily focussed, hence a newspaper, printed sign, or calender, placed against the machine and brought into sharp focus, is a valuable aid. With the black letters in best focus the machine will be sharp.

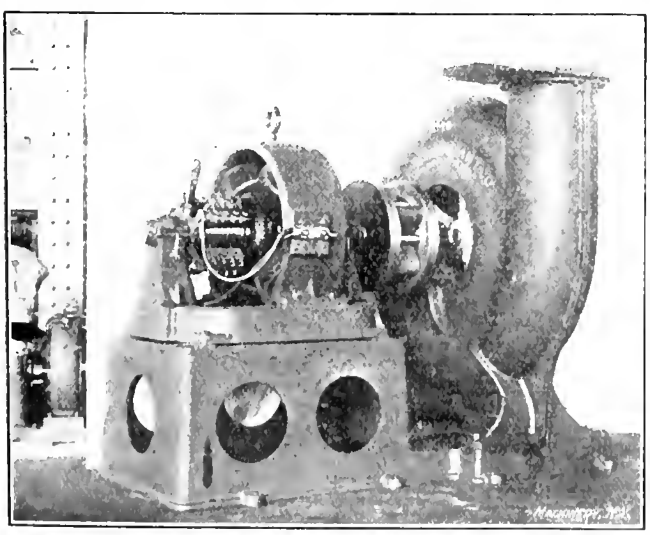


Fig. 8. Illustrating the Use of a Small Stop and Long Exposure. In a Well-lighted Shop about 30 feet from the Windows, at Noon, the Exposure was Seven Minutes, Seed 26 Plate, and F64 Stop

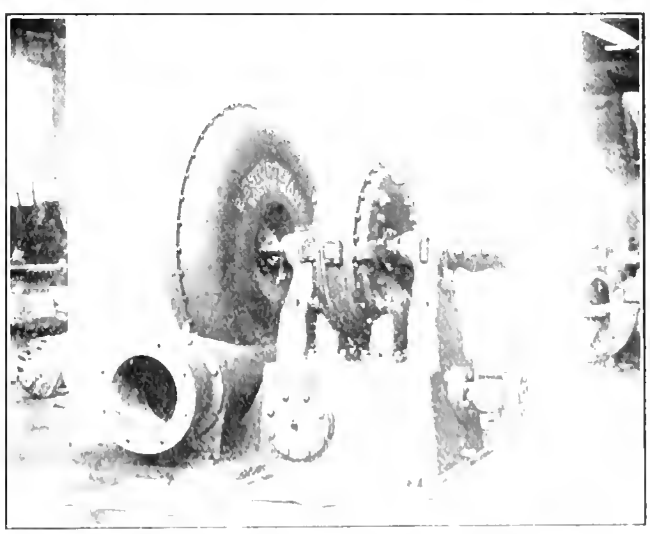


Fig. 9. Under Saw-tooth Roof at Noon, Exposure Seven Minutes, Cramer Banner X Plate, F.32 Stop

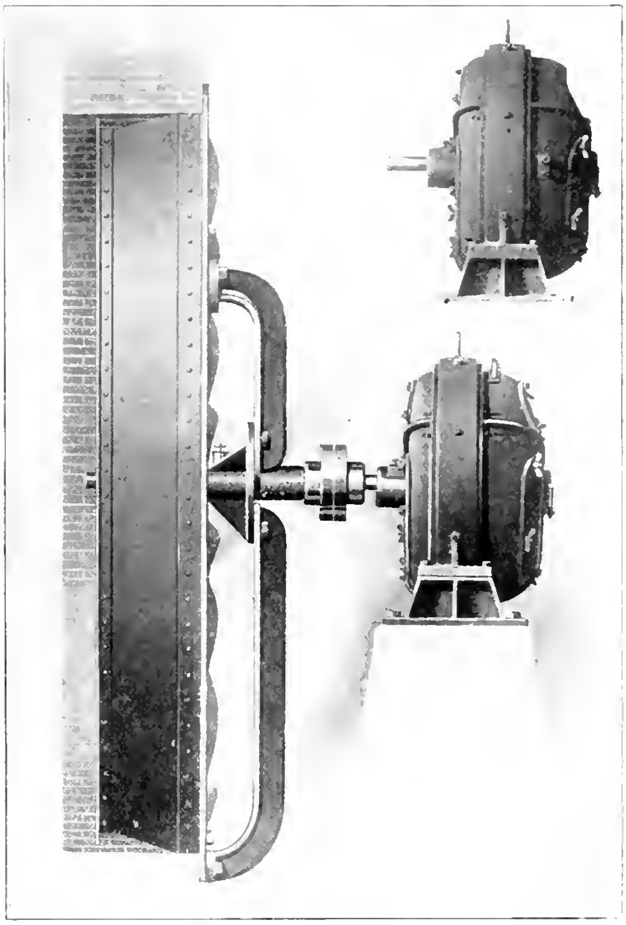
Stop.

The choice of stop, or opening, must be governed by several conditions, and here is a chance for one to use his judgment. A small stop requires a long exposure, gives a sharp picture, and brings all parts of the apparatus into focus. This last point should not be overlooked, if the distance from the camera to some points of the machine is far greater than to others. When all of the machine lies in the same plane a large stop will probably give as good a picture, and the exposure will be of much shorter duration. To get the detail

of small parts, such as the armature of a motor, a small stop is desirable. It sometimes happens that a small stop is out of the question, for a very long exposure (15 minutes to one-half hour) would prevent the men in the shop doing their work, or might delay passing to and from machines. In general, it may be said that the stop should be as small as conditions will allow.

Exposure.

The length of time the plate should be exposed is determined solely from experience and a knowledge of conditions.



Figs 10 and 10A. Photograph of Motor to be combined with Wash Drawing, and the Result. The Photograph of Motor was Retouched to make it blend with Drawing.

It is almost useless to give any figures, for the light varies, not only in different shops, but in the same shop, according to the season and time of day. The size of the stop and the speed of the plate are also controlling factors. Under-exposure is far more common than over-exposure. In a well-lighted shop at a distance of 10 to 20 feet from the windows, with a "Seed 26" or "Cramer Crown" plate, and a small stop, 3 to 8 minutes is usually required. The writer finds a moderate speed plate, such as a "Cramer Banner," very satisfactory, for it has considerable latitude, yet is not so slow as to consume an excessive amount of valuable time.

Exposure is a most important part of photography. The length of time may perhaps be easiest determined by comparing the existing conditions with those under which a satisfactory negative has been made. This determination of exposure is unconsciously followed by everyone. To make the comparison easy, the same size of opening and the same kind of plate should be used as much as possible.

A machine with few polished parts, and painted black, or the armature of a motor, requires a long exposure. When in a bright light, polished parts may show undesirable reflections, but the parts may be given a frosty appearance by dabbing them with putty, which can easily be wiped off with benzine or gasoline. Lettering, such as the maker's name, and the size of the machine, can be well brought out in a photograph by chalking just before exposure.

Developing.

The procedure of development, and the kind of developer to use for negatives made in the shop, are not different for negatives made elsewhere. Almost the only consideration is the printing quality. In any large manufacturing plant, the advertising or sales departments may make a rush call for a large number of prints from a certain negative. Unfavorable weather may render it impossible to get the prints off for several days. In plants of this kind, the developer should be so selected, and the depth to which the development is carried should be such, as to yield clear, quick-printing negatives. Over-exposure should be avoided.

Pyro is deservedly a favorite with many, because of the ease with which slight errors in exposure may be counteracted. But its liability to spoil, and cause stained or slow-printing negatives, has led some to discard it. Pyro developer will be preserved indefinitely by dissolving a small quantity of oxalic acid (10 grains to 16 ounces) in the water in which the pyro is to be dissolved. The oxalic acid should be dissolved before the pyro is added. All stains may be eliminated by using a little acetic acid in the hypo bath (1 ounce to 1 quart of water).

An intelligent manipulation of the developer requires experience and some knowledge of chemistry. Probably the most common difficulty is that of getting negatives with contrast, for the shadows often show too much detail where there should be practically clear glass. To print such negatives to sufficient depth to make these shadows strong, causes the high lights to become dimmed. If the exposure has been properly timed, the cause of excessive detail in the shadows is probably too much sulphite of soda (in pyro developer) or too much alkali. A reduction in the amount of alkali will almost invariably effect an improvement.

Printing and Paper.

The photographer may receive orders for prints of any one of three kinds—blue prints, silver prints, or developed prints. For general sales use, the blue print is widely used, for it is

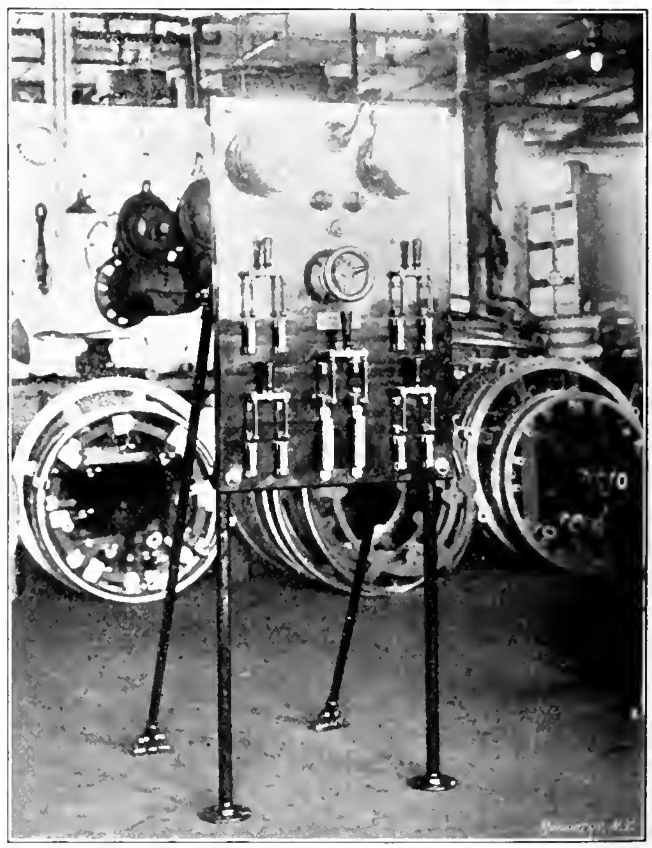


Fig 11. Carelessly-made Photograph. Intense Direct Light from Windows caused Over-exposure and Reflection at top of Switchboard. The Lower Part is Good. Windows should have been Curtained.

quickly made, inexpensive, can be folded without cracking, and is of a businesslike appearance. It is well to purchase the prepared stock in metal tubes; being of higher grade it will yield far better prints than the cheaper blue print paper used for making shop prints from tracings.

The silver print is by far the best for retouching and half-toning; it gives the detail and smooth surface necessary for these processes. When making a print for half-toning, it

should not be too dark in the shadows, and the tone should be of a good chocolate. A deep brown tone is superior to a blue or purple, which photograph lighter. Yellows and reds should be avoided. In mounting a print for retouching, the cardboard should be thick to prevent warping, and very smooth. The smoothest card possible is the only suitable board for mounting.

Machinery salesmen frequently want their prints mounted on cloth so that they will stand the wear and tear of constant use; the cloth also provides a means of binding. Cloth-mounted prints are often ferrotyped, that is given a glossy surface which adds to both appearance and durability. This finish is obtained as follows: The wet print is placed face down on the ferrotype plate, which has been made scrupulously clean and lubricated slightly with soap or glycerine. After removing all bubbles, the back of the print is covered with paste and the cloth pressed in contact with the print. When the print dries the corners will start from the ferrotype plate, from which it may easily be stripped when perfectly dry. It is then trimmed, the strip of cloth or binding being left on the proper edge. Velox or other gas-light prints, except with certain grades of paper, have too rough a surface for retouching. They are more "contrasty" than silver prints, and show less detail. For framing and for rush orders, they are very satisfactory for they can be turned out rapidly, even if the weather is cloudy, or if the short days of winter are at hand. A negative that is too thin, in other words, a "flat" negative, will yield a better print on a gas light paper.

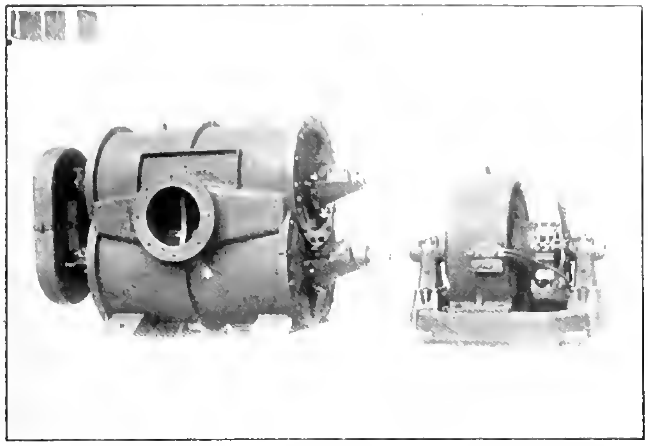


Fig. 12. Blower and Motor posed for Photograph

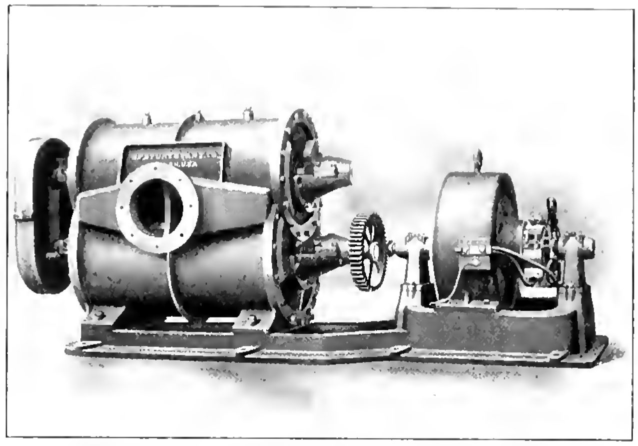


Fig. 12A. The Result after the Artist has done his Work.

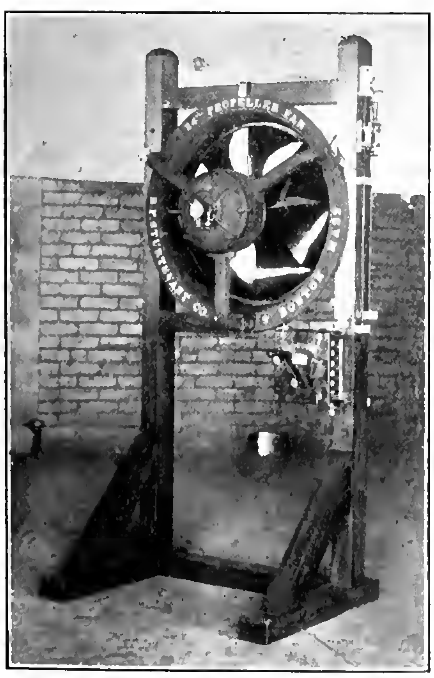


Fig. 13. The Motor-driven Fan and its Controller.

Fig. 13A. The Picture of the Child

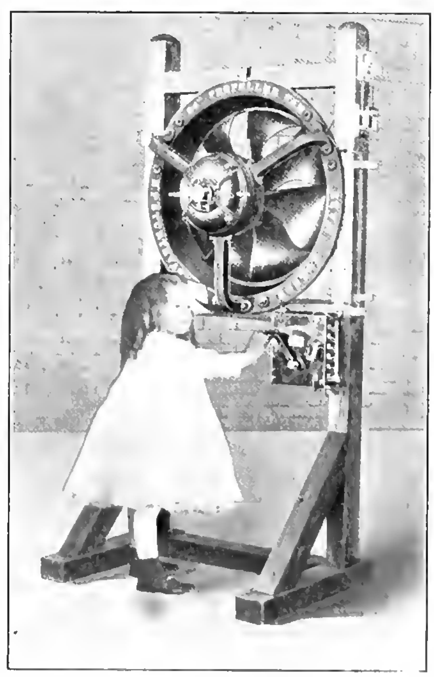


Fig. 13B. The Result of the Combination.

"Faking" or Altering Photographs.

In certain lines of work existing conditions render it impossible at times to get the machine photographed just as it is wanted, or perhaps an effect is desired, which, although reasonable or probable, is out of the question. Innumerable cases of extensive alteration, even to the extent of "faking," might be described, but three will serve as examples.

In preparing a publication on electric propeller fans, the writer was unable to photograph a large fan of certain constructive features, for at the time none was in stock and no order was going through the shop. To get the complete photograph of the motor-driven fan, as shown in Fig. 10, a photograph of a motor of the proper type and size was first made. This was painted out and printed on a 10 x 12 sheet of silver paper. An outline drawing of the propeller fan of the correct size for the motor was then made in pencil on the mounted silver print. The artist had no difficulty in placing the concrete base beneath the motor and making a "wash" drawing of the pencil outline. The illustration is worthy of note in that the motor is an actual photograph, while the fan, brickwork, and motor base are not.

A case illustrating the necessity of photographing machinery before it is complete is shown in Fig. 12. The writer needed a picture of a motor-driven rotary blower before the set had been built. A motor of the proper size to drive the blower at hand was placed in position. The relative speeds being known, the pitch and diameter of the gears were easily determined, and the pitch diameters gave the distance between the shafts. Of course no bed or foundation was at hand so that it was necessary to build up the blocking to the desired height. By the means of the electric crane, the motor was placed with the shaft parallel to that of the blower and at the proper distance from it. To make the painting out easier, the blocking for both blower and motor was covered with white cloth, and two background screens were used. The

artist painted in the bed from the working drawings (the patterns not yet being made) and also the gears.

It may strike some readers that the child photographed in the act of starting the electric propeller fan is out of place in a shop photograph. The picture is, of course, designed to show the simplicity of operation. This effect was produced from two negatives. The fan itself in the supporting frame was photographed in the shop, with an exposure of about seven minutes, and the child was photographed in her home against a dark background, with her hand resting on the corner of a table, the height of which approximated the height of the rheostat handle. A double printing and a little artistic work completed the picture. A point to be remembered in this connection is the height of the lens. If the lens had not been at practically the same height in both cases, the child's feet would have had an incorrect perspective.

* * *

BILL'S GARAGE.

ETHAN VIALL.*

My friend Bill and I often get together after the day's work is over and swap stories and experiences. Bill is the superintendent of the general hardware factory just across the street from our shop. His experience has been wide; he is a hustler, and knows how to handle his men to the very best advantage.

One evening our talk ran into a discussion as to whether a man was better off working for himself, or in getting and keeping a good job with some reliable firm. The talk waxed rather warm, and Bill was so positive in his stand that a man was better off working for someone else, that I finally said, "I'll bet a five-dollar note that you've been burnt, yourself." Bill rubbed his head, and, with a rueful smile, replied, "Yes, I have been burnt, and not only that but burned out, and only three or four years ago at that.

He paused to throw away the stub he had been smoking, and, lighting a fresh cigar, he said, "After several years of successful running of shops for other people, I became imbued with the idea that I could do better in business for myself. At that time the boom of the bicycle business, which had furnished work for so many 'mushroom' repair shops and 'toadstool' mechanics, had died out, and the automobile was just passing the experimental stage, and coming near enough to perfection to enable one to take a ride of at least a mile without breaking down. What was left of the bicycle trade had settled into a steady business with all the flourishes gone. Now my work with the largest manufacturer of bicycles in the United States had given me knowledge of 'kinks' in the business unknown to the average repair man, and I also had an intimate knowledge of the automobile shop work as it then existed, owing to this firm being one of the first to get into the new line. Naturally, with this experience still fresh in my mind, my thoughts ran to the establishment of a general repair shop for bicycles and automobiles, and then perhaps later on an automobile factory and a position in the 'trust' that I felt would come as inevitably as Col. Pope's corner of the bicycle factories. (Teddy the 'trust buster,' hadn't begun to 'bust' at that time.)

"Having decided to place my worldly and mechanical knowledge, and what other capital I possessed, in an automobile, so to speak, my next move was to find a suitable town to settle in, as I had decided that I wanted to get out of Chicago for a change. About half way down the state was an enterprising little town of thirty thousand inhabitants, which seemed to be an ideal place for a shop.

"Having decided on the line, the town, and finally the building, I started to work. My plan was to begin modestly and build up my trade gradually. Dropping the auto repair idea for a time, I devoted my energy to the bicycle business. There were five other shops in town but I could vulcanize tires and do brazing, which they could not, and, using these two accomplishments as drawing cards and headings for my advertisements, I soon had enough business to keep myself and two men hustling. The growth of my trade was really phenomenal, which I attribute to thoroughly knowing my business and to advertising. I advertised in 'catchy' ways in every city and county paper, and on the fences at every cross road.

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"In addition to my repair work, my sale of supplies began to assume really respectable proportions. I had started early in the spring and by fall my business was far beyond my widest hopes, but, fearing a dropping off of business due to the stopping of bicycle riding at the approach of winter, I added another line—barber supplies.

"There were thirty-four barber shops in town, so I left my repair work in the hands of my men, and personally went after the job of supplying these shops with everything they used, from face powder and soap, through the different shapes of combs and shears, to chairs and fixtures. I had three big Chicago supply houses to 'buck against,' and also one from a neighboring town, but before the winter was half over I was selling nine-tenths of the stuff used by the barbers in town, and was reaching after the trade in the little towns nearby. As spring approached, I moved to larger quarters, and, still keeping my grip on all I had gained, I began to pull for the

"One night the whole business went up in smoke."

automobile trade for all I was worth. I had but one rival in this, but it was a formidable one, as this firm had sold practically all the automobiles used in the county, which, at this time, numbered about sixty. Nevertheless, with the prestige I had gained in my other work it was but a few months when the bulk of both the repair work and the selling of automobile supplies was mine. All that year my business grew until I was unable to handle all of it, and I sold my bicycle business to one of the other shops, and devoted my energies to the barber supply and automobile business. By the following spring, having added the agency for two popular automobiles, I had one of the best equipped garages in the country for a town of the size I was in. I carried about two thousand dollars' worth of supplies on hand, and, in addition, tools, machines and other things that brought the total up to about five thousand dollars, which, owing to the nature of the business, was all risk and no insurance, and one night the whole business 'went up in smoke,' or at least most of it, for the stuff that was left was hardly worth sorting over. A big twelve-horse-power gasoline engine which I had just installed to furnish power for my machine shop, brought five dollars for junk!

"Tired and discouraged by a misfortune that had cost me the product of two and one-half years' work and about six thousand dollars, I turned over my trade to the man who had bought my bicycle business, and securing a position as superintendent of the hardware factory, I went out of business for myself, but though my financial loss was considerable, yet I count the experience a valuable asset.

"I have no desire to go back to working for myself where I have to get up at half past four in the morning and work till midnight, with no Sundays or holidays. I much prefer to run some other man's shop, where, while I do my best, it is someone else who has the worry over the bills, the payroll and the business, and if anyone thinks that running one's own shop is a snap, let 'em *try* it."

Then Bill got up and we both started for home.

SAFEGUARD IN MACHINERY.

W. H. BOOTH.*

In Great Britain, and probably still more in Germany, the care of the workman is apt to be more rigid on the part of the government than it is in perhaps any other countries. In the opinion of many people who have watched the statistics of accidents, the effect of this care has been largely nullified in Great Britain by the countervailing influence of the Employers' Liability Act, which provides compensation for a workman, irrespective of whether the accident was due to his own wilful disobedience of safety rules or not. It may seem curious that personal injuries should increase as a result of certain compensation. It can scarcely be believed that any man would wilfully injure himself, and one can only attribute such increase of injuries to the unconscious effects of the acts for compensation.

But it is certain that workmen do take extraordinary risks without being called on to do so. Often one may hear an employer blamed because some poor fellow has gone home crippled, in order to put gold into his employer's pocket, but, careless as some employers may be, it is true that the workers are more often to blame than their employer. Men will dip under a suspended weight to save an extra yard in going round it. They will risk their own lives and their employer's solvency for the sake of a trivial economy of time.

The writer was once forced to lower a weight with tackle not safe for half the load put upon it. All hands were called clear, and the extreme danger pointed out, and yet men would pass beneath the load in this dangerous condition, and it was useless to attempt to stop them. If every one were to detail his experiences of carelessness, it would seem that some men cannot be trusted to care for their own lives or for those of others. They do not mean to be hurt; they simply think it will be all right this time, and probably say to themselves "for the last time," resolving not to do it again, and they do this once too often.

Among the inspectors of the Home Office, which is the department of the English government that cares for these things, nothing is left to chance. Often more is enforced than ought to be, for one is sometimes compelled to place fences so that they add to the danger, as when placed too near to a small gas engine fly-wheel, so that it is difficult to start the engine by the usual method for small engines, namely, by turning of the fly-wheel. Probably, in time, no gas engine will be allowed to be started except by an accumulated air pressure. Wheels are guarded very completely. A pair guarded only on their top or in-running sides were ordered to be fully cased in because "some time it might happen" that in some extraordinary way they would turn the other way round.

Machinery fencing is of two sorts. There is the guard over the pair of wheels or other detail, and there is the general guard or fence or cage which contains the whole machine and prevents all access to it except by key. Some things cannot be guarded, such as the cutters of certain woodworking machinery, and these are perhaps the worst things for accident producing, for they are almost invisible when most dangerous. A circular saw might often be better caged than guarded, but a saw may be very considerably protected by a distance guard, when it is impossible to guard by a close cover. The Home Office takes account also of child labor, of overtime for women and young persons generally, of heating, lighting, ventilation, and sanitation, and especially of the precautions to be adopted when persons are employed, as in the glazing of pottery. All pottery people are on the *qui vive* to find a leadless glaze. One hears of leadless glaze, but investigation generally reveals a hidden source of lead. The trouble comes in the putting on of the glaze in solution, and all the evils of lead poisoning accrue, so that a strict watch is kept on all who are employed in respect of medical examination for detecting the first symptoms. Yet people who know they have symptoms will endeavor to hide them, and pass the doctor. Fans, for removal of dust, and all manner of respirators and other safeguards are more or less attended to by Home Office inspectors.

In the pottery trade, the scheme was tried of putting hoods over the heads of the workers, into which fresh air from an absolutely pure source was brought, so that there should always be a draft away from the workers and lead fumes could not get toward them, but somehow this did not answer. The lead taken into the system is not all taken through the lungs. The file cutter who cuts his files upon a block of lead is often careless how he eats food with leaded fingers, and lead will get into the body through the skin.

Copper poisoning does not appear to attract the same attention as lead, but undoubtedly brass workers suffer in health as a result of the copper. A brass founder never has any infectious complaint, it is said, for copper fumes are fatal to germ life, and, finally, are fatal to the man, but the effects are not so painful as those of lead, possibly because the copper salts are soluble and are eliminated, whereas lead accumulates. Brass workers appear to develop a dislike to fresh air. They will not put up with open windows that other men can enjoy, so that a brass shop ought to be fitted with a ventilation system out of the control of the occupants, and should be suitably warmed to fit the enfeebled workers, who might then be much improved.

One of the reasons why Kaffir labor becomes so scarce in the Transvaal mines was alleged to be the extraordinary high pay given to the "boys" during the war. But probably a much more potent cause has been the discovery by the Kaffirs that working rock drills produces miner's phthisis, so that the men died like flies, and now fight shy of mining work. The drills ought to work through an exhausted hood piece, the dusty air being delivered through a water box to settle out the grit. The provision of good water has been shown to be a great help in keeping machinery going. Good air is equally valuable.

Every industry has its own peculiar crop of accidents, from unexpected directions and least suspected causes. It almost seems necessary for accidents to happen in order that weak points in design may be shown up, just as the true stresses in machinery and structural work only show up in actual work, though this is less the case now than formerly when the failure of bridge details began to teach men that they could not allow the same nominal unit stresses in all details, but must take account of the manner of approach of the stress-producing agent or load.

Familiarity may lead to accident. It may also serve to prevent accident. Thus, if the people of England began to-morrow to walk upon the tracks of a railroad in the way usual in America, many thousands would be killed. In a week's time very few would be even hurt. So it is with ordinary machinery. The worker does not get hurt so often as might be thought likely, but, nevertheless, he does sometimes suffer from lack of guards to the more dangerous parts. The knowledge of what to guard, and how to guard it, is quite a special knowledge, demanding acquaintance with the machine and the method of its operation, and a general acquaintance with machinery and with accidents of all kinds.

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* * *

The Stockbridge Machine Co., of Worcester, Mass., has its shop in a building that is not as well suited to the needs of a modern machine tool manufactory as it should be, but by adaptation it has been made to serve the purpose fairly well. Not long ago a Gisholt boring mill was purchased, and its logical location to suit previous steps of manufacture was on the second floor, but the floor would not safely permit the installation of this 11,000-pound machine without considerable strengthening. Instead of doing this, and perhaps getting an unsatisfactory foundation after all, it was decided to build a foundation up from the ground through the first story. This might naturally be thought expensive, but it proved otherwise. The column erected was 3 feet 4 inches by 5 feet 4 inches by 16 feet high. It was constructed of concrete, mixed as follows: Cement, one barrel; sand, two barrels; gravel, ½ cubic foot; and broken stone, 9/10 cubic foot. The center was cored, leaving walls 8 inches thick, and a door was set in one side, thus making the inside of the column available as a fireproof storage vault. The cost of the material was but little over $30.

NOTES FROM THE OLYMPIA EXHIBITION.

JAMES VOSE.*

The engineering and machinery exhibition at Olympia, London, is chiefly representative of machine and hand tools, though many general engineering exhibits are on view. An advisory council, representative of leading engineering associations, manufacturing establishments and commercial institutions affords valuable aid to the organizers, while the educational aspect of the show is kept well in view, special facilities being afforded engineering students to visit the exhibition on organized lines under specially appointed guides. Arrangements also have been made, of which considerable advantage is being taken, for workmen to visit London and the show at a very low cost, while a number of interesting lectures are being given by experts in various branches of engineering.

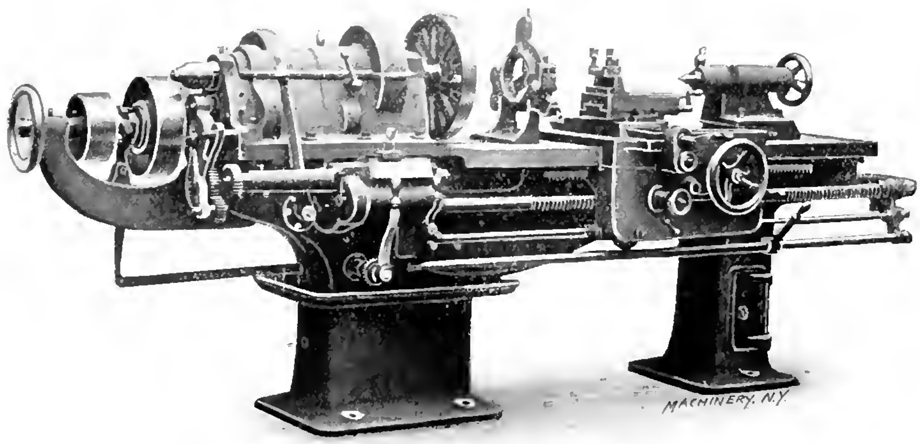

Fig. 1. George Richard's High-speed All-gear-drive Engine Lathe.

Touching on tools particularly, a striking feature is the cosmopolitan character of the exhibits, and the wide distribution of manufacture of types of tools which until recently appeared to be entirely confined to a few pioneers of well-founded reputation. Another noticeable development, emphasized by the exhibits, is the extent to which merchants formerly, by force of circumstances, almost exclusively identified with American tools, now—without in any degree relinquishing their handling of American lines—have taken up British and Continental productions. At the same time, in some cases, the special insight they have gained into the requirements of customers has enabled them to evolve lines of their own which they have commissioned various makers to manufacture for them.

The cutting of spur gears by the process of hobbing appears to have made rapid advances in Europe, quite a number of such machines being shown in operation. We noticed examples built or handled by Reinecker, Biernatzki, Holroyd, Burton-Griffiths, Selig-Sonnenthal, Humpage, Thompson & Hardy, and Henry Wallwork. So far, we have not actually seen an American contribution, though rumors are afloat as to such being under way. (See MACHINERY, October and November, for examples.) New builds of plain or universal precision grinding machines, presenting novel features, are identified with the Newall Engineering Co., Macdonald, Adamson & Co., Ltd., and the Morse Co. The requirements of automobile builders are extensively catered to, crank-shaft lathes, cam grinders, grinders for finishing square holes after the hardening process, cylinder, piston ring, and valve grinders, etc., being prominently in evidence. No lack of choice is experienced in electrically and pneumatically worked portable drills, grinders, etc. Constant-speed belt-and gear-driven lathes, drills, etc., are met with at every turn, though here and there the opinion is expressed that the application of this principle is in some danger of being overdone, and that well-designed cone-driven tools are by no means played out.

In passing, mention may be made of the additional weight provided in American tools, and the increased handiness in manipulative details of current British tools. Judging by the widely-differing types of metal-sawing machines on view, the subject of rapid and economical cutting up of stock is attracting increased attention the world over. A feature of the last year or two is the number of pipe-bending appliances brought to the notice of users, and this tendency is reflected in the variety of machines exhibited, capable of dealing with tubing of the most varied strength and diameters. Some are worked by lever or worm and wheel, while others are hydraulically worked. In some instances, the tubes are filled during bending, and in others this is unnecessary. Although the idea and use of high-speed steels of modern types was introduced from the United States, the large number of British exhibits of such steels, and the articles manufactured from them, contrast rather remarkably with the paucity of American products in this line on view. The high duty imposed on tool steel entering the United States is perhaps not unconnected with this feature of the situation. The show of turret lathes and automatic screw machines is quite comprehensive, the novelties of a few years back being non-accepted standards, and exploited by quite a number of new makers. The systematic grinding of cutting tools has made considerable headway in Europe during the last few years, and a good show of machines for accomplishing this object is to be seen. Many of them have been distinctly influenced by American designs. Several relieving lathes of continental origin, for the production of formed cutters, etc., are shown. It is rather curious that no American or British firm makes this a "leading line." Boring and turning mills are pretty well in evidence in the smaller sizes and also upright drills of the light and medium varieties. A few radial drills are shown, perhaps the most prominent being a Bickford constant-speed belt machine, and a Kendall & Gent double spindle machine also driven by a constant-speed belt. The specialty of the latter machine lies in the fact that one spindle is used for drilling, the other for tapping, and that the saddle carrying them may be instantly moved the required distance for interchanging their positions. Rapid and accurate tapping

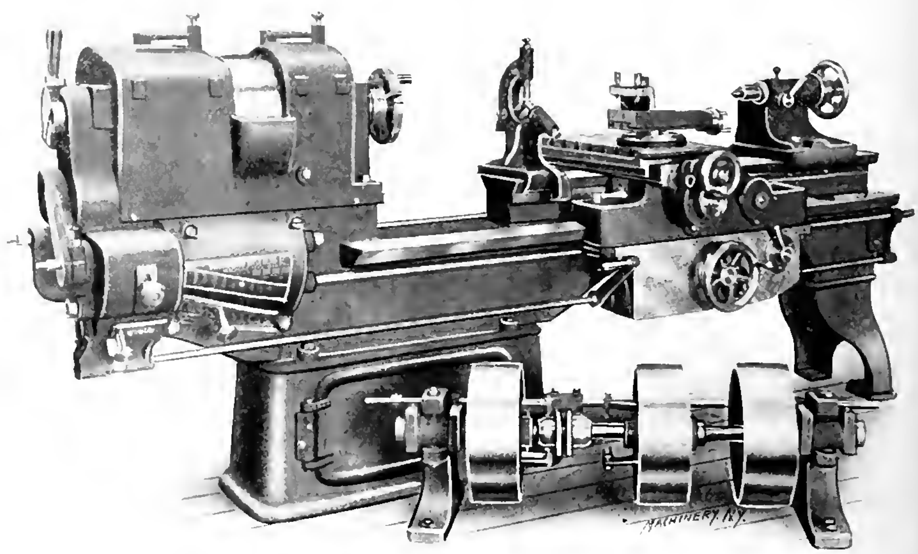

Fig. 2. Drummond Bros. 18-inch Swing Patent Gap Bed Engine Lathe, All-gear-drive.

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is thereby assured, the tapping spindle speed being always correctly related to the drilling speed, though the tap is backed out quickly. Bolt and pipe threading machinery is well represented, the American Landis machine attracting attention by its special form of die, while the "Helios" is a continental type possessing a number of good features. Substantial typical British machines are shown by Joshua Heap & Co., and Kendall & Gent.

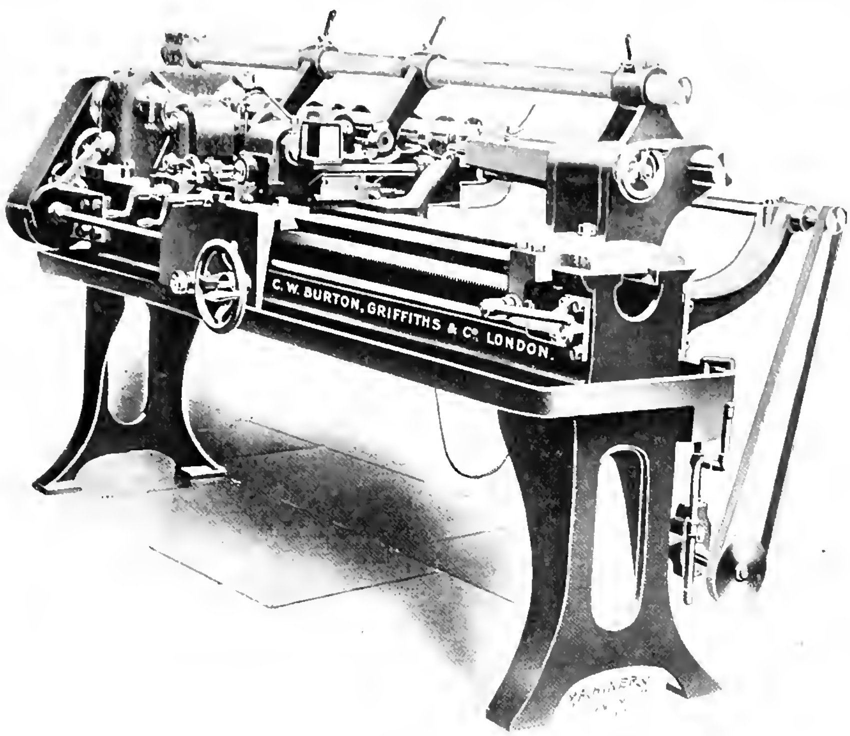

Fig. 3. C. W. Burton-Griffiths & Co.'s Milling and Grinding Machine for Gas Engine Cam Shafts. Cutters and Emery Grinder controlled by Cam Shaft at Rear.

Lathes specially adapted for repair work, in sizes from 7 inches swing to 18 inches swing, are presented by Drummond Brothers, who obtain the advantage of a gap bed while retaining efficient guidance of the saddle by making the sliding ways of the bed in line with the bottom of the gap, the tailstock only being guided by the upper portion of the bed.

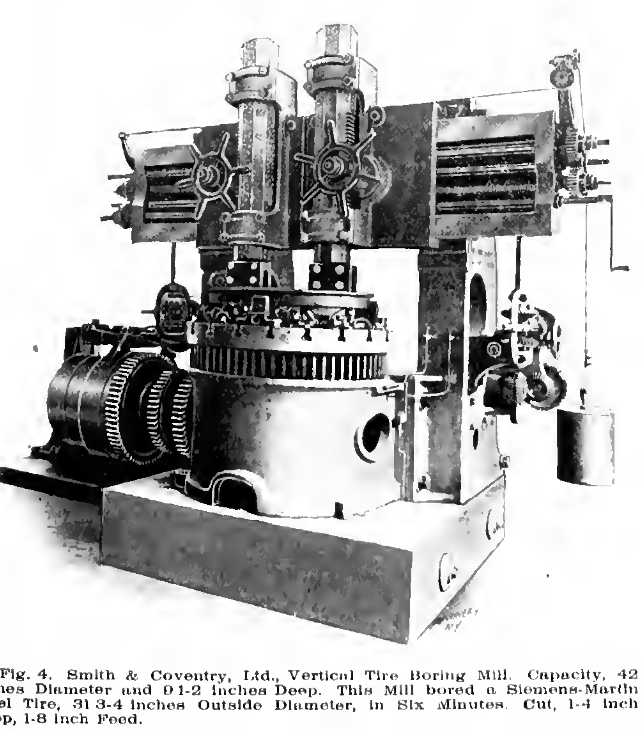

Fig. 4. Smith & Coventry, Ltd., Vertical Tire Boring Mill. Capacity, 42 inches Diameter and 9 1-2 inches Deep. This Mill bored a Siemens-Martin Steel Tire, 31 3-4 inches Outside Diameter, in Six Minutes. Cut, 1-4 inch Deep, 1-8 inch Feed.

The 7-inch swing lathe is powerful enough to reduce a 1⅛-inch steel spindle to ⅞ inch diameter at one cut, or to take a cut ¼-inch deep off a cast iron disk 9 inches in diameter. The saddles of these lathes are arranged to form a tee-slotted boring table—the top slide being quickly removed—well adapted for such repair or new work as motor car cylinders, gear case boring, etc.

In the miscellaneous section, a novelty is the "Dreadnought" file, which has deep semicircular teeth, (see MACHINERY, March, 1907), and is called a milling file, as the cuttings come off in distinct shavings. It is claimed to cut two or three times faster than an ordinary file. A supporting back is used in conjunction with the file. A special feature is its self-cleaning action, which is very marked, and though the teeth are coarse, the surface produced is unusually smooth. It can be resharpened about four times at about half the cost of recutting an ordinary file. The statements of the makers appear confirmed by actual tests at the company's stand, though, of course, fairly prolonged trials will be necessary to obtain data applicable to regular workshop conditions. The show of bevel gear planers is very representative, and includes Bilgram, Reinecker and Zimmerman types, the latter employing two tools simultaneously. The shape of tooth is governed by a former, and a single form controls both tools, thus securing similarity of both sides of the tooth. Taken altogether, the show of machine tools and accessories is probably the most representative ever held in Great Britain, and has attracted visitors from many countries.

The preceding notes only purport to give a general idea of the scope of the exhibition, anything approximating to an adequate description of all the interesting tools would take up the major portion of this issue, but sufficient data have perhaps been brought forward to indicate its value from educational, engineering and commercial standpoints.

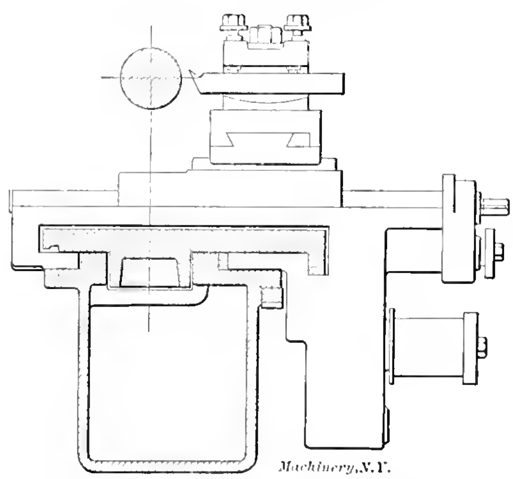

Fig. 5. Cross-section of George Richards High-speed Lathe, shown in Fig. 1, showing Construction which protects Bearings of Bed and Carriage from Chips.

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The development of the shop operation sheet idea, which, by the way, we believe is an entirely new feature in trade journal literature, should bring out methods in machine shop practice that heretofore have been generally overlooked or regarded merely as a matter of course, and we hope to receive the hearty coöperation of our readers in the presentation of what are regarded as standard methods, even though they may be regarded as in the A B C's of the machinist's art. It may be a matter of surprise to some to learn that the preparation and editing of this matter, simple as it looks, is the most difficult of any that we have ever handled. But if any reader has any operation sheet to suggest, he should not let this fact deter him from sending it in and letting the editors wrestle with it, for that is *our* business.

ON DETERMINING SIZE OF FLY-WHEELS FOR MOTOR-DRIVEN PLANERS.*

W. OWEN.†

W. Owen ‡

The question of motor driving for high-speed planing machines brings forward many interesting problems, among which the ascertaining of the correct dimensions for the fly-wheel is not the least.

I read, some time since, in MACHINERY (June, 1905), an article on motor-driven planing machines by Mr. A. L. De Leeuw, in which the writer mentions that he discerns something of a joke in the contemplation of a fly-wheel in combination with a compound-wound motor. Now I, for one, quite fail to appreciate this joke, and always advocate the use of this arrangement for planer driving for the following reason:

The primary function of a fly-wheel is not so much the preservation of a constant speed, as Mr. De Leeuw suggests, as the relieving of the motor from excessive shock at the instant of reversal.

A shunt-wound motor tends to keep the same speed at all loads, but must necessarily slow down for a moment, however large the fly-wheel, at the instant of reversal, thus tending to spark. Of course, the larger the motor, the greater the store of energy in the armature, consequently the smaller the drop in speed and less tendency to sparking, hence Mr. De Leeuw's preference for a *large* shunt-wound motor.

A compound-wound motor, on the other hand, will drop slightly in speed under heavy loads, the percentage of drop, of course, depending upon the amount of compounding. It is this property of the compound motor which enables the fly-wheel to perform its work satisfactorily. A correctly designed fly-wheel will, at the moment of reversal, keep up the speed of the motor slightly higher than that corresponding to the load on the motor at that instant, thus eliminating all possibility of sparking.

Now the determining of the dimensions of the fly-wheel before the machine is made, to fulfill these conditions, necessitates close scrutiny of the engineering press, so as to be continually cognizant of tests taken at different times on high-speed planing machines. A better method, where practicable, is to test the machine before deciding upon either the motor or the fly-wheel.

A machine recently tested under the latter condition gave the following: Average horse-power cutting, 19; average horse-power backing, 11. At the instant of reversal to backing stroke the ammeter needle jumped to 190 on a 220-volt circuit, showing maximum horse-power to be about 55, and the time taken up from the table striking the dog to the attainment of maximum backing speed was 3 seconds.

It was decided to drive this machine by a 30 B. H. P. motor at 500 revolutions per minute, compounded so as to give a maximum variation of about 12 or 14 per cent. Allowing a 40 per cent momentary overload on the motor would bring the maximum horse-power allowable on reversal to 42, and the additional 13 horse-power would have to be supplied by the fly-wheel. The dimensions of the wheel were obtained in the following manner:

As energy in a moving body varies directly as V^2, where V = velocity in feet per second, it is clear that the best place for the fly-wheel is upon the shaft having the greatest number of revolutions per minnte, which, of course, is the motor shaft.

From the figures given, it will be seen that the wheel must be capable of parting with sufficient energy to develop 13 horse-power during the time of reversal, *viz.*, 3 seconds, and its drop in speed must not exceed 10 per cent, so as to keep the actual variation slightly below that allowed by the motor.

Energy to be given out by the fly-wheel $= \dfrac{13 \times 33{,}000 \times 3}{60}$.

Now assnme M to be the store of energy in foot-pounds in this fly-wheel when it makes one revolution per minute, then, as the energy varies as V^2, and V varies as the revolutions per minute, the store of energy in the wheel when making 500 revolutions per minute $= M \times 500^2$.

As the drop of speed of the wheel = 10 per cent speed of wheel at end of 3 seconds then the speed of the wheel = 500 — 10 per cent of 500 = 450 revolutions per minute, and the store of energy then in the wheel $= M \times 450^2$.

Thus the energy given up by the wheel in being reduced from 500 to 450 revolutions per minute $= M\ (500^2 - 450^2)$.

But the energy given up must $= \dfrac{13 \times 33{,}000 \times 3}{60}$, as already shown; therefore $M\ (500^2 - 450^2) = \dfrac{13 \times 33{,}000 \times 3}{60}$.

$$M = \frac{13 \times 33{,}000 \times 3}{60\ (500^2 - 450^2)}.$$

$$= \frac{13 \times 33{,}000 \times 3}{60 \times 47{,}500}$$

$M = 0.45$ foot-pounds.

Therefore, the store of energy in the fly-wheel when making 1 revolution per minute = 0.45 foot-pounds.

The limit of peripheral speed of plate fly-wheels generally allowed in machine tool practice is about 7,000 feet per minute, which quantity will enable us to find the outside diameter of the wheel thus: $\dfrac{7{,}000}{3.1416 \times 500} = 4.4$ feet.

As energy in a revolving wheel $= \dfrac{W\,V^2}{2\,g}$, where V = velocity in feet per second at center of area of rim, $\dfrac{W\,V^2}{2\,g}$ must equal 0.45 when the wheel makes 1 revolution per minute. Therefore $\dfrac{W\,V^2}{2 \times 32.2} = 0.45$.

Velocity of wheel in feet per second when wheel makes 1 revolution per minute $= \dfrac{4 \times 3.1416}{60}$; the diameter of the wheel to center of area, it will be seen, is taken as 4 feet, 4.4 feet being the outside diameter, thus

$$\frac{W \times 4 \times 4 \times 3.1416 \times 3.1416}{2 \times 32.2 \times 60 \times 60} = 0.45.$$

$$W = \frac{0.44 \times 32.2 \times 2 \times 60 \times 60}{4 \times 4 \times 3.1416 \times 3.1416},\quad W = 660 \text{ pounds.}$$

Thus, knowing the outside diameter and the weight of the wheel, the other dimensions are very easily ascertained.

* * *

The muuicipal authorities of Paris, France, on account of the manner in which some lately erected high buildings, imitation skyscrapers, are marring the beauty of that city, are considering to re-enact the lately annulled laws restricting the height of buildings. Such restrictions are very important, not only on account of the appearance of the city, but because of many other problems created by the high buildings. Had it not been for the skyscrapers on the lower part of Manhattan Island in New York, the present traffic problems in that city would not have presented such enormous difficulties. The necessity for hundreds of thousands of people to be transported every morning and night to and from a little plot of land but a few acres in extent is caused by nothing else than the existence of the high buildings, which permit so great a number of people to work on so small an area.

*For previous articles on this and kindred subjects see MACHINERY, June, 1895, Designing and Constructing Modern Steam Engines; May, 1900, Gas Engine Design; July, 1904, Planer with Quick Return of 200 Feet per Minute; June, 1905, High-Speed Planers; July, 1905, An English High-Speed Planer; July, 1907, Size, Weight and Capacity of Fly-Wheels for Punches.

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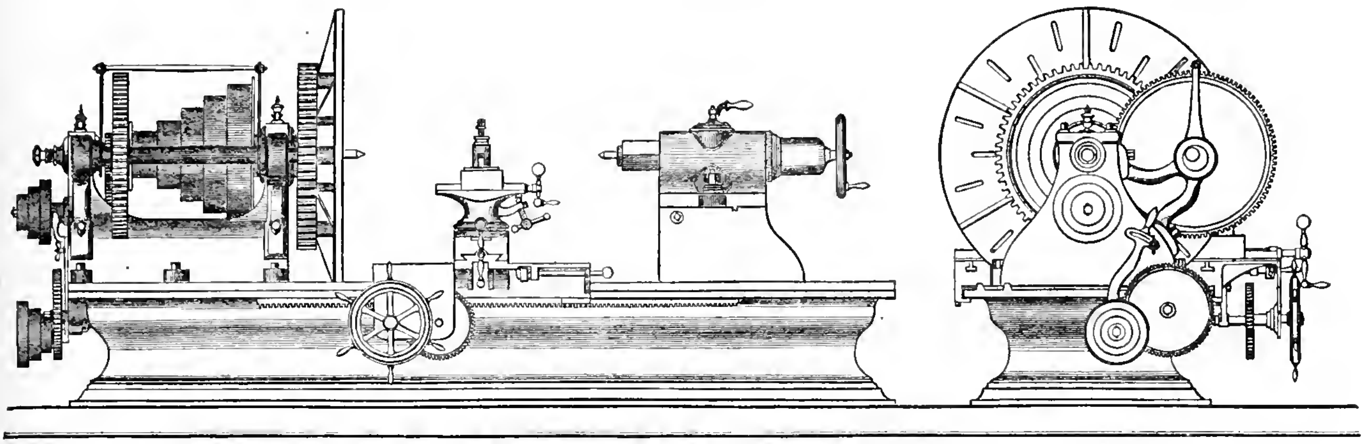
‡W. Owen was born in Blackburn, Eng., in 1881. He served an apprenticeship with Hulse & Co., Manchester, machine tool builders, and in conjunction with his apprenticeship attended engineering courses at the Royal Technical Institute, Salford. Upon leaving Hulse & Co. he went with Craven Bros., also of Manchester, where he is now employed. Mr. Owen is also on the engineering staff of the Royal Technical Institute, Salford. His specialty is machine tool design.

SOME OLD MACHINERY CATALOGUES.

A few weeks ago the editor had the opportunity of examining a number of old machine tool catalogues collected by Mr. Henry E. Eberhardt, president of the Eberhardt Bros. Machine Co., Newark, N. J. The catalogues are interesting from both a mechanical and commercial standpoint. Some day, if not at present, the catalogues of machinery builders issued in the '60's and '70's will be highly regarded by the historian of manufacturing.

The oldest catalogue in the collection is that of the Lowell Machine Shop, Lowell, Mass. It is dated January, 1863, and is of the fourth edition. J. Thomas Stevenson was treasurer, and Andrew M. Moody superintendent. The first edition of the list of tools made by the Lowell Machine Shop was printed in 1851. The company manufactured all kinds of cotton machinery, locomotives, turbine water mills, mill gearing and shafting, but the catalogue before us is devoted to machine tools, including engine lathes, hand lathes, vertical drilling machines, horizontal drilling lathes, boring and reaming lathes, planing machines, shapers, crank-pin boring lathes, bolt cutting machines, gear cutting and dividing machines, slotters, tilt and trip hammers and punch presses. The illustrations are lithographic reproductions of line drawings, each illustration being an insert, blank on the back side. The prices throughout are filled in with ink. The character of the illustrations is indicated by the accompanying reproduction of a "No. 6 engine lathe." This machine had a bed 16 feet long, and would turn a piece $9\frac{1}{2}$ feet long. It weighed 11,000 pounds, and sold for $2,310. It was also made in 18-, 24-, and 32-foot beds. The spindle was made of cast iron, and the lathe would turn 50 inches diameter over the slide and 32 inches over the tool rest. It will be noted that the lathe was back-geared into a gear on the face-plate. This was the largest and heaviest machine built by the company.



Sample Illustration in Catalogue of the Lowell Machine Shop, showing No. 6 Engine Lathe.

Other firms whose catalogues are included in the collection are: William Sellers & Co., Philadelphia, Pa., 1870; Lucius W. Pond, Worcester, Mass., 1874; Brown & Sharpe Mfg. Co., Providence, R. I., 1875; F. E. Reed, Worcester, Mass., no date; Niles Tool Works, Hamilton, Ohio, 1880; Brainard Milling Machine Co., Hyde Park, Mass., 1880; E. E. Garvin & Co., New York, 1883; Putnam Machine Co., Fitchburg, Mass., 1884. Of course the catalogues issued in the early '80's belong to comparatively recent history, but, nevertheless, one notes a great change in the power, massiveness, and general design of machine tools within the last twenty-five years. If space had permitted, several additional views could have been reproduced, showing some of the marked changes in the product of these machine tool builders.

A comparison made between these catalogues and the present issues of the same concerns is instructive, especially in the case of so widely distributed an example as the catalogue of the Brown & Sharpe Mfg. Co. This company's issue of January 1, 1875, is a $3 \times 5\frac{1}{4}$-inch booklet of 74 pages, including the cover, printed on thin paper; the catalogue for 1907 contains 500 pages, $3\frac{1}{2} \times 5\frac{3}{4}$ inches, and it would be much larger if the matter was not condensed so as to include only the essentials.

THE MACHINE SHOP DON'TS AS A SPIRITUAL FORCE.

Nothing ever published in MACHINERY has attracted more attention from practical machinists and others connected with machine shops than the "don'ts" for machinists and draftsmen, which appeared by installments in June and October, 1905, and February and October, 1906, issues. They were contributed by Mr. H. E. Wood, formerly of Pearl River, N. Y., now of Hartford, Conn., and represented, in concentrated form, some of the wisdom acquired by years of varied experience as a machinist and foreman. So popular were these tabloids of shop common sense that they were reprinted in pamphlet form for general distribution, and over 200,000 copies have been put in the hands of mechanics in the United States, Canada, Great Britain, and other English-speaking countries. Now, what we started to say was that while, in common with mechanics generally, we had a keen appreciation of the epigrammatic vigor and general hard sense of these shop don'ts, we had not looked upon them as a particular force for good in the spiritual world, but it appears that they have been so regarded. The following letter from the editor of *The Sunday School Times*, Philadelphia, refers to them in a very appreciative manner:

Recently *The Sunday School Times* published a couple of editorial notes on its first page based on the strikingly suggestive and helpful points in the little booklet that you published, entitled "Don'ts for Machinists and Draftsmen." Rarely have we had anything attract quite so much attention among these front-page editorial paragraphs. I thought you would be interested to know this, and I enclose clippings of the two paragraphs referred to. So you see you are reaching folks in the realm of spiritual character as well as in the realm of mechanical efficiency.

October 30, 1907. C. G. TURNBULL, Editor.

Following is one of the notes referred to:

There are not two different sets of principles for material and spiritual success. Whatever really helps in one field will help in the other,—only the sons of this world are often wiser than the sons of light. A series of "Practical Don'ts for Machinists," issued by a prominent trade publication, contains a good many hints that all of us in life's big machine shop would do well to heed,—though the series is labeled "For the other fellow—not you." Here are some of them: "Don't say 'that's good enough.' Don't borrow tools; buy your own. Don't let your lathe run and cut air. Don't be always looking for pay-day. Don't be too important to do insignificant jobs. Don't take off your overalls before quitting time. Don't try to fool your foreman, for you may get left. Don't wait until Monday morning to fill your oil-can. Don't deny spoiling a piece of work if you have done it. Don't work to a caliper that has been set by another man; set it yourself." The man or woman whose life is controlled by such principles as these is bound to have the respect of fellow-workmen, and the quality of the work done is likely to mean promotion by the Foreman.

* * *

A recent inquiry into some of New York City's municipal accounts discovered that in one instance 165 coat hooks had been sold to the city at 60 cents apiece, which could be bought at retail for about 5 cents apiece; but the worst is not yet. These hooks were put up by a plumber and a helper, who charged at the rate of $8.00 per day for their time. They consumed 31 days doing the job!

REAMERS.—5.

ERIK OBERG.*

Pipe Reamers.

Pipe reamers, Fig. 21, are used to precede pipe taps. They are made of the same sizes as pipe taps, excepting that the dimensions of the pipe reamer correspond to the root diameters of the thread of pipe taps. The taper of pipe reamers is 3/4-inch per foot. They are fluted with the same kind of cutters as hand reamers of sizes corresponding to the diameters at the small end of the pipe reamers. Finishing reamers only are used. The number of flutes for different pipe sizes is as follows:

Pipe Size.	Number of Flutes in Reamer.
From 1/8 to 3/8	6
From 1/2 to 3/4	8
From 1 to 1 1/4	10
From 1 1/2 to 2	12
From 2 1/2 to 3	14
3 1/2	16
4	18

The small end of pipe reamers is slightly chamfered, as shown in Fig. 21, in order to facilitate the entering of the reamer in holes which are of about the same size as the small diameter of the reamer. Dimensions for pipe reamers are given in Table XIX.

Pipe reamers are tested or measured by means of taper ring gages to insure that they are within the permitted limits of variation. The diameter at the small end of the hole in these ring gages equals the diameter at the small end of the reamer. Thus, when the reamer is tested with the ring gage, if the end of the reamer comes exactly flush with the end of the gage, the size of the reamer is exactly

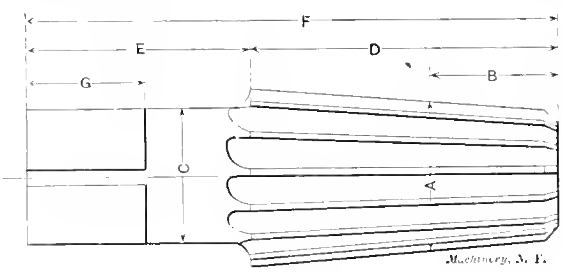


Fig. 21. Pipe Reamer.

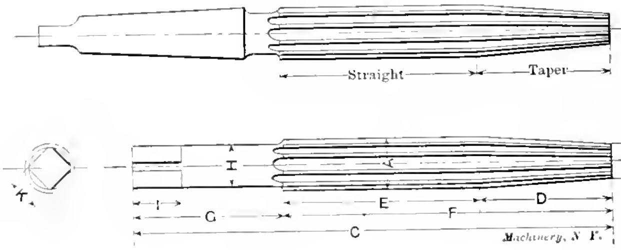
TABLE XIX. DIMENSIONS OF PIPE REAMERS.

Pipe Size.	Diameter at Size Line.	Distance from Size Line to Small End.	Diameter of Shank.	Length of Fluted Part.	Length of Shank.	Total Length.	Length of Square.	Size of Square.
	A	B	C	D	E	F	G	
1/8	0.343	25/64	11/32	1	1 5/8	2 5/8	1/2	1/4
1/4	0.447	9/16	7/16	1 1/8	1 3/4	2 7/8	9/16	5/16
3/8	0.582	9/16	9/16	1 1/4	1 7/8	3 1/8	5/8	7/16
1/2	0.721	3/4	3/4	1 1/2	2	3 1/2	11/16	9/16
3/4	0.931	3/4	15/16	1 5/8	2 1/4	3 7/8	3/4	11/16
1	1.170	15/16	1 1/8	1 3/4	2 1/2	4 1/4	13/16	13/16
1 1/4	1.515	31/32	1 5/16	1 7/8	2 3/4	4 5/8	1	1
1 1/2	1.755	1	1 1/2	2	3	5	1 1/8	1 1/8
2	2.230	1	1 3/4	2 1/4	3 1/2	5 3/4	1 3/8	1 3/8
2 1/2	2.667	1 1/8	2 1/4	2 7/8	4	6 7/8	1 11/16	1 11/16
3	3.292	1 9/16	2 5/8	3 1/4	4 1/2	7 3/4	1 15/16	1 15/16
3 1/2	3.792	1 5/8	2 13/16	3 5/8	4 9/16	8 3/16	2 1/8	2 1/8
4	4.292	1 11/16	3	3 3/4	4 5/8	8 3/8	2 1/4	2 1/4

correct. If the end of the reamer projects through the gage, it indicates that the reamer is too small, and if it comes short of the face at the end of the gage, the reamer is too large. It is considered a permissible error if the end of the reamer projects through, or falls short of, the ring gage 1/32 inch for sizes up to and including 1 inch pipe size, 1/16 inch for 1 1/4 to 3 inch pipe size, and 1/8 inch for larger sizes.

Taper Reamers for Bridge Builders.

Taper reamers for bridge builders, commonly called bridge reamers, are made with Morse taper shank or straight squared shank, as shown in Figs. 22 and 23. The fluted portion is tapered for distance *D*, and is straight for the remaining part *E*, of the flutes. These reamers are used for rough structural construction work, and are not required to be finished with the same degree of care as reamers for machine construction. After hardening, the flutes are usually left unpolished. These reamers are made in sizes from 1/2 to 1 1/4 inch. The taper per foot of the tapered portion at the end of the reamer, as usually made, is given in Table XX together with the essential dimensions of the straight shank



Figs. 22 and 23. Taper Reamers for Bridge Builders.

TABLE XX. DIMENSIONS OF REAMERS FOR BRIDGE BUILDERS.

Diameter of Straight Part of Reamer.	Diameter at Point of Reamer.	Taper per foot of Tapered Portion.	Total Length of Reamer	Length of Tapered Part.	Total Length of Flute.	Length of Shank.	Diameter of Shank.	Length of Square.	Size of Square.
A	B		C	D	F	G	H	I	K
1/2	1/4	1	8 1/8	3	5 1/4	2 7/8	7/16	1/2	5/16
9/16	5/16	1	8 3/8	3	5 1/2	2 7/8	1/2	9/16	3/8
5/8	11/32	1 1/8	8 5/8	3	5 3/4	2 7/8	9/16	5/8	7/16
11/16	3/8	1 1/4	8 7/8	3	6	2 7/8	5/8	11/16	7/16
3/4	7/16	1 1/4	9 1/8	3	6 1/4	2 7/8	11/16	3/4	1/2
13/16	1/2	1 1/4	9 3/8	3	6 1/2	2 7/8	3/4	13/16	9/16
7/8	9/16	1 1/4	9 5/8	3	6 3/4	2 7/8	13/16	7/8	5/8
15/16	5/8	1 1/4	9 7/8	3	6 15/16	2 15/16	7/8	15/16	11/16
1	11/16	1 1/4	10 1/8	3	7 1/8	3	7/8	1	11/16
1 1/16	23/32	1 3/8	10 1/4	3	7 1/4	3	15/16	1 1/16	11/16
1 1/8	3/4	1 1/2	10 3/8	3	7 3/8	3	1	1 1/8	3/4
1 3/16	13/16	1 1/2	10 1/2	3	7 1/2	3	1 1/16	1 3/16	13/16
1 1/4	7/8	1 1/2	10 5/8	3	7 5/8	3	1 1/8	1 1/4	7/8

type reamer. The dimensions for the fluted portion of those with Morse taper shank are exactly the same, the only difference being the total length, which, of course, is dependent upon the size of Morse taper shank used. The common practice is to provide the 1/2 up to 5/8 inch sizes with No. 2, and all sizes 11/16 inch and larger in diameter with No. 3 Morse taper shank. The size of the reamer is measured on the straight part of the flutes. In the case when an odd number of flutes is employed, the size must be determined by a ring gage. The number of flutes is made 5 in all sizes below and including 7/8 inch diameter, and 6 for larger sizes.

Grooved Chucking Reamers.

The tool shown in Fig. 24 is partly a reamer and partly a twist drill. The cutting is performed by the beveled edges *A*, which form an angle of 60 degrees with the axis of the tool. The reamer is provided with three larger semicircular flutes, which are cut on a right-hand spiral, and with

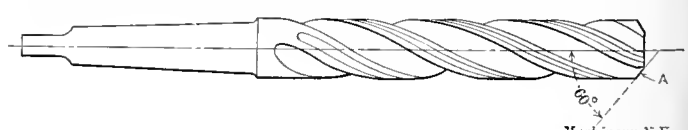


Fig. 24. Grooved Chucking Reamer.

three smaller grooves between these. The larger grooves form passages through which the chips pass away; the smaller grooves convey the lubricant to the cutting edges. This form of reamer is extensively used in screw machines for enlarging cored holes, and also in drill presses for enlarging drilled holes, it being easier to enlarge a drilled hole to size by a grooved chucking reamer than to try to drill the hole to size by an ordinary twist drill.

This reamer is commonly provided both with straight and Morse taper shank. When provided with Morse taper shank,

* Associate Editor of MACHINERY.

the following numbers of taper shanks should be used for the various sizes of grooved reamers:

Diameter of Reamer.	No. of Morse Taper Shank.
From 1/4 to 1/2 inch	1
From 9/16 to 7/8 inch	2
From 15/16 to 1 1/4 inch	3
From 1 5/16 to 1 3/4 inch	4
From 1 13/16 to 3 inches	5

The length of the fluted part being given in Table XXI, the total length of the reamer is dependent upon the length of the Morse taper shank used. When made with straight

TABLE XXI. LENGTH OF FLUTED PORTION OF GROOVED CHUCKING REAMERS.

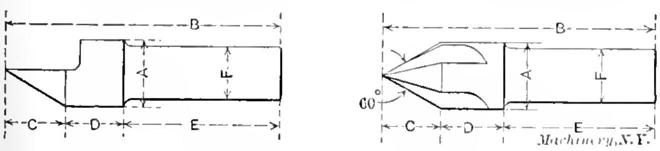
Diameter of Reamer.	Length of Fluted Portion.	Diameter of Reamer.	Length of Fluted Portion.	Diameter of Reamer.	Length of Fluted Portion.
1/4	4	7/8	8 1/4	2	9 3/4
5/16	4 1/2	15/16	8 3/8	2 1/8	9 7/8
3/8	5	1	8 1/2	2 1/4	10
7/16	5 1/2	1 1/8	8 3/4	2 3/8	10 1/8
1/2	6	1 1/4	9	2 1/2	10 1/4
9/16	6 1/2	1 3/8	9 1/8	2 5/8	10 3/8
5/8	7	1 1/2	9 1/4	2 3/4	10 1/2
11/16	7 1/2	1 5/8	9 3/8	2 7/8	10 5/8
3/4	8	1 3/4	9 1/2	3	10 3/4
13/16	8 1/2	1 7/8	9 5/8	..	..

shank, this latter may be selected of such length that the total length of the tool is the same as when a Morse taper shank is used.

The diameter at the point of this reamer is larger than at the shank end of the flutes, the amount of back taper being 0.003 inch per foot. This prevents the tool from binding in the holes chucked. The spiral of the flutes should be so selected that the edges of the flutes make an angle of between 25 and 20 degrees with a plane through the axis of the reamer. This corresponds to a lead of the spiral equal to from about 7 to 8.5 times the diameter of the reamer, respectively. This is practically the same amount of spiral as is used on twist drills.

Center Reamers.

Center reamers are used for forming the centers on which work is to revolve in lathes or grinding machines. They are made in two different styles. The older one, Fig. 25, has



Figs. 25 and 26. Center Reamers.

TABLE XXII. DIMENSIONS OF CENTER REAMERS.

Full Diameter of Reamer.	Total Length.	Length of Beveled Portion, Approx.	Length of Straight Portion.	Length of Shank.	Diameter of Shank.
A	B	C	D	E	F
1/4	1 3/8	7/32	5/32	1	3/16
3/8	1 1/2	5/16	5/16	1	1/4
1/2	2	7/16	7/16	1 1/8	3/8
5/8	2 3/8	17/32	15/32	1 1/4	7/16
3/4	2 1/2	21/32	23/32	1 1/4	1/2
7/8	2 7/8	3/4	3/4	1 3/8	9/16
1	3 1/8	7/8	3/4	1 1/2	5/8

only one cutting edge, formed by cutting away the metal down to the center of the tool, and relieving the beveled portion of the remaining half so that a cutting edge is produced. The second and later style is that shown in Fig. 26, which has four flutes or cuts. These cuts are straight, and the lands between the cuts are relieved on the beveled part. The inclusive angle of the point of the tool must, of course, be that used for lathe centers, or 60 degrees. These reamers are made with a straight shank. The dimensions of both styles are the same, and are given in Table XXII.

Flat-sided Reamers.

Very small reamers are sometimes provided with flats instead of actual flutes, the sharp intersection or corner between two flats acting as a cutting edge. These reamers are used for small dowel and taper pin holes, etc. The diameter of the reamer is, of course, measured over the sharp corners. If the reamer tapers, the taper of the flats will evidently not be the same as the taper of the reamer itself, and the milling machine head used when milling the flats must be set to a different angle than that which the cutting edge makes with the center line. A simple formula, expressing the relation between the taper per foot, the number of flat sides in the reamer, and the angle to which to set the milling machine head, was given in the "How and Why" section of MACHINERY, January, 1907. This formula reads:

Tangent angular setting =

$$\frac{\frac{1}{2}\text{ taper per foot}}{12} \times \text{cosine}\,\frac{360 \text{ degrees}}{2 \times \text{number of sides in reamer.}}$$

Adjustable Reamers.

In order to permit the diameter of the hole reamed to be slightly varied from the standard size, adjustable reamers are used. These may be of two classes, such as are adjustable but still have the cutting edges composing an integral part of the reamer, as shown in Fig. 27, and those which have inserted blades. The former are usually employed in smaller sizes only, while the latter are commonly used in sizes from 1 1/4 inch up to 5 inches diameter. On account of the construction of the class of reamers shown in Fig. 27, the reamer cannot expand uniformly its entire length; when that is desired, the reamer with inserted blades must be selected.

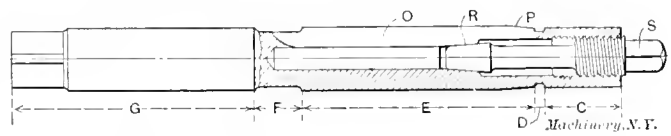


Fig. 27. Expansion Reamer.

Adjustable reamers are often called expansion reamers, and there is no real difference between the two kinds. If any distinction should be made, it would be advisable to call reamers of the type shown in Fig. 27 expansion reamers, as the change in diameter is actually effected by expanding the tool itself, while inserted blade reamers should be called adjustable reamers.

Referring to Fig. 27, the reamer shown is originally an ordinary hand reamer provided with a guide. The distance *C* represents this guide; *D*, a small neck or groove between the guide and the reamer body; *E*, the cutting edges; *F*, the neck between the cutting edges and the shank, and finally *G*, the shank. At the forward end of the cutting edges there is a small taper at *P*, the same as in ordinary hand reamers, and the diameter of the guide, which is not fluted, is in the same proportion to the full diameter of the reamer as for hand reamers.

The body of the reamer is hollow, and three slits are cut with 1/32-inch saw from the outside to the hole in the center. One of these slits is shown in the cut at *O*. The inside hole is tapered at *R*, and a tapered plug *S*, provided with a threaded part, serves as expander. The thread engages a threaded portion in the reamer guide, and, when the expander is turned so that the plug moves inward, on account of the taper at *R*, the cutting edges of the reamer are forced outward, a slight spring action being possible because of the slits being cut through the reamer body. The slits should extend into the neck, and end at the upper end of the guide, as shown. They should be cut in the bottom of a flute, so as not to impair the cutting edges.

Reamers of this type cannot be recommended for accurate work. It is evident that the expansion takes place opposite the tapered part *R*, and that the cutting edge is sprung up in an arc. The reamer will have no parallel cutting edges, and, unless the guide fits the original hole closely, will hardly be able to ream straight. For cheaper grades of work, however, the feature of a simple means of expansion may be deemed valuable.

Reamers of the inserted blade type were discussed in the July issue of MACHINERY, and it does not seem necessary to repeat the statements there made. In order to give an idea, however, of the dimensions which should be followed in

laying out any type of inserted blade reamer, Tables XXIII and XXIV are appended. The dimensions given in these tables are, of course, not intended to be followed too strictly, as varying designs may require modifications. The dimensions will, however, serve as a guide in laying out adjustable reamers, when required to be designed for special conditions, and will give an idea of the general proportions. They refer, of course, more particularly to reamers of a design similar to that shown in the article in the July issue, referred to above.

Inserted blade shell reamers should be ground with a back

TABLE XXIII. ADJUSTABLE HAND REAMERS.

Diameter of Reamer.	Length of Cutting Edge.	Thickness of Blade.	No. of Blades.	Total Length of Reamer.	Diameter of Reamer.	Length of Cutting Edge.	Thickness of Blade.	No. of Blades.	Total Length of Reamer.
$1\frac{1}{4}$	$2\frac{3}{4}$	$\frac{3}{16}$	6	9	$2\frac{1}{2}$	4	$\frac{1}{4}$	6	$12\frac{1}{2}$
$1\frac{3}{8}$	$2\frac{7}{8}$	$\frac{3}{16}$	6	$9\frac{3}{8}$	$2\frac{3}{4}$	$4\frac{1}{4}$	$\frac{1}{4}$	6	13
$1\frac{1}{2}$	3	$\frac{3}{16}$	6	$9\frac{3}{4}$	3	$4\frac{1}{2}$	$\frac{1}{4}$	8	$13\frac{1}{2}$
$1\frac{5}{8}$	$3\frac{1}{8}$	$\frac{7}{32}$	6	$10\frac{1}{8}$	$3\frac{1}{4}$	$4\frac{5}{8}$	$\frac{5}{16}$	8	14
$1\frac{3}{4}$	$3\frac{1}{4}$	$\frac{7}{32}$	6	$10\frac{1}{2}$	$3\frac{1}{2}$	$4\frac{3}{4}$	$\frac{5}{16}$	8	$14\frac{1}{2}$
$1\frac{7}{8}$	$3\frac{3}{8}$	$\frac{7}{32}$	6	$10\frac{7}{8}$	$3\frac{3}{4}$	$4\frac{7}{8}$	$\frac{5}{16}$	8	15
2	$3\frac{1}{2}$	$\frac{7}{32}$	6	$11\frac{1}{4}$	4	5	$\frac{5}{16}$	8	$15\frac{1}{2}$
$2\frac{1}{4}$	$3\frac{3}{4}$	$\frac{1}{4}$	6	12	..	..	..	..	...

TABLE XXIV. ADJUSTABLE SHELL REAMERS.

Diameter of Reamer.	Length of Cutting Edge.	Thickness of Blade.	No. of Blades.	Diameter of Reamer.	Length of Cutting Edge.	Thickness of Blade.	No. of Blades.
$1\frac{1}{4}$	$1\frac{5}{8}$	$\frac{3}{16}$	6	3	$3\frac{1}{4}$	$\frac{1}{4}$	8
$1\frac{3}{8}$	$1\frac{3}{4}$	$\frac{3}{16}$	6	$3\frac{1}{4}$	$3\frac{1}{2}$	$\frac{5}{16}$	8
$1\frac{1}{2}$	$1\frac{7}{8}$	$\frac{3}{16}$	6	$3\frac{1}{2}$	$3\frac{3}{4}$	$\frac{5}{16}$	8
$1\frac{5}{8}$	2	$\frac{7}{32}$	6	$3\frac{3}{4}$	4	$\frac{5}{16}$	8
$1\frac{3}{4}$	$2\frac{1}{8}$	$\frac{7}{32}$	6	4	$4\frac{1}{4}$	$\frac{5}{16}$	8
$1\frac{7}{8}$	$2\frac{1}{4}$	$\frac{7}{32}$	6	$4\frac{1}{4}$	$4\frac{1}{2}$	$\frac{5}{16}$	10
2	$2\frac{3}{8}$	$\frac{7}{32}$	6	$4\frac{1}{2}$	$4\frac{3}{4}$	$\frac{5}{16}$	10
$2\frac{1}{4}$	$2\frac{1}{2}$	$\frac{1}{4}$	6	$4\frac{3}{4}$	$4\frac{7}{8}$	$\frac{3}{8}$	10
$2\frac{1}{2}$	$2\frac{3}{4}$	$\frac{1}{4}$	6	5	5	$\frac{3}{8}$	10
$2\frac{3}{4}$	3	$\frac{1}{4}$	6	..	..	..	..

taper of 0.012 inch per foot. The shank of inserted blade hand reamers should be ground 0.002 inch smaller in diameter than the minimum size for which the reamer is intended.

The present article is the concluding one in the series of five articles on reamers which have been presented. It has been the purpose of the author to give such information as would be the most useful to the practical tool-maker. For this reason, the processes of manufacture, which the practical tool-maker is presupposed to be familiar with, have not been dealt with except in cases where reference to these processes seemed necessary to explain certain points, but the actual figures for dimensions, number of flutes, etc., have been the more carefully stated in every case, as there has never hitherto been published any systematized information on these subjects.

* * *

Not the least of the many notable applications of electricity in the arts which have effected substantial economies, is electric soldering. The gas-heated soldering iron was a decided improvement over the ordinary bit heated in a charcoal furnace, but it has faults very noticeable when compared to the electrically-heated iron. The flexible tubing, auxiliary air supply, waste heat and danger of poisoning by the escape of gas are all absent with the electric equipment. But aside from the convenience and flexibility of the system, the increased efficiency is in itself a deciding factor. A manufacturer of tin lanterns counted on five per cent of the day's output being "leakers" when using gas-heated soldering irons; with electric irons the percentage has dropped to one-half per cent, and the most of these defects are due to checks, cracks, and similar defects in the stock, largely caused by the forming dies. The practical result is that each man's daily output is increased nearly five per cent, with no added exertion; in fact, the conditions of working are easier than before.

THERMIT REPAIR OF STEAMSHIP STERN FRAME AND RUDDER POST.*

A remarkable repair was recently effected on the steamship *Corunna*, of the Canadian Lake Navigation Company, at Montreal. This vessel is of 1,296 tons register, 240 feet long, 35 feet beam and 21 feet in depth. In getting away from her pier in the Lachine Canal, the stern of the vessel was caught

Fig. 1. Rudder of Steamship "Corunna," showing new Stem Welded with Thermit.

by the current and swung against the stone walls of the canal, the shoe or skeg being broken off close to the heel, while the rudder post was broken at a point about eighteen inches from the top of the rudder. Owing to the serious nature of the injuries, it would have been necessary to tow the vessel to Cleveland, there being no adequate dry-dock in

Fig. 2. Showing Thermit in Shoe of Stern Frame, before Cutting Off Gate.

Montreal to make these repairs in the usual way, were it not for the fact that by the thermit process it is possible to effect such repairs without removing the stern frame from the ship or requiring the aid of machinery of any kind other than a compressed air blow torch and a few pneumatic tools. It was

* For other articles on thermit and thermit repairs see MACHINERY, March, 1901, "Some Future Possibilities of Aluminum," by C. Vickers; March, 1903, "The Thermit Process," by Frank C. Perkins, "The Use of Thermit for Repairing," and "Thermit and Its Possibilities"; December, 1903, "Lecture upon Thermit."

therefore decided that several thousand dollars could be saved by repairing the frame and rudder post with thermit, and the Goldschmidt Thermit Co., 90 West street, New York, was advised by telegraph to send an engineer to direct the operation.

On inspection it was found that the rudder post was broken off inside the tube, while the stern frame had been bent 12 inches out of line, the shoe being completely broken about 13 inches from the center line of the post. On account of the break in the rudder post being in an old scarf weld, fully 11 inches in length, it was not deemed advisable to attempt to

Fig. 3. Near View of Stern Frame Shoe Repair, showing Large Size Thermit Weld and Gate.

weld this again, so about 14 inches of the rudder post adhering to the rudder was cut off and a new piece of shafting, 8 feet long, was welded on in place of the old post, as shown in Fig. 1. In order to facilitate operations, the rudder was removed from the ship and the post welded on shore, this being done to prevent interference with the operation of welding the stern frame.

It was necessary to have a supply of compressed air in order to operate a gasoline torch and some pneumatic tools, so an old Westinghouse steam driven air brake compressor

Fig. 4. Showing Stern Frame Shoe after Gate was Cut Off.

was obtained and mounted on board ship, steam being piped from a donkey boiler. A receiving tank was placed on the edge of the dock and piped to the compressor.

With the apparatus in place, preparations were made to do the welding, the rudder being the first repair to be made. This was unshipped and welded in exactly two working days, the operation being in all respects similar, though on a smaller scale, to the method pursued in welding the stern frame. It is sufficient to say that the section which had to be welded was circular, 5¼ inches diameter, and was reinforced at the weld by a collar of thermit steel 8 inches long and 1 inch thick. For this operation 150 pounds of thermit, 25 pounds of steel punchings, and 3 pounds of metallic manganese were used. The results were extremely satisfactory, and when the riser and gate were cut off, the metal was seen to be of very fine grain.

The next operation was to straighten the stern frame, after which a series of holes were drilled along the line of the fracture, to provide for a free flow of thermit steel. As soon as this had been done, a collar of yellow wax was shaped around the fracture, the frame section being approximately 5 x 13 inches at the forward edge of the collar and 6 x 7 inches at the rear portion, while the section at the break was about 6½ x 7 inches. This collar was made 8 inches long with a middle ordinate of 1 inch; a sectional view would show approximately the segment of a circle. On the bottom, however, it was made only ¾ inch thick, in order that the draft of the vessel might not be made any greater than could be helped.

With the wax in position, a sheet iron mold box was placed around it, allowing for 6 inches of sand on all sides. Wooden patterns were constructed for a narrow gate and large riser, and provision was also made for leaving a small hole near the bottom of the mold, for the wax to run out when heated. After the mold was completed the flame of a strong gasoline blow torch was directed into this hole, and the heating continued until all the wax was out of the mold and the parts to be welded had been brought to a bright red heat. In the meantime a crucible containing 350 pounds of thermit, 70 pounds of steel rivets (1 inch x ⅜ inch in size), and 7 pounds of metallic manganese, was placed in position over the pouring gate.

It required about three hours to bring the sections to the proper heat, at which time the torch was removed, the hole at the bottom plugged up with a sand core, backed up with a few shovelfuls of sand, the thermit ignited in the crucible and the resulting superheated steel tapped into the mold, where it filled the space formerly occupied by the wax. The mold box was not removed for about 15 hours, in order that the thermit steel might become thoroughly annealed, but it was found, upon taking away the mold, that the weld was perfect in every respect, being inspected and passed on by Lloyd's surveyors, Capt. Reid and Mr. Calderwood. Figs. 2 and 3 show the thermit weld and large riser, which latter is characteristic of successful thermit repairs the same as of good steel castings. Fig. 4 shows the stern frame shoe after the riser was cut off.

The total time required for the two welds amounted to five working days, but there is no doubt that had the work been done in a properly equipped dry-dock, it could probably have been completed in three days or less.

* * *

We stated in a note in our December, 1906, issue that manufacturers of taps and cutting tools which cannot be ground after hardening did not consider it good policy to make these out of high-speed steel, on account of the high heat necessary when hardening, which caused the edges to fuse. We understand, however, that at the present time several firms are able to harden high-speed steel taps, hobs and similar tools in such a manner that the cutting edges are not impaired, and Wheelock, Lovejoy & Co., Boston, Mass., it is stated, have demonstrated that such hardening can be successfully accomplished by using a barium chloride bath in a standard gas-burning furnace. The investigations have been carried out in connection with blue chip high-speed steel, but equally satisfactory results may be secured with other high-speed steels. The application of barium chloride for hardening purposes was first developed abroad. Barium chloride in crystal form is placed in a crucible in the furnace, and melts into a bluish, milky fluid. When used as a hardening bath, the temperature varies from 2,000 to 2,300 degrees F., and very uniform results are claimed to be obtainable by this process; but the exact time during which each particular tool will have to be subjected to the treatment in the hardening bath will have to be established by experiments. It may be mentioned, however, for the guidance of those who are to use this process for hardening, that, according to the *Iron Age*, a ⅝-inch tap is subjected to a temperature of 2,100 degrees F. for four minutes when hardening by the process mentioned.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2 50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

TO MAKE MACHINERY OF PERMANENT VALUE.

Some of our readers seem to be under the impression that the frequent references to previous articles on machine design, etc., lately appearing in the form of foot-notes, were made to advertise back issues for sale. This is a mistake. We have scarcely any copies for sale, and, not infrequently, it has occurred that an issue was entirely exhausted before the next month's issue was published. The cost of clerical labor, storage, etc., makes it unprofitable for publishers of trade papers to print more copies than are required to meet the immediate demand. No; the reason for making references to what has gone before is simply to make MACHINERY of greater permanent value to those who keep its files. We feel that the reader who does not keep a file loses a large part of the value of his subscription. The subject which has no importance to you to-day may be what yields your bread and butter next year, and any literature on it will be very valuable. The text-books are indispensable, but they cannot cover everything, nor can they keep up to date. The side lights thrown on certain features of design by the published experience of contributors are most valuable, often being of a nature that the text-books ignore. There, too, is the matter of historical record of machine tool growth. The columns of MACHINERY present a most complete record of its development—a record that no one interested can afford to lose.

To those who feel that they cannot afford the cost of a permanent binding by a book-binder, we would suggest the use of a Shipman binder, 9 x 13 inches, price, about 80 cents. This binder will hold two years' issues. Place the indexes in front of each volume, and separate the two volumes with a sheet of heavy colored paper. In this way a large amount of valuable material will be put in shape for instant reference, and at a very low cost.

* * *

RESULT OF MECHANICAL FILE TESTING.

Something more than two years ago a British machine was developed for mechanically testing files and autographically recording the result. The autographic record shows the cubic inches removed by a file from a standard test bar, the number of strokes taken, the period when the file cuts most effectively, and when it ceases to cut because of being worn out. The publication of comparative results obtained from tests made on files purchased in the open market created a sensation among file makers and file users. The difference between the best files and the poorest files was so great that a manufacturer clearly could not afford to use the poorest files, even if supplied free of cost. This result, of course, merely confirmed what every intelligent shop manager already knew, but the mechanical record of the actual difference in cubic inches removed and strokes made was a more definite proof.

The valuable result of the file testing machine's work is the great improvement that has taken place since the file maker was given the means of accurately testing his product. At the advent of the file testing machine, the best files were able to remove about 12½ cubic inches, and the best files were about twelve times as effective as the poorest. In 1907, two years after, the file makers had so improved their product that the best file tested removed at the rate of eight cubic inches per 10,000 strokes, and 55 cubic inches of cast iron with *one side* of the file, or about 4 2/5 times the total removed by both sides, by the best files of two or three years ago.

If it was possible to produce such a remarkable improvement in the hand file, simply because of the use of an adequate testing appliance, what might be the result in many other lines of manufacture if rigid efficiency tests were impartially carried out? We all have learned that efficiency, so-called, is only comparative, and that no one can say anything has reached ultimate efficiency. Now that attention has been called to that simple yet perplexing tool—the file—it is entirely possible that its manufacture and action will not only be greatly improved but changed. In fact a radical change in file making has already been made by one British maker, which promises great improvement.

* * *

THE GROWING INEFFICIENCY OF WORKMEN.

A discouraging aspect of present industrial conditions is the inefficiency and general slackness of workmen in the building trades. The lack of the old-time pride in the mastery of a trade is very noticeable to one coming in contact with carpenters, plumbers, tinners, and others of the house-building trades. Not only do these workmen, in a great many cases, care nothing for their trades, but they rather pride themselves on being able to draw full pay for a minimum of knowledge and skill in their business. Not long ago the writer engaged a so-called carpenter to do a trifling job of interior work. The material cost at most 50 cents, and the time required was, say, two hours. The charge for the service was more than a first-class carpenter got for a full day of ten hours, ten years ago. The worst of it is that the job was of a grade that an amateur should have been ashamed of. This case is not merely individual; it is representative of a general state that is of grave import. The workman tries to do as little as possible for a maximum wage. Does he improve his condition by such action? No; on the contrary the general cutting down of productive capacity is one cause of the increase of cost of all building construction. Rents are higher because masons, brick-layers, carpenters, plumbers, tinners, roofers, painters, decorators, produce less. The consequence, of course, is a very substantial increase in the cost of living to all, for all must help pay.

The endeavor to better industrial conditions by reducing production is analogous to trying to lift oneself by one's boot straps. It is impossible to improve general conditions by reducing efficiency. *We believe in high wages and a full day's work.* The plumber who spends half a day putting a washer into a kitchen faucet is an encumbrance. He is essentially dishonest, and is a discouragement to the honest workman who would render honest service to his employer. It cannot be gainsaid, however, that the greed which would deny to workmen a just share of the profits accruing from their industry and general proficiency in manufacturing is largely responsible for creating the "ca-canny" spirit in America, a spirit which is the curse of Great Britain and which is reducing that country to a low level in the industrial scale. What will be the outcome here if there is no change for the better?

THEORY AND PRACTICE.

Many writers upon mechanical subjects, as well as many persons directly employed in mechanical work, treat the words theory and practice as if the ideas which these words signify were to be considered strictly apart from each other. They seem to consider that a distinct, clearly defined line can be drawn between the territories of theory and practice. It is a common error to speak of theory and practice as if they were in opposition to each other, the expression "right in theory, but wrong in practice," not being at all uncommon.

In the first place, there is really no defined line between theory and practice, and many a case could be cited where the theory of yesterday is the practice of to-day. Theory is nothing but an analysis of the laws which must be followed in practical work if that work is to be correctly carried out; and practice simply means the application of theory to the work carried out. Theory is nothing but common sense logically applied, and practice is the use of theory in productive work. In the second place, theory and practice can never disagree. If they do, then either the theory is incorrect, there is a flaw in its logic, and it ceases to be acceptable, or the common practice is wrong, and should be corrected to agree with the theory, logically arrived at by the application of common sense. While it is true that theory without practice would be useless, if it could be comprehended as existing in its extreme meaning, so practice without theory becomes next to useless, in our time at least, for it would signify only the rudest form of unskilled labor. While this is rather an unprofitable subject to discuss, still it is well to impress the idea that theory and practice cannot be considered apart, and that when it is done, it is liable to cause a confusion of ideas.

On the other hand, it is true that one may, with propriety, speak of things as being theoretically correct and commercially correct; the latter expression then simply signifying that a certain article, while produced in a way that really is not the best practice if one desires to arrive at extreme accuracy, still is such as to answer the purposes for which it is intended. Thus a screw thread may seldom be theoretically correct, but it may be commercially near enough to the exact form to serve its purpose. But this usage of these words does by no means imply that theory and practice are in opposition to each other. They are complements of each other, just as the work of the brain complements that of the hand. No man ever worked entirely by his brain, just as no man ever worked only by his hands. Brain and hands coöperate constantly, although in different degrees. So also do theory and practice. And in the same way as any work done mainly by bodily labor is always the better done the more the element of brain enters, that is, the more common sense is used, so also, the more true theory used in practical work, the better the result; for, as one of our European contemporaries says, *nothing is more practical than theory.*

* * *

THE FAILURE OF THE SMALL CAPITALIST.

One of the notable features of a period of great prosperity, such as that we have experienced, is the large number of new firms of comparatively small capital which spring into being at just about the time the wave of enthusiasm reaches its height. Most of these enterprises are wrecked when the wave breaks on the jagged rocks in the succeeding recession. They are short-lived at the best, and their increase forms one of the surest of the danger signals announcing the coming of reaction. The cause of this phenomenon may be coolly and dispassionately studied, though a vast amount of personal suffering is involved in the individual cases of which it is composed.

The condition is readily explained. When the tide of business begins to rise, following a preceding ebb of business, it finds men of small means with their resources nearly exhausted by the strain of the stringency through which they have passed. Men of great capital and foresight, however, carefully discerning the sign of the times, are gradually extending their operations, adding to their capital from time to time as fast as they can make money from their business, or borrow it from the banks. Business increases rapidly by such operations as these, and the new-found prosperity begins slowly to work its way downward from class to class, until finally the working man himself finds that his wages are somewhat larger than they have been for some time, and he is at last able to lay up a little store from the surplus left, over and above his living expenses. If the individual working man has a fertile brain and a little energy, this unwonted surplus acts as a stimulant, exciting his imagination, and urging him on in the venturous path of engaging for himself in a small way in some form of business in which he believes he can make a success.

Now, in all probability, at about the time this resolve has been reached, the climax of the good time has already been attained. Men of larger means and broader outlook have already begun to draw in their lines closer, fearing the coming stringency, and all of this is done so quietly and silently that the small capitalist never realizes that the best is passed, and the worst is yet to come. From such conditions as these result the great crop of pitiful failures which have marked every period of depression the country has passed through. It would seem wise for the small capitalist to store up his enthusiasm within his breast, and his money in the savings bank, until the next depression is passed and the country has again laboriously commenced to climb to a succeeding period of prosperity. It will take more courage to start in business then, but it will be an evidence of greater wisdom.

The acute thinker, on meditating the cause of this phenomenon, will easily conclude that it represents only one more example of the truth of that motto we sometimes see displayed for sale in the picture store windows: "Ain't it —— to be poor!"

* * *

LIABILITY OF EMPLOYERS.

In connection with the editorial entitled "Liability of Employers" in the November issue of MACHINERY, engineering edition, it may be deemed proper to quote some figures as to the average amount of expense due to accidents and injuries to employes, for which employers are held liable. The Fidelity and Casualty Co., of New York, has compiled some figures on this subject in its *Monthly Bulletin.* These figures cover the years from 1893 to 1900, and refer to the experience of the principal employers' liability insurance companies. It appears from these figures that, taking the United States as a whole, and the average of all classes of occupations, the average loss per $100 of wages paid was as follows:

Year.	Average Loss through Employer's Liability per $100 of Wages Paid.
1893	25.5 cents.
1894	27.6 "
1895	28.5 "
1896	29.9 "
1897	31.9 "
1898	33.6 "
1899	37.7 "
1900	36.2 "

The increase seen in these figures for late years does not depend on greater number of accidents, but is, undoubtedly, mainly due to new legislation tending to increase the liability of employers. The figures given express the average of all occupations, and it is stated that the figures are larger than those which concern manufacturers only would be, as the losses are greater for contractors than for factories. On the other hand, the figures given represent actual losses, and not premiums which are paid to the insurance companies. These are by necessity higher, but it has been estimated that 40 cents per $100 of wages paid would, in a factory of the ordinary class, cover the cost of insurance. In other words, the expense involved to insure a man earning, say, $600 a year would be $2.40 per annum, or less than 0.8 cent per working day. Considering this small amount, and as the insurance is, in fact, finally paid by the employes themselves, through their productive labor, it may well be repeated that employers should not place themselves in opposition to legislative measures of the kind referred to. The effect on the industries of the country as a whole cannot help but be greatly beneficial, and the movement for increased interest in safety appliances will receive all the more recognition.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

Consul J. I. Brittain, at Kiel, suggests that, when writing to German firms, American business men should enclose sufficient postage to pay for replies. If one has no German stamps, he should enclose American 5 or 10 cent stamps. This tends to create a better feeling in the matter.

A correspondent to the *Times Engineering Supplement* states that the German government railways have a fund for payment of premiums to employes who invent any appliance which may be useful in railway practice, and that during the last traffic year $3,700 was paid on that account to employes.

In our engineering review of last month we made mention of the very extensive use of American machine tools in Great Britain. In connection with this, it is of interest to note a statement made by Consul F. I. Bright, of Huddersfield, England. According to this statement, two large Huddersfield firms are equipped to an extent of 75 per cent. with American machines.

It has been claimed that the highest speed ever attained by an automobile was that accomplished at the Brookland motor track in England, where a 200-horse-power Darracq car attained a speed, for a short period, of 115.4 miles per hour. However, at Ormond Beach, Florida, on January 26, 1906, a mile was covered at a speed of 127.5 miles per hour, and at Ostend, Belgium, a speed of 117.5 miles an hour was attained for one kilometer, July 14, 1906.

It has been stated officially that the *Mauretania*, sister ship of the *Lusitania* frequently referred to in our columns, during her trials covered 300 miles at an average speed of 27.36 knots, and that she covered the full course of the trial run, 1,200 miles, at an average speed of 26.03 knots. These are by far the highest speeds ever heard of in connection with ocean liners. The record speed 27.36 knots equals a speed of about 31.5 statute miles per hour.

Some experiments by Prof. Ira Hollis, of Harvard University, says the *Magazine of Commerce*, show that cork has a distinct value for increasing the frictional resistance of metallic surfaces in contact. The coefficient of friction of materials usually used for brakes—leather or metal—is only half that of cork. Cork inserts may be used to advantage on the brakes of street railway cars, and also on pulleys to increase the grip of the belts. It is found that cork wears down no faster than the solid socket in which it is embedded. Its frictional resistance, apparently, is but slightly diminished by oil or moisture.

Attempts have recently been made at Stockholm, Sweden, says *Engineering*, with a view of devising a simple method of distinguishing between ordinary tool steel and the high-speed variety. The latter contains chrome and tungsten in considerable quantities, and as these elements form colored compounds with certain reagents, it was hoped that it might be possible to determine if a given sample of steel was of the common or high-speed variety by applying to a polished surface of it an indicating paper, previously moistened in a suitable reagent. No success was, however, attained, but it was afterward observed that while ordinary tool steel dissolves rapidly in dilute nitric acid with a copious production of nitrous fumes, high-speed steels are unattacked, at least so long as the content of chromium does not fall below four per cent.

In an article in the *Electrical Review* (London) the author discusses the question of electric *versus* hydraulic elevators. From the point of safety, it is contended, there is no difference between these two classes of elevators, if made by responsible firms; but a great difference is claimed as to running expenses. If power for both elevators be purchased from a power company, when there is but one elevator, the cost of hydraulic power is about $40, electric power, about $15. If there are several elevators in the same building, the charges for water power are reduced, and the figures then are $20 for the hydraulic elevator, and from $15 to $6 for the electric, according to the price of electricity. The author finally quotes Sir William Preece as saying that the London post office has found that the relative costs of working electric and hydraulic elevators are as one to five.

We mentioned in our engineering review of last month the success of steam turbines in a recently built German torpedo boat. It is now reported that the German government has placed a contract with a prominent ship-yard in Germany for the building of a large cruiser which will cost between $8,000,000 and $9,000,000. The new vessel will be fitted with Parsons turbines, a decision which shows that the prejudice which formerly existed in official quarters against this type of machinery is being overcome. The remarkable superiority in speed attained by the turbine-driven torpedo boat previously mentioned, over a sister vessel fitted with reciprocating engines, and the trial performances of the turbine cruiser *Stettin*, which developed a speed of 25.8 knots, have evidently fully convinced German navy experts that the turbines are superior, at least where high speed is the primary object.

According to the *Times Engineering Supplement* of July 31, one of the interesting exhibits at the Ironmongery Exhibition recently held at Islington was a new brazing flux, called "castolin," the invention of Messrs. Wasserman & Co., Lausanne, Switzerland. It is a preparation for brazing cast iron. The preparation is in the form of paste, and is rubbed into the pores of the broken surfaces. The pieces are then accurately joined together and tied; they are placed in a fire, and when as warm as the hand can bear, more of the castolin is rubbed into the grooves of the fracture. It is then covered with borax and "castolot" solder, and is placed in the fire again until red hot and the solder runs freely, when it is allowed to cool slowly and the piece is polished. It is said not to require a special plant, is always ready for use, contains no oxides, can be applied by any one used to ordinary brazing, is unaffected by time, and will not break again in the same place.

A recent report by a committee appointed by the British Board of Trade indicates, according to the *Mechanical Engineer*, that British manufacturers do not place great confidence in large industrial exhibitions. The same sentiment among German manufacturers recently gave the death-knell to an organized movement for a large world's fair in Berlin, to be held in 1913. American manufacturers, judging from the slight interest taken in the Jamestown exhibition, evidently have come to a similar conclusion, that is, that the matter of great, or so called international exhibitions has been largely overdone. After the failure of the Jamestown exhibition to arouse any interest worth mentioning, it is to be hoped that our government will, for a long time to come, refrain from aiding schemes of this kind, which so little benefit our industries. Specialized exhibitions on a smaller plan are of far greater value to both the manufacturer and the public.

Some newspaper writers like to tell a great deal about Europe being rather "slow" as compared with industrial America. A note in *Engineering*, however, seems to indicate that at times they perform over there some feats that have hardly ever been equalled here. The fitting of the machinery to the steamship *Peiho* by Barclay, Curle & Co., Ltd., is probably a record in its field. The machinery consisted of triple expansion engines having cylinders, 26 inches, 45 inches, and 76 inches in diameter with 54 inches stroke, and four single-ended boilers working at 200 pounds pressure. The boilers

were put in between 6:30 and 8:30 P. M., a Friday afternoon. The whole of the work in the stoke-hole, including the fitting of funnel and ventilators, was completed in less than eight hours on Saturday. On Monday morning the work of putting the engines in place was started, and at 5 P. M. in the afternoon the work was completed. This, it must be admitted, would make even our own "hustlers" work hard to equal.

A project of daring dimensions has, according to the *Oesterreichische Wochenschrift für den Oeffentlichen Baudienst*, been considered by the International Navigation Congress. This project involves no less an undertaking than a trans-Alpine waterway, consisting of a canal from the Danube at Vienna to the Adriatic at Triest. The initial expenditure has been assumed to amount to from $120,000,000 up to as much as $300,000,000, but as this waterway would be a link in a chain of waterways connecting the Baltic with the Adriatic, it has been estimated that it would accommodate an enormous freight traffic. The canal would have to be constructed with twenty-two tunnels of a combined length of nearly six miles. There already are, in Europe, some large canal tunnels, notably one on the Marne-Saone canal, where one tunnel is nearly three miles long and over 700 square feet in section, and one on a canal, at Condes, which is about 1,000 feet long and over 1,100 square feet in section. The cost of these tunnels is at the rate of about $1,000,000 a mile.

Consul-General R. J. Wynne, of London, in referring to the new British patent law, which goes into effect on January 1, 1908, quotes the following, which will be of direct interest to American machinery builders: If a patented article or process be manufactured or carried on exclusively or mainly outside the United Kingdom, then, unless the patentee prove that the patented article or process is manufactured or carried on to an adequate extent in the United Kingdom, or give satisfactory reasons why it is not so manufactured or carried on, the comptroller may make an order revoking the patent forthwith, or he may make an order revoking it after a specified interval if the patented article or process be not in the meantime adequately manufactured or carried on within the United Kingdom; but in the latter case, if the patentee give satisfactory reasons for the failure so to manufacture or carry on within the prescribed time, the comptroller may extend the period by not more than one year. To obtain such an order, application must be made to the comptroller at least four years from the date of the patent and one year from the passing of the act; moreover, any decision of the comptroller is to be subject to an appeal to the High Court, and no order is to be made that will be at variance with any treaty, convention, arrangement, or engagement with any foreign country or British possession.

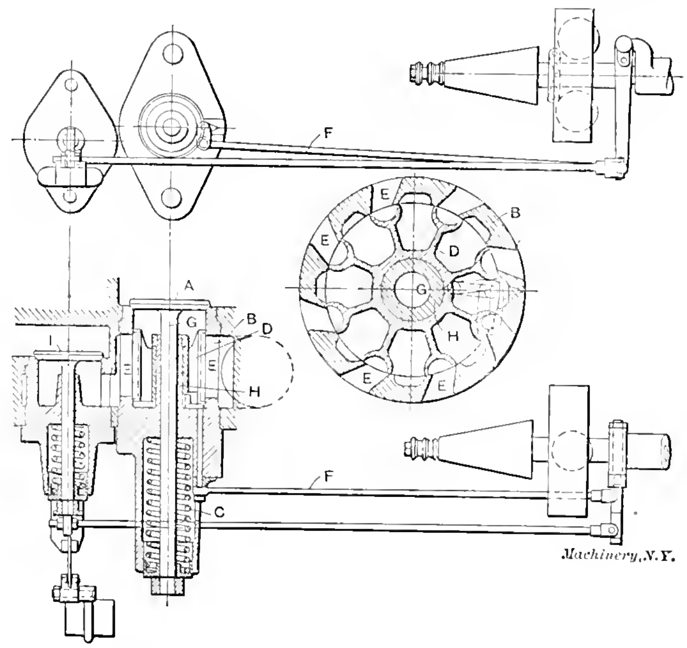
In an article on making steel and killing men by Mr. William Hard, published in the November issue of *Everybody's Magazine*, a terrible indictment is found against the managers of steel-making concerns for great loss of life and limb. During the past year, forty-six men were killed in the South Chicago plant of the United States Steel Corporation, and in no case was there a great casualty; there were forty-one separate accidents resulting fatally. But this is not all. One-hundred-eighty-four were disabled for at least thirteen weeks, and three-hundred-ninety-eight were disabled permanently. Of minor accidents, there were many hundreds more. The prime cause of these accidents is contributory negligence on the part of those injured and their fellow workmen. For example, it is a common practice to lift a slag-pot with the crane chains hooked to the rim of the pot rather than to lugs with which these pots are supposed to be provided. But, avers the author, if the company was made liable to pay a flat fine of $20,000 for every fatality, it is a moral certainty that slag-pots would not be lifted by their rims. Why? Because the company would make it a point of business to insist that this and all other similar dangerous practices be stopped. Now its business is making steel and the safety of human life is merely a secondary consideration. It is cheaper to kill and maim than to provide against accidents.

GOVERNING DEVICE FOR INTERNAL COMBUSTION ENGINES.

The Mechanical Engineer, October 19, 1907.

Internal combustion engines are commonly governed by throttling the admission of gas and air into the cylinder in such a manner that when working at full load the working fluid is admitted freely into the cylinder and practically a cylinder full is drawn in to form each working charge. As the load decreases the throttling of the admission causes a less quantity to be drawn in, and less than a cylinder full forms the charge for the next impulse of a reduced power, the degree of the throttling and the quantity drawn in to form a charge being varied by the governor.

An arrangement for obtaining the desired amount of throttling is shown in the accompanying cut. The admission valve *A* is arranged in a casing *B*, and is operated by a cam and lever, moved inward by means of the lever, and returned to its seat by means of a spring *C*, the opening of the valve *A* taking place during each suction stroke. The inner portion of the casing *B* is arranged with a number of parallel slots *E* through which the working fluid is drawn before passing



Governing Device for Internal Combustion Engines.

through the valve *A* into the cylinder. A light rotary valve *D* is provided, having as many arms as there are slots *E*, the outer edges of these arms being spread out so that in one position the slots are entirely covered. When in this position, although the admission valve may open in the ordinary manner, only as much of the working fluid can gain admission to the cylinder as will be allowed by leakage past the edges of the outer portions of the rotary valve *D*. The valve *D* will be moved into this position by the governor only when there is a light load on the engine. Should the load increase, the governor, by means of the rod *F*, rotates the valve *D* and opens the ports *E* to any desired extent. The outer end of the arms of the rotary valve *D* are hollowed so as to present only small fitting edges, thus reducing friction and risk of sticking. The ports *E* also have narrow fitting edges for the same reason. As it is not desirable to carry this method of governing down to very light loads, it is worked in combination with the ordinary hit-and-miss governing which comes into operation whenever the engine runs on very light loads, as indicated in the cut. It is not necessary therefore that the rotary valve *D* should do more than throttle the working fluid to a moderate extent, and it may therefore be left free in its movement, thus allowing the governor to move it with ease. The rotary valve *D* may either rotate upon the spindle *G* of the admission valve *A*, or upon a sleeve *H* through which the spindle of the admission valve moves, this latter arrangement being shown in the cut. The governor may be arranged so as to operate the hit-and-miss governing as well as the partial rotation of the valve *D*, as is also shown

TESTS OF EMERY GRINDING WHEELS.

Mitteilungen über Forschungsarbeiten, No. 43, 1907.

On behalf of the Verein Deutscher Ingenieure, and with the assistance of Messrs. Ludwig Loewe & Co., of Berlin, Germany, Dr. G. Schlesinger has conducted some tests on the durability and safety of emery grinding wheels. One of the objects of the research was to demonstrate that the regulations laid down by the Prussian Government in 1897 as to the maximum circumferential speed of such wheels—*viz.*, 82 feet per second—should be relaxed. The manufacture of emery wheels had at that time been taken up by incompetent and inexperienced men, and serious accidents had occurred, so that restriction was needed. The emery wheels and the grinding machines have, however, been so much improved of late that a revision of the regulations appeared opportune.

Dr. Schlesinger has, in his trials, adopted workshop conditions, except that he disregarded the safety regulations prescribed by law. Most of the twenty-eight wheels experimented upon were not especially ordered, but taken from the stocks of good firms. The wheel and the test-piece, of cast iron, wrought iron, or steel, were both rotated, and the experiments continued during ten hours for two or four days. The experiments lasted three months. No accident occurred, and in no case did the wheel fly apart, although the speed was raised to the maximum which the driving electric motor permitted. Under the continued strain the wheels began to crumble, emery grains breaking off. The wheels were cylindrical, 20 inches in diameter and 2 inches in width, and were revolved at speeds of 82, 99 and 115 feet per second. The test-piece was fed along at different rates, as a rule ½ to 1 inch per revolution of the test-piece, which was revolving at a maximum circumferential speed of 99 feet per minute. In extreme cases the grinding wheel absorbed 30 horse-power, while in practice 6 horse-power will hardly be exceeded.

The emery wheels were run wet during the experiment, and those wheels which allowed the water dripping upon them to percolate as if they were porous sieves answered, on the whole, best. In this respect the cement used for binding the emery grains is very important. In order to assist the purchaser, Dr. Schlesinger suggests that every emery wheel should bear a notice stating whether the wheel is to be used dry or wet, that it has stood a circumferential speed of 165 feet per second, but that it should not be used at any speed exceeding 115 feet per second.

INDUSTRIES OF BIRMINGHAM.

Derrick's British Report, August, 1907.

Birmingham is the third city in England, and her population has risen in a hundred years from 90,000 to 500,000, but within a distance of twelve miles from the town hall there dwell over a million people. It is built on an elevation, the huge teeming workshops, factories and warehouses, being in the lower parts of the town. It is the principal center of metal manufacture, the industry consisting of the production of an infinity of articles in gold, silver, brass, steel, etc. The manufacture of small arms has become a very important department of enterprise in recent years, hundreds of thousands of gun barrels being tested annually at the local gun-proof offices. The manufacture of engines and boilers has allocated to it a premier place in Birmingham's characteristic industries, the largest works being in a district known as Soho, lying to the northwest of the city, where Watt and Boulton made the first steam engines ever employed in British industry. There are extensive and flourishing chemical works, and the cycle trade competes with that of Coventry, the chief cycle center of Britain, distant but a few miles.

Birmingham has been termed the workshop of the world, as it has a greater variety of manufactures than any other city. These comprise iron and brass founding, rolling, stamping, plating and drawing of metals; manufacture of jewelry; pearl buttons; hooks and eyes; studs; cycles and cycle fittings; railway wagons and carriages, coach and railway lamps; cricket bats and sports outfits; perambulators and mail carts; wire; steel pins; metal bedsteads; art metal work; fenders; coaches; air guns and rifles of every kind; tools and machines; keys, screws, bolts, locks; plate glass; fancy leather goods; spectacles; umbrellas; furniture; gas and electric fittings; electro-plating and gilding; bell-founding; fancy aluminum goods; greenhouse and garden requisites, etc.

A great bulk of the bronze and copper coin of Britain is coined in the city for the Imperial mint. Birmingham also mints an important value of similar coin for other countries. The city also claims to be the largest hardware manufacturing center in the world. Within the place and its environs there is made everything from a pin to a hundred-ton gun, a pagan brass god to an anchor for a man-of-war. Birmingham has the distinction of being the world's metropolis for over a dozen distinctive branches of manufacture. The epithet "Brummagem," which at one time conveyed the idea of something cheap and unreliable, no longer has force or point.

A feature connected with the prosperity of Birmingham, and one that distinguishes it from other large industrial centers in the kingdom, is the absence of any marked contrast in the wealth of the people. In Manchester, Liverpool or Leeds you find merchants or manufacturers of immense wealth; a numerous and affluent middle class; the operative earning masses with sufficient to live in comfort and save money, the scale terminating with a sprinkling of shiftless, improvident non-productive people. Birmingham has been described as a place of small fortunes, the meaning being that there are more examples of the skilled mechanic or other operative who has, through some special knowledge of a branch trade or minor industry tributary to a large enterprise, succeeded in starting out in business as his own master and prospering therefrom. For instance, a large manufacturing concern employs in the building or construction of, say, a machine or other complex production characteristic of Birmingham, an infinity of processes, parts of structure or methods of treating material. It is competent for the mechanic or other artisan, who formerly undertook the mentioned work as an employe, having saved, or in other ways accumulated, a small capital, to establish himself on his own footing, his best customer not infrequently being his aforetime employer.

For example, suppose that a man has been engaged for years as an employe in turning out the bosses or the small rollers for bedsteads. The material and the necessary machinery perhaps are not expensive; the chief items of stock-in-trade are the skill and knowledge of the artisan himself; so that the whole circumstances are such as to enable the man of modest capital to become a master. Birmingham is noticeable for the prevalence of this class of manufacturer—the man of small fortune made out of a tributary industry.

THE PRESENT POSITION OF THE GAS ENGINE.

Paper by Mr. Dugald Clerk, read before the British Association.

In this paper the author first reviews the present condition of the gas engine industry in Great Britain. Engines of small and moderate powers are built in large quantities, and the principles that have to be followed in their design have been thoroughly investigated, and a type, almost standard, has been arrived at. The author understands small and moderate power gas engines to be those with less than 100 horse-power per cylinder. At the present time, about 300 such engines are turned out in Great Britain per week. These engines are recognized to be as reliable as the best steam engines of similar dimensions, and to be more economical. The small engines mostly use coal gas, and the larger, producer gas. With regard to large gas engines, British engineers have assumed the conservative attitude (and so, as we know, have American manufacturers as well), but experience in the design of larger units is constantly being acquired. English designers have always felt the desirability of keeping down cylinder dimensions as much as possible, on account of a general recognition of the fact that there are practical difficulties with large diameter cylinders, due to unequal expansions in the cylinder metal resulting in cracking, and also because of the appreciation of the fact that increase in cylinder dimensions and other details of the unit require an expenditure in metal and workmanship, the amount of which grows in a proportion having a far greater acceleration than the increase of the power obtained. The two main problems met with in large gas engine design may be stated as follows. The one is to build engines

of large power which will be reliable and be able to run economically for long periods without breakdowns, and the second is to be able to build such engines at such a cost as to enable them to compete effectually with steam engines, even in the matter of first cost. The first of these problems has been satisfactorily solved on the European continent, but it has been recognized that the solution of the first problem has involved weights of material and cost of construction which have almost left the second problem out of consideration. The author stated as his personal opinion that he did not think that the tremendous units of gas engines which of late have been designed on the Continent were commercially desirable, and he thought that there were difficulties preventing a successful competition of gas engines with steam engines of greater power than about 500 horse-power, excepting in cases where the gas engines could be operated with blast furnace gas, in which case the cheapness of the fuel made these engines desirable. If gas engines are to be run with producer gas, the fuel is rather expensive for large units, if it has to be produced out of anthracite, and no really satisfactory producer has been constructed for producing gas from bituminous coal.

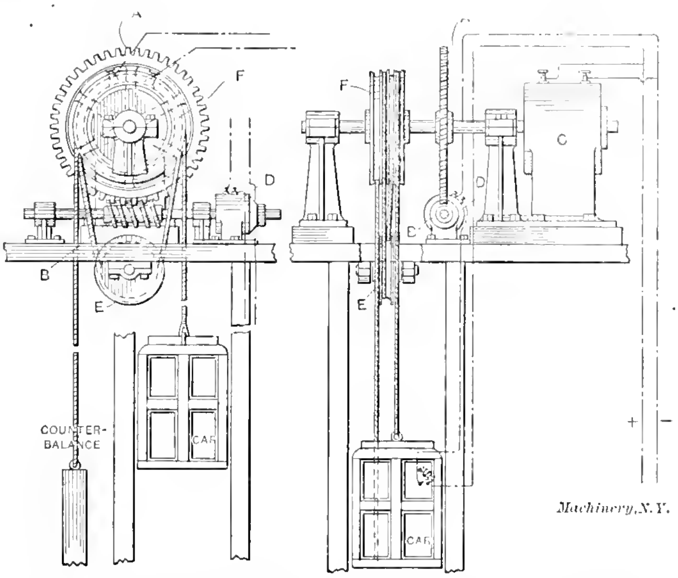
One of the main difficulties in the design of large gas engine cylinders is the contradictory conditions required for obtaining sufficient strength, and at the same time permitting the cooling of the cylinder. The enormous pressure in the large units require thick castings, but, in order to allow the heat to be carried away from the cylinder walls to the water in the water jacket, thin castings are called for. Engines of small dimensions do not present this difficulty, but where the metal is required to be about three inches thick in order to resist the internal pressure, the difference between the temperature on the inside of the cylinder and on the water side becomes serious, and great stresses are set up in the walls, which finally lead to the cracking of the casting. It has been found that cylinders 50 inches in diameter are too large in ordinary gas engine design, and nothing but the highest skill in designing, and the greatest care in choice of material, enable such cylinders to withstand, for any length of time, the severe stresses to which they will be exposed when in use.

[In this connection, it may be proper to call attention to some figures in regard to the operation of gas and steam engines as stated in a late issue of the *Practical Engineer*. Here the author, in discussing the commercial efficiency of high power reciprocating steam engines compared with that of gas engines for driving electric generators, points out that the efficiency of the gas engine, unlike that of the steam engine, does not increase in proportion to the increase of power, and that above a certain power, the cost of gas engines, per horse-power produced, is almost independent of the number of units adopted. If, therefore, a plant of 4,500 horsepower be taken as an example in order to make a comparison between two types, while the steam engines may be properly made in say three units each of 1,300 horse-power, the best results for gas engines may be obtained with six units of 750 horse-power. The following figures tend to show that a gas engine installation is the cheaper, as the cost per kilowatt hour, including depreciation and working expenses, for the steam engines varies between 0.524 cent and 0.742 cent, while for gas engines supplied with high-temperature furnace gas, the same cost would amount to only 0.178 cent, and that for a gas engine with producer gas supplied with coal at $3 per ton would be 0.406 cent. Of course, these figures refer to British conditions. The figures for American conditions would surely be considerably higher, but there is no reason why there should be any difference in the proportion between the costs of the steam engines and gas engines.]

HIGH-SPEED ELEVATORS.

At the regular monthly meeting of the American Society of Mechanical Engineers, held November 12, Mr. Charles R. Pratt presented a paper on high-speed elevators in which he called attention to certain dangers existing in gearless 1-to-1 traction electric elevators as now built, and described the construction of his new elevator machine, designed to overcome the dangers pointed out. The type of elevator selected for the new Singer Building and the tower of the Metropolitan Life Insurance Building, is of the older gearless 1-to-1 traction type, the driving mechanism being a motor located over the hoistway with a traction sheave and a brake pulley mounted on its armature shaft. The ropes from the car pass over the traction sheave down under an idler sheave and again over the traction sheave, thence to the counterbalance, thus giving two half traction turns over the sheave to drive the car and counterbalance. The accompanying cuts, Figs. 1 and 2, illustrate the general scheme so far as the arrangement of the sheaves and motor is concerned.

The diameter of the traction sheave is about 40 inches, which is the least permissible for proper wear of the size of ropes used. The diameter gives a circumference of about 10½ feet. Running at normal speed a motor of about 50 horse-power is required to handle a net load of 2,000 pounds, lifting at a speed of 600 feet per minute. However, if it runs at the low speed of 57 revolutions per minute a motor of about 200 horse-power size, cost and weight will actually be required. The loss of motor efficiency, however, is more than compensated for by the elimination of friction. This elevator



Figs. 1 and 2. Elevator Machine of the Type to be used in the Singer Building, showing Pratt's Safety Device, which is not part of that Installation.

machine is a product of elimination throughout, all unnecessary frictional parts having been discarded, and it eliminates:

a. Friction of worm, spur, screw or rope and sheave gearing.
b. Excessive size of winding drums.
c. Dependence upon automatic limit stops.
d. Inertia of large moving parts of metal and water in hydraulic elevators.

Experiments made by the author on this form of traction rope drive using iron wire hoisting ropes running in smooth round grooves in the traction sheave with from 1½ to 7½ half traction turns demonstrated that the least traction obtained is with new dry ropes on new dry grooves. After considerable use there is not 5 per cent difference in traction between a dry rope and a rope flooded with lubricant. Thus, the fact is established that if this elevator will handle its full load when first started with new ropes, it will always handle its full load safely.

This type of elevator has two distinct advantages over all others, being, unlimited rise and safe normal limit stops. Its unlimited rise is obvious. Its safe normal limit stops are due to the landing of the car or counterbalance on buffers. When either the car or the counterbalance reaches the bottom of the hoistway the tension on its rope leading to the traction sheave is so reduced that all traction is lost and the motor and sheave can keep on revolving with no further travel of car or counterbalance.

The new Singer Building and the Metropolitan Life Insurance tower call for a speed of 600 feet per minute at a rise of 500 feet and over. The selection of the elevators of the Metropolitan Life Insurance building was referred to a most distinguished board of engineers, *viz:* Messrs. Mailloux, Knox, Spangler, Knight and Duenkle, and the gearless 1-to-1 traction elevator was selected. The author then stated that although

the gearless 1-to-1 traction electric elevator has been used in high-class passenger elevator service but a few years, its success proves the merits indicated in theory. There have been no accidents to suggest danger, but in his opinion there has been two most important elements of safety neglected, *viz:* positive speed control and holding power. The brake pulley, being of the same or but little larger diameter than the traction sheave, must have a frictional resistance at the brake shoes, when the brake is on, equal to the net load. The brake and motor are alternately deprived of their motive and holding power every few seconds. Should one happen to let go before the other takes hold, the car falls free to the bottom of the hoistway unless checked by some safety device. There is no positive means to hold a car or prevent it attaining a dangerous speed.

Mr. Pratt's patent No. 865,205, dated September 3, 1907, is designed to take care of these danger elements. The safety feature consists briefly of a worm-wheel *A*, Figs. 1 and 2, mounted on the armature shaft. Meshing with this worm-wheel is a worm *B* driven by a small auxiliary motor *D*. The main and auxiliary motors are worked from a common controller, and start and stop together. The pitch of the worm is such that the worm-wheel cannot over-run. If the small motor does not run, the main motor cannot turn the armature shaft. The effect is obvious. The auxiliary motor must run in step with the main motor, although it does little or no actual work in lifting or lowering the load. It simply operates as a positive lock, the lock always being in engagement with the worm-wheel yet running at such speed as to offer no retardation save at starting and stopping. The auxiliary motor working under no load tends toward perfect acceleration, and it tends to stop the car without jolt.

The advantages claimed for the gearless 1-to-1 traction electric elevator, with the Pratt improvements, are as follows:

a. Positive limit stops.
b. Absolute limit of speed.
c. Perfect acceleration.
d. Shortest possible distance in starting and stopping.
e. Perfectly smooth action.
f. Dead lock at stop position.
g. Highest possible rise and speed.
h. Little space occupied.
i. Low cost of installation.
j. Low cost of operation.
k. Perfect safety.

The difficulty with this device lies in controlling the auxiliary motor so as not to consume a great deal of energy in friction and lost work. The author states that two electric motors can operate without interference when positively geared together, as witness the design of the Central London Railway elevators by Mr. Frank J. Sprague, and intimates that no real difficulty exists in securing coördinate action in this case.

STANDARD PROPORTIONS FOR MACHINE SCREWS.

Abstract of Report presented before the Americon Society of Mechanical Engineers, May Meeting, 1907.

A committee appointed by the American Society of Mechanical Engineers to investigate the subject of machine screw proportions and to recommend standard specifications for machine screws, made its first report at the December meeting, 1905. Some criticism, however, of this report made it necessary to call for a second, and what was intended to be a final, report at the May meeting, 1906. (See June, 1906, issue). In the discussion that followed this report there were, however, several diverging opinions expressed on this subject, and the committee was therefore continued and was supposed to report at the December meeting in the same year. For some reason the report, however, was not accepted by the Association before the Indianapolis meeting in May of this year. In connection with the tables given in the present data sheet supplement, we herewith present some of the most important points of consideration in the new standard for machine screws which has been accepted by the American Society of Mechanical Engineers.

The standard diameters of machine screws are to be 21 in number. The included angle of the thread is 60 degrees, and the flat at the top and bottom of the thread for the basic standard is ⅛ of the pitch. The uniform increment between all sizes from 0.060 inch to 0.190 inch is 0.013 inch, and for larger sizes 0.026 inch, making the largest size 0.450 inch in diameter. The number of threads is made a function of the diameter as expressed by the formula

$$\text{Number of threads per inch} = \frac{6.5}{D + 0.02}.$$

This formula, however, gives the results approximately only, as even numbers of threads are chosen in order to avoid fractional or odd numbers.

In regard to the limits for variation from the basic standard, the maximum screw shall conform practically in all respects to the basic standard. The minimum screw shall have a flat at the bottom of the thread of 1-16 of the pitch, and the difference between the maximum and minimum root diameter will allow at the bottom of the thread any width of flat between 1-16 and ⅛ of the pitch. (See cut). The maximum tap shall have a flat at the top of the thread equal to 1-16 of the pitch, and the difference between the maximum and the minimum external diameter will allow at the top of the thread any width of flat between 1-16 and ⅛ of the pitch. The minimum tap shall conform to the basic standard in all respects except in diameter, as plainly shown in the cut. The difference between the minimum tap and the maximum screw is settled upon in order to allow for errors in pitch, and for the wear of the tap in service. The formulas in Table I give the relation between the various dimensions determining the sizes of taps and screws in this standard.

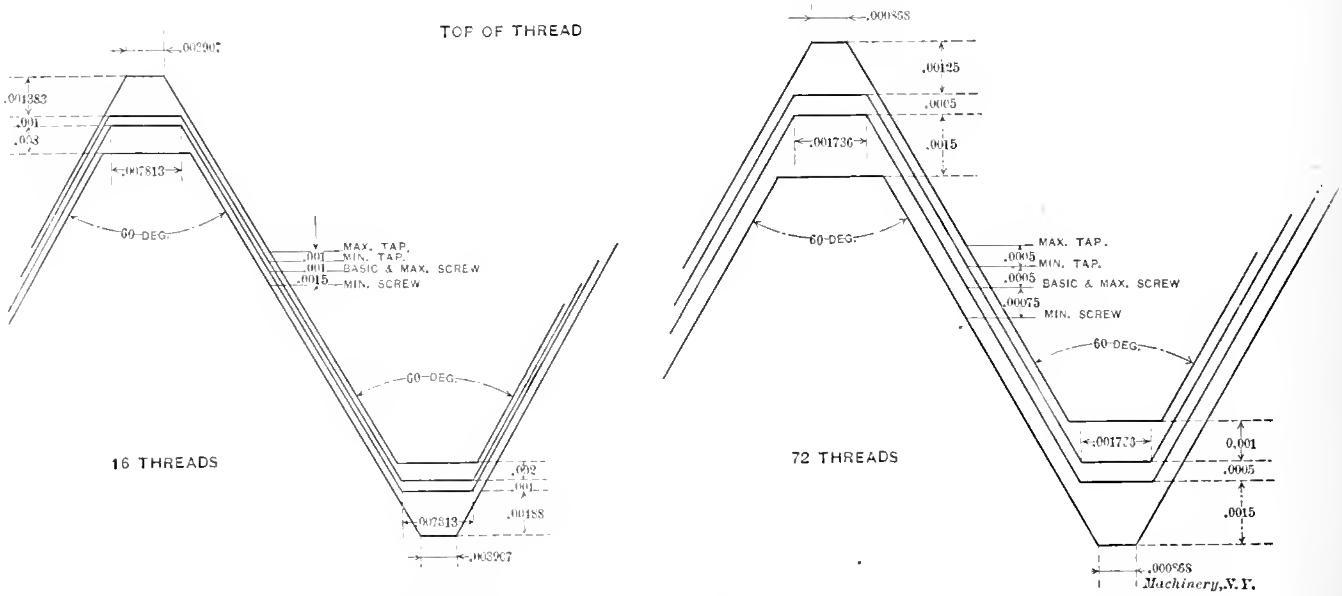


Diagram showing Relation between Diameters of Taps and Screws.

The reference thread gages should be made from unhardened steel, 0.35 per cent carbon, and a set should include both reference thread gages for screws and reference thread gages for taps, each of these to represent the maximum and minimum diameters. Table II gives the thickness of double end

TABLE I. FORMULAS FOR PROPOSED STANDARD FOR MACHINE SCREWS AND TAPS. BASIC STANDARD THREAD, U. S. FORM.

T. P. I. = Number of Threads per inch.

SCREWS.

Max. External Diam. = Basic External Diam.

Max. Pitch Diam. = Basic Pitch Diam.

Max. Root Diam. = Basic Root Diam.

Min. External Diam.

$$= \text{Basic External Diam.} - \frac{0.336}{\text{T.P.I.} + 40}$$

Min. Pitch Diam.

$$= \text{Basic Pitch Diam.} - \frac{0.168}{\text{T.P.I.} + 40}$$

Min Root Diam.

$$= \text{Basic Root Diam.} - \left[\frac{0.10825}{\text{T.P.I.}} + \frac{0.168}{\text{T.P.I.} + 40}\right]$$

TAPS.

Max. external Diam.

$$= \text{Basic External Diam.} + \frac{0.10825}{\text{T.P.I.}} + \frac{0.224}{\text{T.P.I.} + 40}$$

Max. Pitch Diam,

$$= \text{Basic Pitch Diam.} + \frac{0.224}{\text{T.P.I.} + 40}$$

Max. Root Diam.

$$= \text{Basic Root Diam.} + \frac{0.336}{\text{T.P.I.} + 40}$$

Min. External Diam.

$$= \text{Basic External Diam.} + \frac{0.112}{\text{T.P.I.} + 40}$$

Min. Pitch Diam.

$$= \text{Basic Pitch Diam.} + \frac{0.112}{\text{T.P.I.} + 40}$$

Min. Root. Diam.

$$= \text{Basic Root. Diam.} + \frac{0.112}{\text{T.P.I.} + 40}$$

templet thread gages, for each pitch of the standard screws recommended, for the practical inspection of machine screws. The formula

$$\text{Thickness} = \sqrt{\text{pitch}} \times 1.443$$

provides a limit for the error in lead on screws and taps. These templet thread gages are to be made of steel, hardened, and being double ended and having maximum and minimum limits, respectively, are to represent at the largest end the pitch and root diameters of the basic standard, while at the small end they should represent the minimum limits for the pitch and root diameters of screws. The threads of these templet gages should be made by taps having the thread enough larger than the standard in the outside diameter to insure clearance at the top of the thread of the screw. In addition to the threaded holes, these gages should have plain cylindrical holes representing, respectively, the external diameter of the maximum and minimum screw.

TABLE II. DOUBLE END TEMPLET THREAD GAGES FOR INSPECTION OF SCREWS.

$$\text{Thickness} = \sqrt{\text{Pitch}} \times 1.443$$

Threads per inch	Thickness	Threads per inch	Thickness
80	0.161	30	0.263
72	0.170	28	0.273
64	0.180	24	0.295
56	0.193	22	0.308
48	0.208	20	0.323
44	0.217	18	0.345
40	0.228	16	0.361
36	0.240	14	0.385
32	0.255	..	.....

BALL BEARINGS. 1.

Abstract of Paper by Henry Hess, presented before the American Society of Mechanical Engineers, May Meeting, 1907.

Although the field of usefulness of the ball bearing is as wide as the domain of mechanical engineering, but little information on ball bearings can be found in the engineering hand books or text books. Generally the subject is dismissed with occasional reference. Sometimes a formula for carrying capacity is given, but this is usually wrong. There is of course much matter scattered through the technical press giving isolated experiences with a few bearings that happen to come within some one's observation. But, undoubtedly, the insufficient information on the elements of ball bearings is responsible for the directly contradictory statements to be found, and the generally accepted opinion that ball bearings are suitable only for comparatively light loads. This was the situation found by Prof. Stribeck, a German investigator, who has been experimenting with ball bearings for the German Small Arms and Ammunition Factories, of Berlin. The present paper is a résumé of Prof. Stribeck's report, together with a number of notes based on the author's experience.

The Wear of Ball Bearings.

Sliding bearings wear out by abrasion of the carrying surfaces, but ball bearings do not give out on account of wear. In fact, they do not wear. They may be ground out by admitting grit, but that is an abnormal condition for ball bearings, the same as it would be for sliding bearings. The only normal cause for the giving out of ball bearings is the stress on the material, when this stress exceeds certain limits. Lightly loaded bearings can be so designed as to eliminate this cause altogether, and to insure practical indestructibility. In heavily loaded bearings this condition may not be possible to realize within practical dimensions, but the proportions may be so chosen that the stress will not cause a break-down within the lifetime of any mechanism to which the ball bearing is applied. An important principle in the design of ball bearings is that the balls may be subjected to loads, increasing as the shape of the supporting surface more nearly becomes complemental to that of the ball. A ball running between races having a flat or straight line cross section will not support as great a load as if the section were curved, or in other words, if the balls were running in a groove. The groove, of course, must never have a curvature equaling that of the ball, as that would substitute sliding for rolling contact.

Formulas for Loads on Ball Bearings.

The frictional resistance of a ball bearing is lower the less the number of balls. Bearings should be designed to have between 10 and 20 balls. For this number of balls the equation

$$P_a = \frac{5}{z} P_b \qquad (1)$$

should be used. In this equation

P_b = total load on the bearing consisting of one row of balls, in kilograms.

P_a = greatest load on one ball, in kilograms.

z = number of balls.

The load carrying capacity of a ball is $P_a = k\,d^2$, in which

d = the ball diameter, in eighths of an inch.

k = a constant depending upon the material and shape of the ball supporting surface. This constant should vary between 3 and 5 for common materials for ball bearings and between 5 and 7.5 for improved steel alloys.

As balls are usually made to English measurements, one-eighth inch has been selected as unit for the ball diameters.

From equation (1) we have

$$P_b = P_a \frac{z}{5}, \text{ and substituting } k\,d^2 \text{ for } P_a, \text{ we have}$$

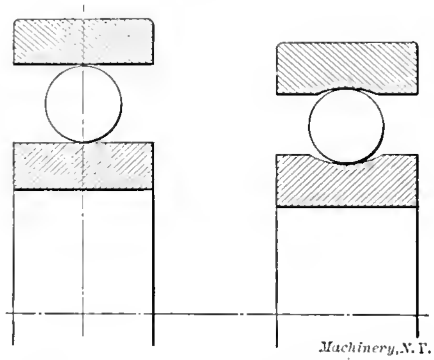
$$P_b = k\,d^2 \frac{z}{5}$$

Speed rotation, in as far as it is uniform, does not affect the carrying capacity of a ball bearing. This applies, however, only to radial bearings, but not to thrust bearings of the collar type. In these, the carrying capacity decreases with the increase of speed. Variations in load reduce the

carrying capacity, the effect increasing with the amount of load change and the rapidity of the change. Uniformity of ball diameter is very essential as the calculated carrying capacity can be realized only if each of the balls sustains its share of the load. High finish on both ball and ball sustaining surfaces is also essential. The presence of grinding scratches will very materially cut down the load carrying capacity.

Frictional Resistance of Ball Bearings.

The frictional resistance of ball bearings has, by actual measurement, been found to vary from 0.0011 to 0.0095. These are the coefficients of friction referred to the shaft diameter, thus permitting direct comparison with coefficients of sliding friction. Ball bearings having a coefficient of friction materially above 0.0015 under the greatest allowable load should not be recommended, because they are too short-lived. The high resistance indicates the presence of too large an element



Figs. 1 and 2. Example of Simple Radial Bearings.

of sliding friction. The coefficient of 0.0015 for a good ball bearing under its greatest load, independent of the speed within limits, will, however, rise to approximately 0.0030 under a reduction of the load to about 1/10 of the maximum.

The Requirements of a Good Ball for Ball Bearings.

The requirements for a good ball are, in the first place, truth of shape and size. The permissible limit of error will vary with the character of the material. It is evident that where a ball is larger than the other balls in the bearing, it must be capable of a deformation sufficiently large so as to permit the others to carry part of the load, and for that reason, the smaller the deformation, the more accurate to size must the ball be. In the second place, a high degree of surface finish is essential. What is usually considered a very good finish is in a ball bearing totally inadequate. Grinding and polishing marks must not only not be recognizable by the naked eye, but, if detected with an ordinary pocket lens, the balls should be condemned. This, at least, is true of balls for bearings expected to have long life, and to carry heavy loads under high speed. The third condition for balls is that the material out of which they are made has an elastic limit as high as can be had. The uniformity of

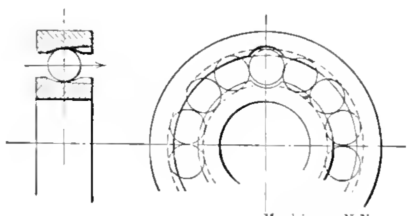


Fig. 3. Objectionable Filling Groove in Ball Bearing.

hardness throughout the mass of the ball is also very essential. General uniformity, in fact, is one of the most important factors, for it will not do to say that because some balls in a lot are better than the others, the design may be based on the poorer ones. Such reasoning would result in the better balls carrying more than their share of the load, producing too heavy a stress, and possibly breakage, of these balls. Lower quality, provided it is uniform, is better than such a condition. The limits of error in regard to the truth and size should not exceed 0.0001 of an inch.

Radial Bearings.

Other things being equal, it is always best to arrange sustaining surfaces at right angles to the load direction. That gives a design of bearing such as shown in Fig. 1, but a better carrying capacity is to be had from the modifications shown in Fig. 2, in which the ball races have curved cross section instead of straight lines. The grooved races have the advantage of greater sustaining capacity, as has already been mentioned. Cutting a local groove from one side into the races, as in Fig. 3, for the purpose of assembling the balls between

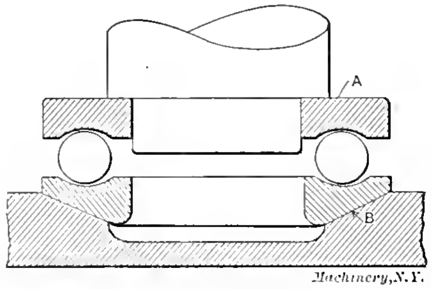
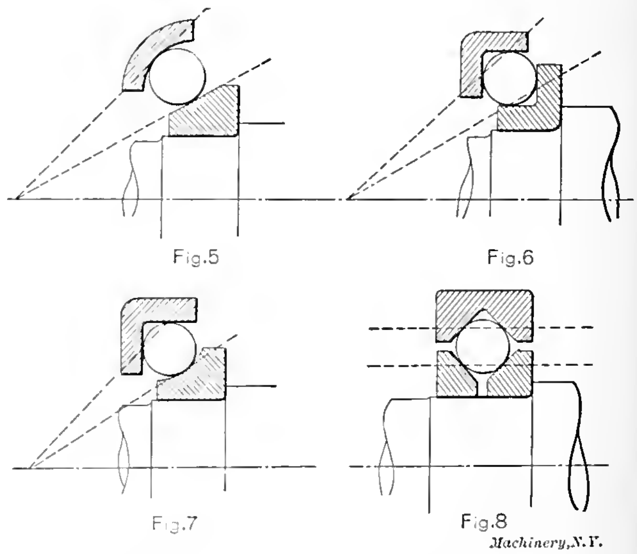


Fig. 4. Collar Thrust Bearing.

the two races, is common practice, but it is not good practice. So long as the loads are low enough, a filling opening may be of no account, but at high speeds and loads this groove is objectionable, since then the catching of the balls at the junction of the filling groove results in damage to the balls and through these to the race surface.

Thrust Bearings.

In thrust bearings, of the type shown in Fig. 4, the requirement that the sustaining surface should be at right angles to the direction of the load is provided for. These bearings are frequently made with the surfaces *A* and *B* parallel. Providing that these surfaces are made truly parallel, that design is good, but in practice it is seldom possible to get these surfaces truly parallel, because even if such parallelism were



Figs. 5, 6, 7 and 8. Example of Angular Bearings.

possible of attainment, it could not be maintained under the deflections due to the load. It must be remembered that initial errors or deflections of a thousandth of an inch will cause the balls on one side to carry the entire load. For a given case this would demand bearings of larger size than otherwise necessary. By seating one plate on a spherical surface as shown at *B*, Fig. 4, the lower plate can adjust itself in such a way as to distribute the load over the entire number of balls. The speed at which these bearings are run enters decidedly into the carrying capacity of this type of bearing. The utility of these bearings is greatly reduced when speeds exceed 1,500 revolutions per minute.

Angular Load Bearings.

The shapes and modifications of angular load bearings are innumerable. Figs. 5, 6, 7, and 8 may be taken as typical instances of these bearings, representing 2, 3, and 4-point contacts. In order to secure rolling contact, the contact points

of balls on races should form points on a cone of rotation whose apex lies in the center line of the shaft, or they may form points on the surface of an imaginary cylindrical roller that would be parallel to the shaft. The defect in all these forms of bearings is their adjustable feature. This places them absolutely at the mercy of every one capable of handling a wrench. A bearing properly proportioned with reference to a certain load may be enormously overloaded by a little extra effort applied to the wrench, or on the other hand the bearing may be adjusted with too little pressure, so that the balls will rattle, and the results consequently be unsatisfactory. The prevalent idea that angular ball bearings can be adjusted to compensate for wear is erroneous. The wear will form a groove on the loaded side of the race, deepest at the point of maximum load, and adjusting the cone endwise will only cause

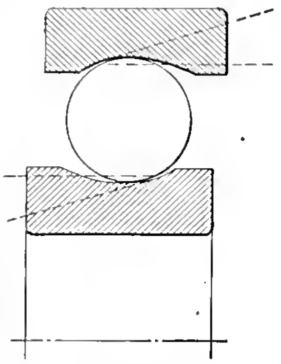


Fig. 9. Radial Bearing used as Thrust Bearing.

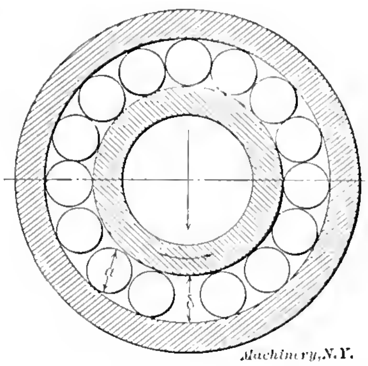


Fig. 10. Diagram used in Analyzing Condition of Sliding Friction.

the balls to be more tightly pinched between the sound portions of the races, which will most likely cause overload. The rough surface of the groove previously worn will attack the balls, and in due time the entire race and bearing will be destroyed.

Theoretically, it would seem that a radial bearing would be incapable of carrying thrust load, owing to the wedging of the balls between the races. In Fig. 9, however, is shown the condition of a ball bearing where the ball does not entirely fill the space between the races if the bearing is not under load, and which, when under load, will assume the position shown. The ball does not come in contact with the race grooves where these are deepest, but so that the tangents to the race curvature at the contact points form angles with the line of thrust. A calculation of the amount of the wedging action in Fig. 9, with the radial freedom of ball permissible in these bearings, indicates an inadvisably large amount of wedging. Actual running tests, however, as well as a large fund of accumulated experience, have absolutely proved that these bearings will carry much more thrust load than the

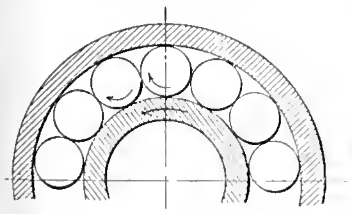


Fig. 11. Diagram showing Direction of Rotation of Balls, indicating Sliding Friction.

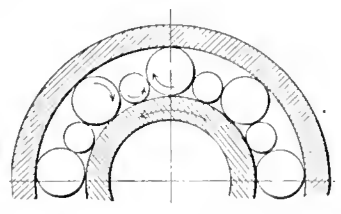


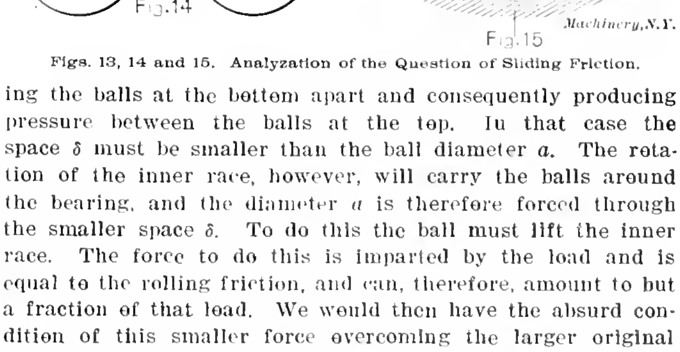
Fig. 12. Fallacious Means for avoiding Sliding Friction between Balls.

calculation of the theoretical wedge angle indicates as possible. It is probable that the deformation which occurs at the point of ball contact, which results in small surface *areas* of contact, instead of mere *points*, has a mean tangent to the compression surface of greater inclination, and that the wedge is therefore more blunt. It has been experimentally determined that the thrust carrying capacity of the uninterrupted type of annular bearings is to the radial capacity as 0.1 is to 1, and may be as great as 0.25 to 1, the variation depending upon the ball diameter, race curvature, and number of balls. It has been experimentally found that speed has but a slight influence on the thrust carrying capacity of this class of ball bearings, and for speeds above 1,500 revolutions per minute, these radial bearings are more efficient thrust carriers than the collar type.

The Supposed Sliding Friction in Ball Bearings.

Many designers have supposed that in ball bearings adjacent balls press against one another with considerable force. With the inner race in Fig. 11 running as indicated, the balls will also rotate as shown. The surfaces of the balls run in opposite directions, and therefore rub against one another. This is assumed to be a serious defect by those who reason that these surfaces are in contact under pressure. The same general cure in innumerable forms, as shown in Fig. 12, has been proposed time and again. This cure consists in the provision of smaller balls interposed between the larger ones, so that all the contacting surfaces roll in the same direction relative to one another. This remedy is, however, fallacious, in that it brings about the very condition it seeks to avoid. If two large balls, Fig. 13, compress a smaller one between them, and the three have their centers connected by a straight line, they will retain their relative positions, but if the interposed ball has its center to one side, as in Fig. 14, then this ball will be forced outward. The resort to a cage for retaining the interposed roller or ball results in the latter being pressed against the sides of the cage, and keeps the ball in forcible sliding contact, the very thing that it was intended to avoid. In another design, Fig. 15, the interposed member is brought into contact with the race, and while the various balls have a rolling contact in relation to one another, the interposed member has a wrong direction with reference to the race against which it is forced, and thus a sliding contact is produced. All these designs are based on a failure to recognize that axiom in mechanics according to which a force whose direction is normal to the supporting surface has no component in any other direction.

Analyze the conditions in a ball bearing, and, referring to Fig. 10, suppose that the shaft is loading the inner race, and that the latter is fallaciously assumed to act as a wedge, forc-



Figs. 13, 14 and 15. Analyzation of the Question of Sliding Friction.

ing the balls at the bottom apart and consequently producing pressure between the balls at the top. In that case the space δ must be smaller than the ball diameter a. The rotation of the inner race, however, will carry the balls around the bearing, and the diameter a is therefore forced through the smaller space δ. To do this the ball must lift the inner race. The force to do this is imparted by the load and is equal to the rolling friction, and can, therefore, amount to but a fraction of that load. We would then have the absurd condition of this smaller force overcoming the larger original force. Were we to assume that the inner race is not raised by a ball in passing, but that the ball is compressed sufficiently to get through, it would mean the absurdity that the small force represented by the rolling friction would be sufficient to deform the ball. The author concludes this portion of his paper by the remark that it may seem unnecessary to dwell so much on this fallacy of ball bearing design, but its surprising prevalence seems to justify the emphasis laid upon this phase of the subject.

[Having given space to the theoretical considerations in ball bearing design in this issue, a coming issue of MACHINERY will contain that portion of Mr. Hess's paper which deals with the practical side of the subject—the correct mounting of ball bearings.—EDITOR.]

* * *

It is stated in the *Brass World* that lead which contains a small quantity of tin and antimony does not corrode as readily as pure lead. When exposed to a damp atmosphere, the surface will not turn white as rapidly.

ERECTING MACHINERY FOUNDATIONS.*

J. A. PRATT.†

Machinery foundations are built usually of stone, stone and brick, and concrete. The principal characteristics of these materials are briefly as follows.

Stone is a very strong and durable material, and has great vibration-absorbing power but it is quite costly. Brick is not so durable as masonry, but it is cheaper and is everywhere available. In a brick foundation, stones are usually placed under the parts of the machine which rest on the foundation. Good bricks should have plane faces, parallel, sharp edges,

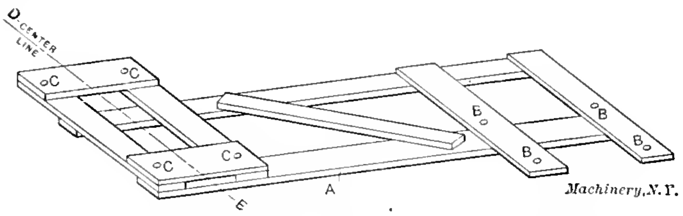


Fig. 1. Templet for locating Bolts for a Simple Engine.

and sharp angles; their texture should be compact, and free from holes. Concrete is a mixture of cement, sand, and broken stone, or gravel. Portland, Rosendale, and Black Diamond cements are used as the first ingredients; if Rosendale or Louisville (Black Diamond) cements are used in mixture, the foundation should not be put in use for two weeks after it is completed.

Method of Testing Cement.

Soundness and setting qualities of a cement are important, and tests of stock can be obtained from the mills. The following is a brief outline of the method of testing: Make four or five pats about 2 or 3 inches in diameter and about ½-inch thick at center, and thin at the edges. Put them on glass plates for the tests. The initial or first set is determined when this pat will bear a wire 1/12-inch diameter loaded with a ¼-pound weight. This should not take place in

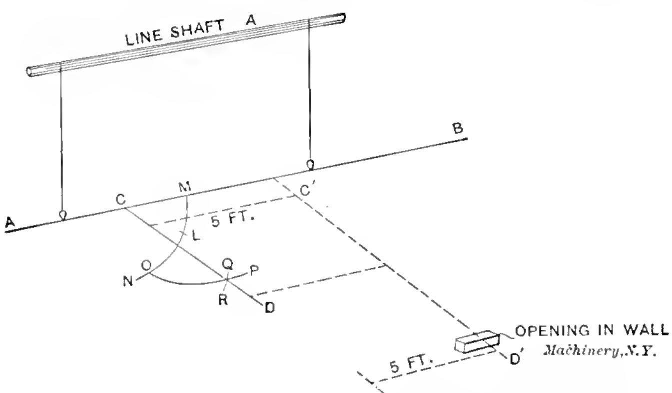


Fig. 2. Illustration of Method used for locating Reference Lines.

less than half an hour. The final set is determined when a pat will bear a wire 1/24-inch diameter loaded with a 1-pound weight, which it should do in less than eight hours.

Preparation of Lime Mortar.

Lime mortar is made by slaking lime entirely covered with water, to keep it from burning. Make of 1 part lime and 5 parts clean sand, and mix a day or so before using. If cement is used in the mortar, the cement should be thoroughly mixed with water and added just before using. Lime cement mortar is mixed as follows: One part cement, 3 parts lime, 5 parts sand.

Pure cement mortar is used a great deal at present and is mixed as follows: One part cement, 3 parts sand. Be sure to use this before initial set takes place.

Size of Broken Stone.

The broken stone, or gravel, should pass through a 2-inch screen and over a ¼-inch screen, and neither "tailings" or "fines" should be used in the concrete. It is best to avoid using limestones or stones of slate formation in foundation concrete. A typical mixture for concrete is 1 part cement, 3 parts sand, and 5 parts broken stone.

Mixing Concrete.

In mixing, the broken stone should be wet down before using; throw sand and cement on mixing board first, and mix well together in dry state; add sufficient water by sprinkling, so that water can be squeezed from a ball of the mixture in the hand. Do not mix ahead of needs, as cement concrete must be in place before initial set has taken place.

Preparing Foundation Pit.

Let the foundation pit be deep enough to go below the frost line of the locality. On the bottom of this pit prepare the foundation bed, by first going over the whole bottom of the pit with rammers, and thus tamping it down. Place on this surface good sized stones about a foot apart, and fill the

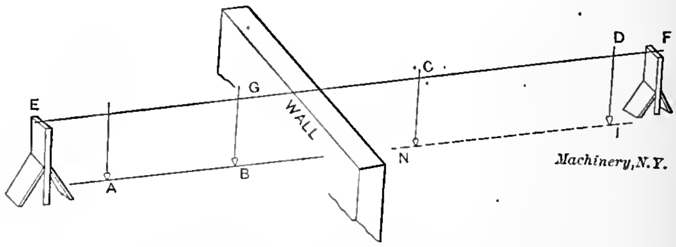


Fig. 3. Locating Reference Line by carrying the Line through a Wall.

spaces between these with concrete of the mixture given above. This bed may be from 1 foot to 18 inches thick.

Construction of Templet.

The next step is the making of the templet by which all the holding-down bolts are correctly located. This templet should be solidly built of good pine boards about 1 inch thick, and, say, 1 foot wide. Lay out accurately on it all bolt holes and all center lines.

Fig. 1 shows a templet for a simple engine. The edge of the board shown at *A* should be planed straight, as it is used as the main center line of the engine. From this edge or center line are located all other center lines on the templet. From the foundation drawing lay out the main shaft center line *D*, *E*, perpendicular to edge *A*. Next lay out the centers of all holes from these two lines, taking dimensions from the drawing. Bore holes about 1 inch larger in diameter

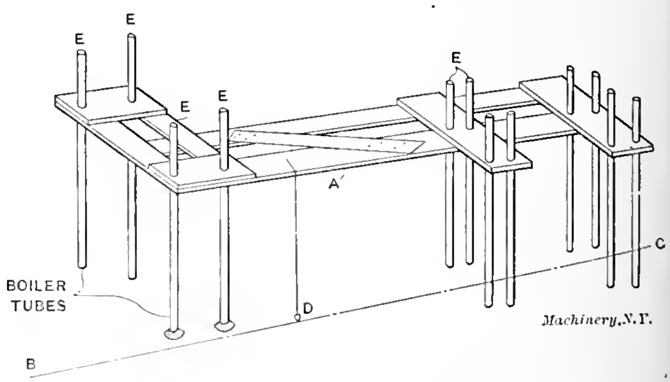


Fig. 4. Leveling and setting the Templet true to Reference Lines.

than the foundation bolts. These large holes will permit the use of pipes as centers for the holes when building the foundation.

Locating Reference Lines.

The next step is the getting of reference lines from the center line of the shaft to which the engine is to be connected by belting or gearing. Figures 2, 3 and 4 will give some idea of the methods used in such layouts. Fig. 2 shows at *A* what we assume to be the old line-shaft, over which we drop two plumb-bobs. Hang these so they will be about 1 inch from the floor, and when they are perfectly steady, let them drop, making a slight dent on the floor. Make this mark as deep as required by the use of a scratch-awl. Then stretch a chalked line, and snap a line on the floor, passing through these points. We now have a line parallel to the line-shaft to which we must connect. If some present installation of machinery is in the way on the floor, transfer this

* See also MACHINERY, January, 1903, engineering edition: Shop Construction—4, Foundations; August, 1903, engineering edition: Concrete Foundations; and March, 1907: Foundations for Machine Tools.

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line to the ceiling overhead, where it will serve the purpose just as well.

Since the engine center line will usually be perpendicular to the shaft line, we must establish a perpendicular to this line, and the method of doing it is shown in Fig. 2. Select the point from which the perpendicular is to be drawn, which, of course, will be taken at the position where the engine must finally line up. This point C is taken as a center, and with any radius—the longer the better—swing arc $M\ N$.

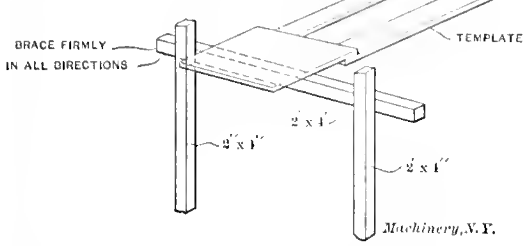

Fig. 5. Frame for supporting Templet.

Next take M as a center and swing short arc L, intersecting $M\ N$. Now from L as a center swing arc $O\ P$. Take O as a center and swing arc $Q\ R$. The point of intersection of $O\ P$ and $Q\ R$, and the selected point C on the given center line, will determine the required perpendicular. Notice that the radius for striking the various arcs is not changed from the start to the completion of the operation. Trammels should be used when describing these arcs. The line $C\ D$ may be extended indefinitely, so the engine can be located at such distance from the shaft line as conditions of belting or gearing require.

A machine to be installed, possibly, may be in another room with a partition between the engine shaft and the shaft to be driven. In this case we have to carry the line through the partition. Fig. 3 shows the method followed in getting the lines located. Two stiff wooden uprights are erected at any selected distance from the wall in question, and the line is stretched tightly between them.

Assume that line $A\ B$ is the portion we have placed on the floor, while the dotted portion shown on the farther side of the wall is the portion we desire to locate. Set the two uprights or targets E and F, and stretch the line. Adjust the line by letting two plumb-bobs hang so they touch the line struck on the floor. Bring the target line $E\ F$ so it will just touch the plumb-bob strings. Now the portion of the target line, $E\ G$, is exactly over the perpendicular, which was located as described in Fig. 2. The portion of the target line $G\ F$ now becomes an extension of $E\ G$, and by dropping plumb-bobs as shown at $C\ D$, so they just touch this line, we may locate a second section of line, either parallel to $A\ B$ or in direct continuation of it on the farther side of a wall.

This line may be struck on the ceiling as well as on the floor if obstructions are in the way. It is usually extended through a convenient window, which may or may not be in

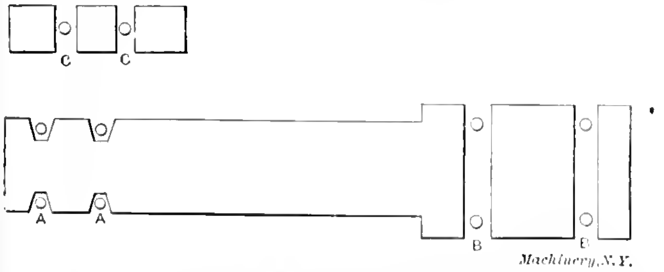

Fig. 6. Laying Out the Foundation.

direct line with $C\ D$, Fig. 2. In such a case, we measure off in perpendiculars from the first line such a distance as the opening through which we wish to pass the line may require (in this case 5 feet), and after passing the line through the wall, measure back again. This work is indicated in dotted lines, Fig. 2. All perpendiculars are struck as directed in connection with $C\ D$, Fig. 2, using trammel points and large radii.

Locating the Templet.

The templet should be slung from the roof timbers if they are in place, and, if not, a good stiff framework of 2 x 4's should be put up. A portion of such a frame is shown in Fig. 5. There should be one at each end of the foundation, and they should permit the templet being slung high enough to complete all work without cramping the masons for room.

In concrete work it is not always necessary to keep the templet in place till the foundation is up to full height, as the setting of lower layers of cement will hold any centers for bolt holes firmly in place, and there is no necessity for a support at the top.

After the templet is hung, it must be carefully leveled up, and the edge A, Fig. 4, set perfectly true with the line $B\ C$ which we placed on the floor of the pit. To do this, drop plumb-bobs over the edge A, and move the templet until they are true with $B\ C$. Now nail the templet firmly to the framework. Next cut some pieces of boiler tube long enough to reach from the foundation bed to 6 inches above the templet, and of same diameter as the holes bored in the tem-

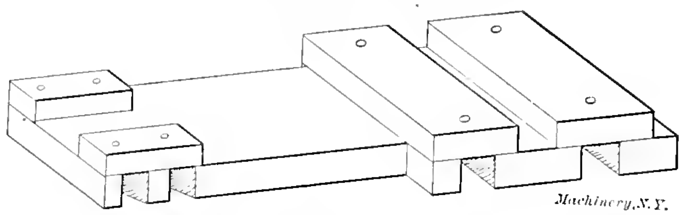

Fig 7. Appearance of Pocket Covers in Place.

plet. Slip these tubes through the holes and set them plumb. As each tube is set, build a little wall of cement around the lower end to keep it in place. See tubes at E, etc., in Fig. 4.

The foundation should be larger at the top than the base of the machine for which it is built. The "batter," or inclination of the sides from the vertical, should be from 1½ to 3 inches per foot. See Fig. 8.

Locating the Bolt-head Pockets.

Now lay out the form of the foundation on the base as shown in Fig. 6. The various pockets are shown at A, B and C. These pockets usually should be placed in a foundation for convenience in tightening up the bolts. In small work, however, the bolts are often set in the templet (instead of using tubes and masonry built around them) leaving them solid in foundation. In such cases pockets are not needed. Pockets should be high enough to permit the bolts being dropped below the upper surface of the foundation while placing the machine. The pockets should be covered with

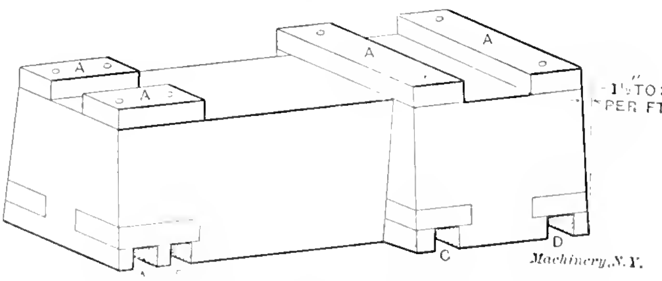

Fig. 8. Foundation with Cap Stones in Place.

a stone or iron slab as indicated in Fig. 7. In placing these stones, slide the boiler tubes up through the templet and set the covers so the tubes can be freely turned when held by the templet and cement guide on foundation bed.

Leveling Cap Stones.

The feet of the machine should rest on stone slabs about 8 inches thick. All brick or stone used should be wet down before placing, unless the weather is freezing, in which case mortar may be mixed with hot water and the work protected with boards at night.

Fig. 8 shows a foundation with the cap stones in place. Be very careful that all cap stones are set level, and all in the same plane or parallel planes.

Fig. 9 shows the method of leveling stones with each other by use of a pair of cast iron cubes, straight-edge and spirit level. Level the stone which is placed at the highest part of the foundation first. After setting the cap stones, the foundation is complete. Then transfer the center line from the foundation base to its top face, and it is ready for the machine.

Advantages of Concrete for Foundations and Method of Construction.

Concrete makes an ideal foundation material, since, when it is set it becomes practically one solid piece. The method of construction is much different from putting up a masonry foundation, and much less expensive. The bed is prepared and the templet is carefully set to center line as described before. All concrete work is molded in forms. The timber for these forms should be about 1 inch thick, dressed on one side for the purpose of getting a smooth surface on the work, and braced about every 2½ feet. Fig. 10 shows a foundation form set up and braced for filling. Two methods of external bracing are shown. At *A* the braces are carried horizontally to the side of the excavation; at *B* a piece of timber is firmly set in the ground, outside the base, and all bracing brought to it. The inside of the form should be braced about every foot in height; the upper brace of one of these sections is shown at *C*. Such braces are placed inside for the entire height of the foundation, spaced as just mentioned. As the concrete is put in place the braces are removed.

The form should be carefully placed to the layout of the foundation, and pocket molds set. Fig. 11 shows a pocket mold and Fig. 12 a top view of the form set ready for filling. The pocket molds are simply wooden boxes of the same outside dimensions as the pocket is required inside, and finished smooth. These molds should be soaked in water 2 or 3 hours before using to prevent their swelling and sticking in the concrete. They may be nailed to the main mold, or wires may be fixed to them, which pass through the main mold, and tightened by means of wedges in a manner similar to that used by a molder in holding suspended cores. These pockets must be firmly fixed in place.

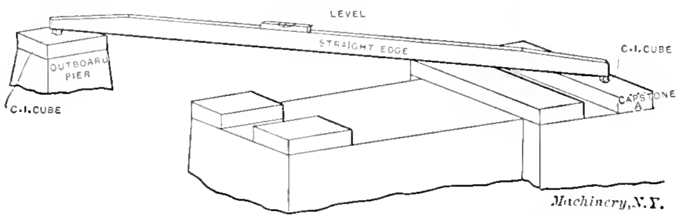

Fig. 9. Method of leveling Stones with each other.

The next step is filling the form. Do not use concrete that has stood mixed much over 20 minutes. Ram with rammers weighing about 1 pound per square inch of face area, and ram until water just shows at the surface. Put down in layers about 6 inches thick, and work down next to forms with a shovel to get a smooth surface. The foundation may be filled with good sized stones, about the size of a man's head, about 1 foot apart and at no place less than 1 foot from foundation surfaces. Wet these stones before laying. If the work is stopped at night, make grooves in the surface, and when starting next morning sprinkle and dust over with dry cement.

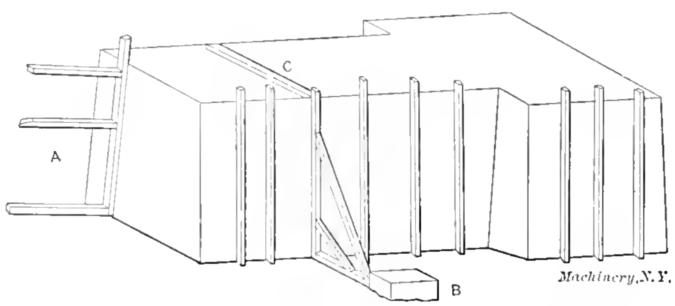

Fig. 10. Foundation Form set up and braced for Filling.

As soon as the cement has set, strip off the forms, as it is much easier to patch when cement is somewhat green.

Foundation work is sometimes "slushed" instead of being rammed. In this case, the concrete is mixed just wet enough so it cannot be piled up. The concrete is then dumped into molds, and worked in them to prevent air bubbles. The first method gives a more homogeneous structure, as there is no chance for the broken stone to settle. Turn the pipes occasionally as the foundation goes up, to prevent their becoming set, if they are to be removed. Sometimes they are left in the foundation as a sort of lining to the foundation bolt holes. When the machine is set approximately true, the space around the foundation bolts may be filled with liquid cement, lead, or melted sulphur.

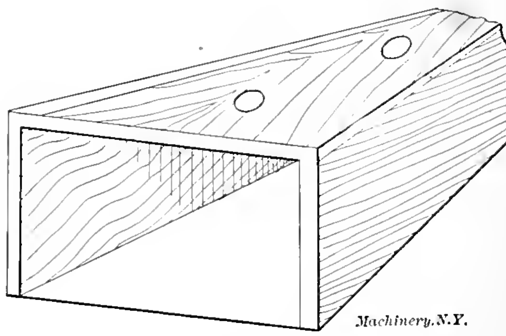

Fig. 11. Pocket Mold.

* * *

An Austrian journal, *Technische Neuerungen*, has published some computations, taken, it states, from an English source, which give an idea about the cost of our inventive age. Not counting trade-marks, copyrights or registration of labels, there have been 3,500,000 applications for patents since the patent system was inaugurated, and about 2,500,000 of the applicants have been granted letters of patent, the United States having granted almost one-half of these, or about 1,000,000. The government fees for this alone have amounted to about $180,000,000. This, however, is only small part of the expense incurred for patents. Solicitor's fees and the expense incidental to maintaining the granted patents may be estimated to at least $1,100,000,000. A conservative estimate places the total cost of litigation for protecting patents to $1,700,000,000, and the promoters' rake-off to $1,200,000,000. The total cost of development has been estimated at more than $6,000,000,000, so that the grand total of all these various items, all incidental to patenting and exploiting patents, is about $10,200,000,000, and with a reasonable interest for an average of thirty years, the total cost to the world for its patented inventions should be placed at about $30,000,000,000. Now, the main question is if individual inventors, for the protection of whom we must consider that many of these charges have been paid, actually were benefited to any amount in the least proportionate to the stupendous sums expended.

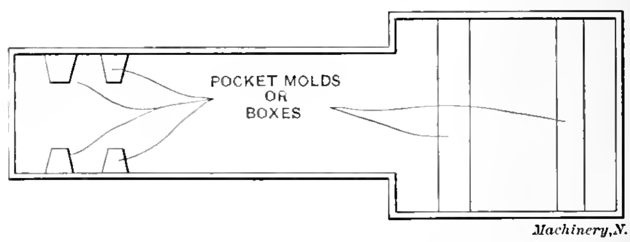

Fig. 12. Top View of Form ready for Filling.

* * *

The Northern Pacific Railway Co. has recently built a novel roundhouse at Dilworth, Minn. This roundhouse contains 44 stalls, having pits so arranged that the ashes from the engines can be dumped into them, thus avoiding the delay which is often caused by sending the engines to an outside ash pit. There is a depression in each roundhouse pit, which contains perforated pans for receiving the ashes. These pans, which are about 72 by 30 inches, are submerged in water for the purpose of cooling the ashes. There are two pans in each pit so that two engines can use the pit before the ashes need to be removed. The pans, when filled, are lifted by an electric hoist which travels on an overhead track, and carried to a cinder shed where the ashes are dumped from the pans into cars. This arrangement will make it possible to clean and bank the fire without delay, which will mean a saving in coal, and a reduction of the terminal expenses.

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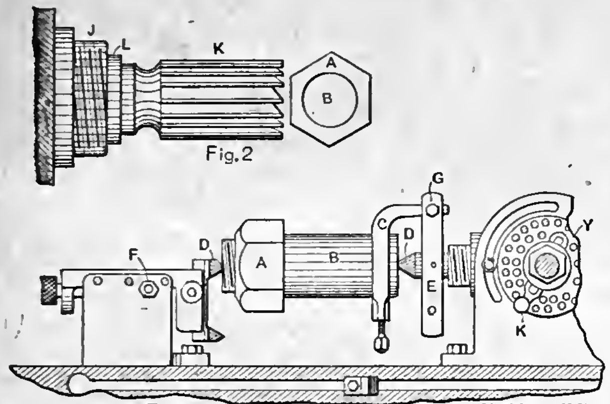
SHOP OPERATION SHEET NO. 46.

W. S. Graffam. MACHINERY, December, 1907.



To Set Up the Job of Milling the Faces of a Hexagonal Nut.

NOTE.—A simple and elementary operation is here chosen, for the reason that the principles and mechanical details by which it is accomplished are practically applicable to many milling machine jobs of a much more complicated nature. The most accurate milling may nearly always be done with an end mill. Consequently the various steps in connection with milling the flats of a hexagonal nut, will be given. Let it be assumed that the nut to be milled is to finish 1.5 inch short diameter, or the diameter across flats. It is supposed to have been drilled, tapped, faced, and chamfered. The threaded nut arbor upon which it is held is 1.25 inch diameter across the body. The milling machine is supposed to be provided with graduated dials reading to thousandths of an inch on all feed screws.

1. Screw the nut A tightly against the shoulder of the nut arbor B.

2. Clamp a lathe dog C upon the opposite end of the arbor B.

3. Bring the tail-stock up to the proper position and clamp it. Place the nut arbor B on the centers D of the machine, with the tail of the dog C in the slot of the carrier E, and clamp it with the set-screw G. Bring up the tail center and clamp it by nut F.

4. Clean the taper hole in the main spindle J (Fig. 2). Select a reducing collet L, wipe it clean, and place it in the hole in the spindle J. Wipe clean the hole in the collet L. Select an end mill K, of sufficient diameter to entirely cover one of the faces of the nut A. Wipe the taper shank clean and place it in the collet L, fixing it with a light blow from a lead hammer.

NOTE.—The importance of thoroughly cleaning the collets, and wiping the shanks of all mills clean before using, cannot be overestimated, as small chips which are scarcely visible will cause the mill to run out of true.

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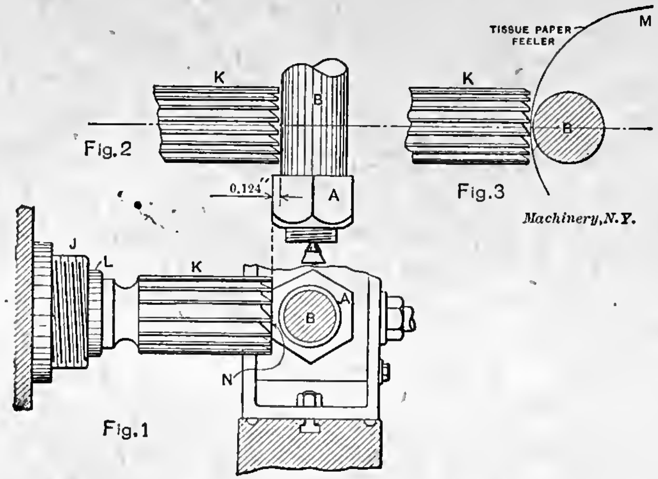
SHOP OPERATION SHEET NO. 47.

W. S. Graffam. MACHINERY, December, 1907.



To Set the End Mill for Milling the Faces of a Hexagonal Nut.

NOTE.—The short diameter of the finished nut is assumed to be 1.5 inch. The body diameter of the nut arbor upon which it is held to be milled is 1.25 inch. The thickness of the tissue-paper feeler is .001 inch.

1. Place a tissue-paper feeler M over the arbor B (Fig. 3), and bring the cutting end of the end mill K, lightly against it, not hard enough to cut the paper.

2. Caliper the diameter of the arbor B (in this case 1.25 inch), add twice the thickness of the tissue paper ($1.25 + 0.002 = 1.252$). Subtract this from the finish short diameter of the nut A ($1.5 - 1.252 = 0.248$), and divide the result by 2 ($0.248 \div 2 = 0.124$). This may be expressed thus:

$$\frac{1.5 - (1.250 + 0.002)}{2} = 0.124.$$

It may be done thus: Subtract one-half the diameter of the arbor B ($1.25 \div 2 = 0.625$), plus one thickness of paper ($0.625 + 0.001 = 0.626$), from half the short diameter of the nut A ($1.5 \div 2 = 0.75$) to obtain the distance to move the work from the end of the mill K ($0.75 - 0.626 = 0.124$). The machinist will probably favor taking the diameter thus: $1.25 + 0.002 = 1.252$, and

$$\frac{1.500 - 1.252}{2} = 0.124, \text{ the distance required.}$$

3. Set the pointer on the cross-feed dial at 0.124, as obtained in step 2.

4. By turning the cross-feed crank, draw the work somewhat farther away from the end mill K than necessary (to take up back lash). Reverse the motion and move the work up until the dial reads zero.

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SHOP OPERATION SHEET NO. 48.

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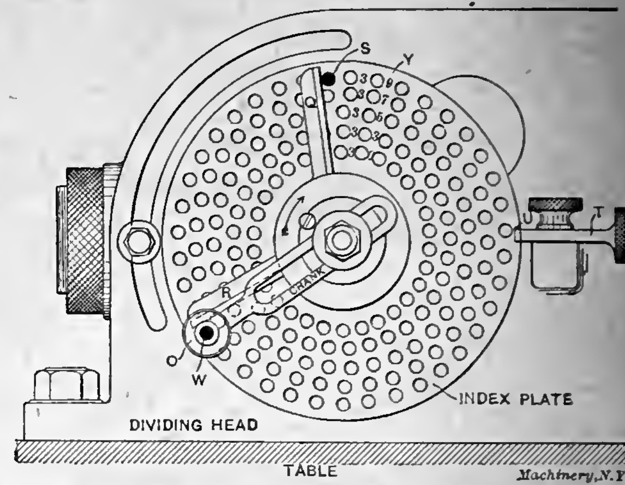


To Set the Indexing Device and Take the Cuts for Milling the Faces of a Hexagonal Nut.

NOTE.—Ordinarily the dividing head of a milling machine is so arranged that 40 revolutions of the index crank rotate the spindle through one revolution; that is, it has a ratio of 40 to 1. This ratio is here assumed.

1. Select an index plate Y having one or more circles of holes whose number is divisible by 3 (in this case 39), and put it in place on the dividing head.

2. Find the indexing thus: The ratio being 40 to 1, and the number of sides of the nut being 6, we have $40 \div 6 = 6\ 2/3$ turns of the index crank O to change from one face to the next.

3. Set the sector arms Q, R, so as to include two-thirds of a circle of 39 holes, plus one hole, or 27 holes ($2/3 \times 39 + 1 = 27$), and clamp them together.

4. Insert the stop-pin T in the slot U of the index-plate Y, and set the crank O to bring the pin W to the radius of the 39 row of holes, if this has not been done.

5. Turn the index crank O a portion of a revolution, in the direction of the arrow, to take up back lash, and insert the pin W in the hole at S. Bring sector arm Q against pin W.

6. With the lateral and vertical movement feed cranks bring the work directly over the cutting surface of the end mill K.

7. Start the machine. Feed the work down past the end of the mill K, making the first cut. Return the work to its original position.

8. Give the index crank O six turns in the direction of the arrow, and, in addition, move it from the sector arm Q to R, making 6 2/3 turns in all, as per Step 2. Swing the sector arm Q around against the pin W.

9. Proceed with the remaining cuts as described in Steps 7 and 8.

NEW SHOP OF J. E. SNYDER & SON.

H. P. FAIRFIELD.*

Since 1892, and up to recent date, the shop of J. E. Snyder & Son was located in a large power building on Beacon St., Worcester, Mass. Owing to a steady increase of business, which made the old quarters too small, and because of a wish for more convenient and better lighted shop conditions, the company has built and moved into the building shown by the accompanying photographs. The new shop is located at the intersection of Parker and Dewey Sts., convenient to car lines running to all parts of the city and to the union station.

In selecting this location, attention was paid to the needs of the workmen, and the reader will note that the shop is surrounded by residences, making it an easy matter for the workmen to secure a home within an easy walking distance of his employment. This is a feature too little thought of by some firms when choosing a site for a new works. The construction is of concrete blocks, giving a building which is not only substantial for its purposes, but pleasing in appearance, an essential point when it is remembered that the location is residential. Special attention was paid to uniform lighting, and Figs. 1 and 2 demonstrate the means employed, the walls consisting largely of windows, and the central area of the roof of glass monitors.

The views showing interiors also show the method of lighting. There are four bays from north to south, those on either side receiving light from the wall windows, while the two central ones are lighted by the roof monitors.

The shop is so well lighted, that when taking the interior photographs shown, no difference in the time of exposure was found necessary, and the writer has never before found this to be true.

Fig. 3 is a view taken near the shipping door at the north end of the building, and shows the erecting bay with a portion of the shipping floor. The offices and drafting rooms are located at the right of this view.

Fig. 4 is taken from the north end near the offices, and shows the gear cutters, milling machines, and lighter lathes, and looks out toward the setting-up floor.

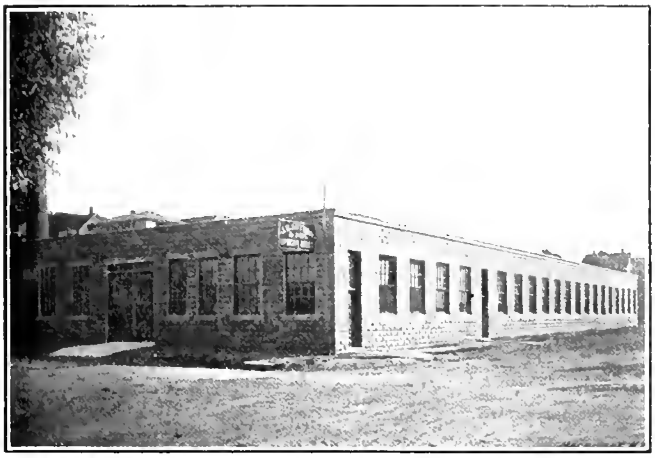


Fig. 1. View from the North.

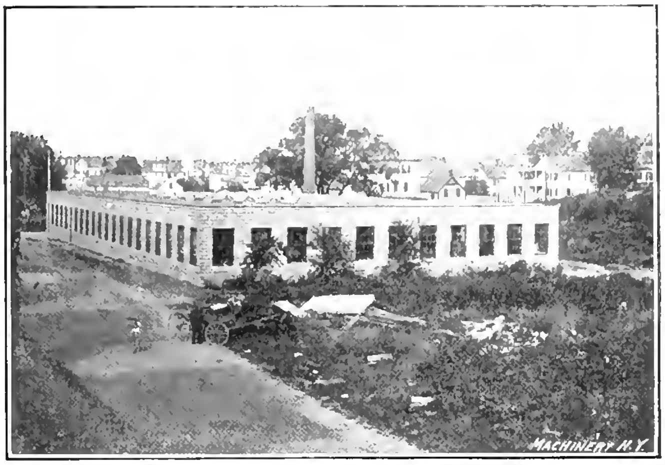


Fig. 2. View from the South.

Fig. 3. Shipping Floor and Erecting Department.

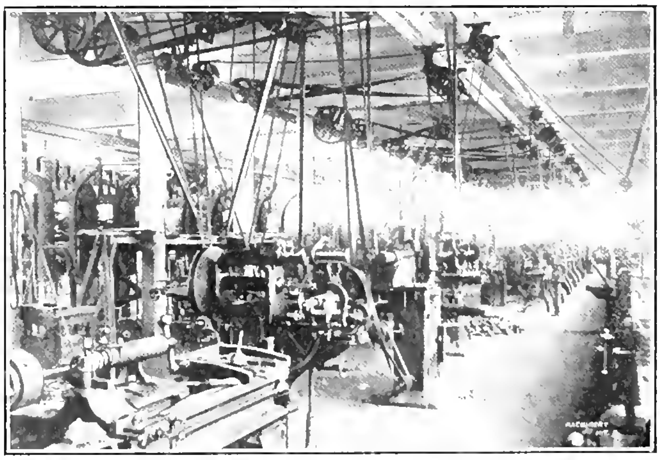


Fig. 4. Gear Cutting and Small Lathe Work.

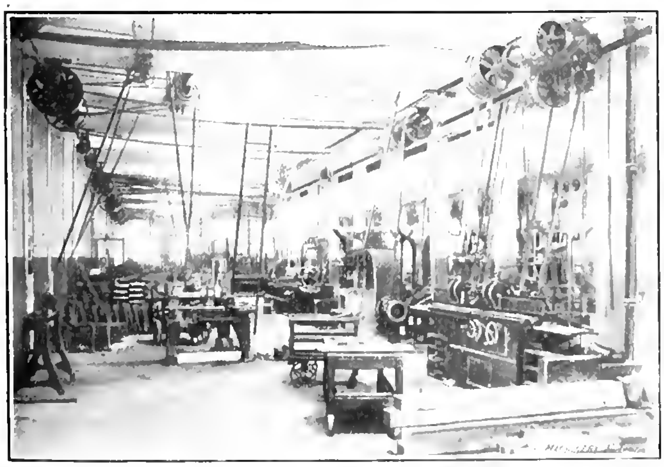


Fig. 5. Grinding, Boring and Heavy Turning, also Tool-room in Middle Distance.

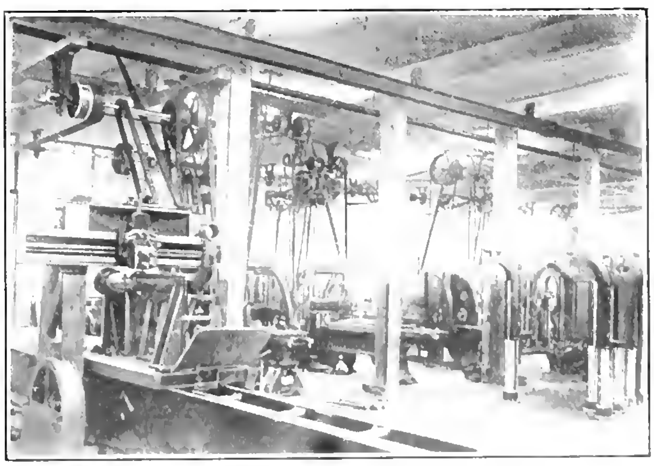


Fig. 6. Planers as seen from Erecting Floor

* Address: Worcester Polytechnic Institute, Worcester, Mass.

In Fig. 5 is shown the grinding, boring, and heavy turning machines, and in the middle distance the wire netting surrounding the tool room can be seen. A view of the planers from the setting-up floor is shown in Fig. 6.

About 1882, Mr. J. E. Snyder first began to manufacture, in a small way, the drilling machines for which he has since become so well known. Then the firm name was Currier & Snyder, and the shop was located on Central St. In 1884, the firm removed to Hermon St., and in 1892 to Beacon St. Mr. Snyder bought out Mr. Currier's interests in 1894, and his son entering the business with him in 1902, the present firm name of J. E. Snyder & Son was adopted.

Like many machine tool builders, they have deemed it best to concentrate their efforts in manufacturing a single, straight line of machines, namely, drilling machines in all sizes from small lever machines to those of the largest back-geared drive and geared feed machines. These are built in lots of forty, sixty, eighty and one hundred, according to size. Their products go to all parts of the world, and foreign orders are now booked for months ahead. At the present writing the company has about sixty machinists in its employ, having very recently moved into its new quarters.

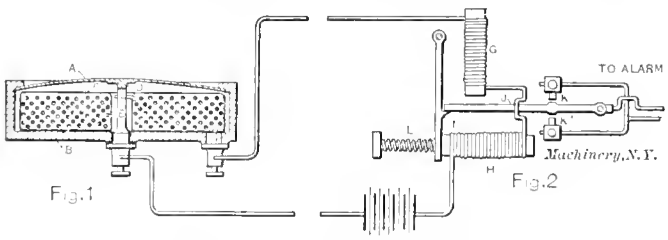
* * *

THE BURGLAR AND THE SAFE MAKER.

GEORGE P. PEARCE.*

The fight between the burglar and the safe maker is very similar to the fight between the armor plate manufacturer and the gun builder. First one is ahead, and then the other. The only difference is that the safe maker has never been far enough ahead to make himself prominent. The burglar is very enterprising in his bad way, for he was among the first to use the electric current for burning holes in a plate. He took advantage of "Thermit," and now, according to October MACHINERY, he is getting quite handy with the oxy-acetylene blow pipe. Any attempt to discourage him with ethyldichloracetate fumes, or other noxious or dangerous vapors, as suggested, would surely be a failure, for a modern safety helmet would enable him to attend to his business without much inconvenience. The following is a description of an attachment for protecting safes, which in my opinion would possibly check successful attempts at burglarizing for some time at any rate.

Let an electric contact device be made along the lines suggested in Fig. 1. The top plate *A* being a sheet of thin springy brass, and the frame *B* a casting. The coil *C* is a resistance, the contacts *D* and *E* are of platinum, and the connections are as shown. In assembling, the plate *A* should be slightly sprung out, as shown, so as to cause a good contact between *D* and *E*, and then the whole box hermetically sealed. This device would be suspended inside the safe, the



Device for making a Safe Burglar proof.

wires brought out through air-tight joints and connected to the alarm, shown diagrammatically in Fig. 2, which could be placed in any desired location. In operation, the safe would be closed as usual, and the current switched on. This would cause a large current to flow through the contacts *D* and *E*, and the electro-magnets *G* and *H*. This current would cause *G* to attract *J*, closing contact *K* and thus throwing in circuit the auxiliary current and ringing the alarm. Next it would be necessary to obtain a partial vacuum in the safe by means of a small pump. This would cause the air confined in the contact device to push the spring surface *A* outward, thus breaking the contact between *D* and *E*. The current will still be able to flow through the resistance coil *C*, but it will be greatly weakened, and the electro-magnet *G* will not be powerful enough to hold *J*, which will fall and catch on step *I*. Magnet *H* will still be magnetized enough to just overcome the tension of the spring *L* and thus keep *I* in position; thus contact at *K* will be broken, and the alarm will cease to sound. The partial vacuum will also cause the door to be tightly drawn against the rubber packing and thus prevent leakage.

Now as soon as a burglar makes a hole in the safe, the air will rush in, and spring plate *A* will return to its first position and close the short circuit. The extra current will magnetize *G* to a greater extent and cause it to pick up *J*, closing its contact with *K*, and operating the alarm. Should the burglar cut the wires, the magnet *H* would lose its magnetism, and *I* would be drawn back by the spring *L*, allowing *J* to fall and make contact with *K'*, thus again operating the alarm. A resistance could not be inserted between the line wires to balance the resistance coil *C* while the wires were cut, because the resistance of *C* would be unknown. If the new resistance was too great, or too small, it would either cause the magnet *G* to lift *J* and ring alarm through the contact *K*, or it would decrease the power of magnet *H*, which could not then overbalance the spring *L*, which would pull *I* back and let *J* fall and close the contact *K'*, and again ring the alarm. Any attempt at testing the wires would also disturb the balance in the alarm box and cause the signal to be given, and thus it would certainly be a difficult matter to get the valuables without sounding the alarm.

* Address: 384 Prospect Ave., Buffalo, N. Y.

* * *

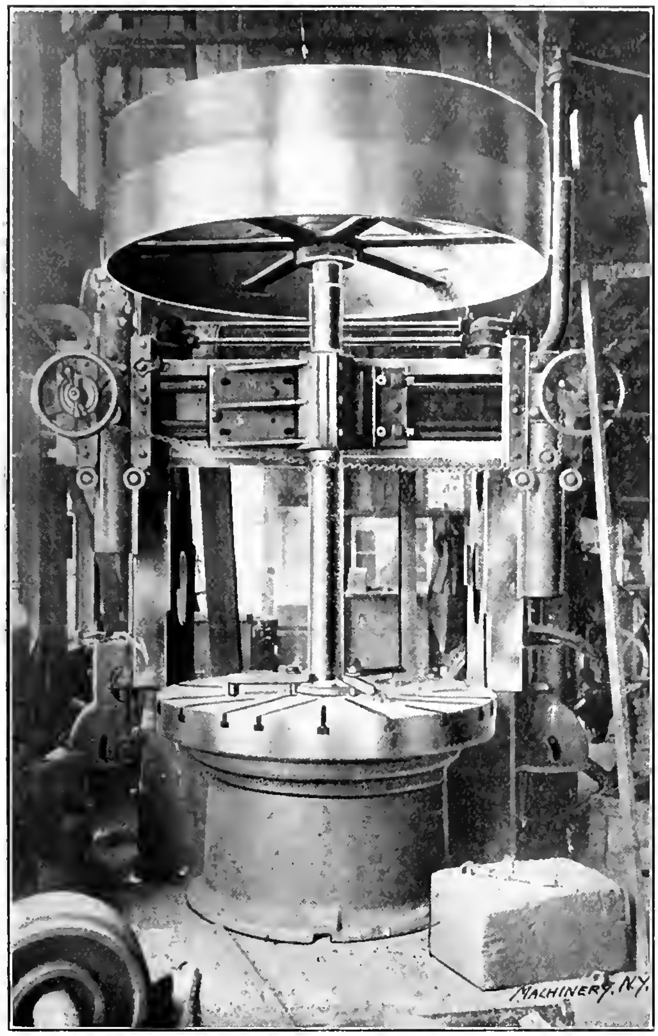
TURNING A 76-INCH PULLEY ON A 60-INCH BORING MILL.

R. C. PORTER.*

The accompanying half-tone shows the manner in which a 76-inch pulley was successfully finished at the shops of the California Iron Works Co., Eureka, Cal. The shops in question are not equipped with lathes or other turning machinery to finish work of a larger diameter than 60 inches, as the ordinary run of work in this shop does not call for machinery of larger sizes. A case came up, however, in which a pulley 76 inches in diameter and 21 inches wide was required to be turned. After some meditation, it was concluded that by rigging a 60-inch Colburn boring mill as shown in the cut and as described below, it was possible to finish the pulley on this machine. In the first place, the casting shed was searched for some old 6-inch post boxes, which were then planed on the back and bolted to the cross rail of the boring mill. In order to enable these boxes to be used for the same kind of work in future jobs, dowel pins were also provided, so that the boxes could be located in exactly the same position if wanted for use again. These boxes were, of course, not as yet babbitted. A piece of 6-inch shafting was now turned on one end to fit the hole of the pulley, which had previously been finished to size in a radial drill press, and key seated. The other end of the shafting was turned to fit the center hole in the face-plate or table of the boring mill. The length of the shafting, of course, had to be made such that when the pulley was placed on its upper end, and the lower end fitted into the table, the shaft would reach fully through the hub of the pulley, so as to give a satisfactory bearing. An extra heavy piece of pipe flange was then keyed to the lower end, and faced true with the shaft, after which the arbor was erected on the mill, the flange bolted to the table, and the shaft located in the center by means of placing the end to fit the center hole in place in the table. The machine was then started, and the arbor was trued up until it was running perfectly correct for its whole length. The boxes bolted to the cross-rail were then babbitted, so as to give an upper bearing to the shaft. As in this case it was necessary to feed the tools upward instead of down, the tool-holder heads were detached from the machine and reversed, the left-hand head being put on the right-hand side and *vice versa*. The pulley was then hoisted in place by a crane, and was keyed firmly to the upper end of the arbor. Tool-holding bars were now placed in the heads, one on each side of the pulley, one taking a roughing and the other a finishing cut. On account of the width of the pulley it was not possible to finish the whole face at one setting, and, therefore, when one-half of the pulley was turned, it was reversed and the other half

* Address: California Iron Works Co., Eureka, Cal.

finished. The face was crowned the same as any ordinary pulley. Novo steel was used in the tool-holding bars or cutting tools, and a feed of 0.043 inch, and a 1/4-inch depth of cut for the roughing cut was used. In order to prevent the chips from falling down into the tool-holder heads and injuring



View showing the Way in which the Pulley was attached to the Boring Mill.

the ways, burlap was thrown over the heads and the guides. This arrangement worked very satisfactorily, so much so, in fact, that it was concluded to finish two 96-inch diameter by 10-inch face band mill-wheels in the same manner.

* * *

AN OLD-TIME APPRENTICESHIP.

BACK-NUMBER APPRENTICE.

The apprentice who starts in nowadays to learn the greatest of all trades (though by no means the best paid), the machinists' trade, has a much easier time in a great many respects, than he would have had fifteen or twenty years ago. Now he works so many weeks, or months, on various machines, and so many more at the bench, or on the floor, and passes through a regular course, often having a special foreman to look after him, and see that he learns all that he should in each branch.

They used to start us snagging castings, cutting bolts, and sweeping up the shop. Happy were we, when the boss came around and told us to help some one do a little repair job over in the mill, or out in the yard somewhere. The erecting floor, so called, was a space between the drill-press and the wood planer, in the "wood butcher's" end of the shop, and directly in the passage to the blacksmith shop and the pattern shop. Here were brought pumps, engines, water-wheels, or anything else that couldn't be repaired where it stood, and the apprentices, sometimes assisted by some superannuated pensioner, would scrape off the accumulations of grease and dirt, while some of the handy-men, who did anything, and everything, would take it apart and stack up the pieces in some out of the way corner, until they were needed. Here the "cubs" reveled in dirt, hoping that they might get a chance to bore out a bushing, or plane up a pillow-block cap, or do any other little job that called for a "pretty fine fit," or a "light drive," as the case might be. One man in the shop had worked "down country," and was used to seeing men who used micrometers every day, but to us, they were a useless extravagance, and if anybody had attempted to use one, he would have been considered as putting on airs. How we did look up to a man who could take his calipers over to the mill and caliper a shaft, and then come back and bore out a gear to fit "just right," without any worry or fussing. We would stand beside his lathe, when the boss was out, and watch the boring tool chattering its way through the pulley, or gear, while he leaned carelessly against the ways, and explained that *he* always set his inside calipers just a "feel" to his outside calipers, and of course couldn't make a mistake.

I recall an experience of my own which may be of interest. I was told to turn the bolts for a flange coupling, and make them a light driving fit, and, of course, I wanted to make a record, so I rushed the job along until the bolts became heated. They were finished, and driven into the coupling while in this condition, and after a while the boss came around to inspect the job. In the meantime the bolts had become cool, and the boss was able to drive them out with his hand. I learned more about the expansion and contraction of metals from this simple experience, than a year's study of physics would have taught me.

The variety of work that we had was not as great as it is in a job shop, but it was varied enough to keep it from being monotonous. Once there was some difficulty with one of the Westinghouse single-acting vertical engines, which made it necessary to send an expert up from Pittsburg to investigate. The engine had to be rigged up so that indicator cards might be taken, and I had the pleasure of helping on the job. The expert, a gray-bearded, white-haired old man, seemed to me to be the smartest man I had ever seen. He would take a card, and then taking it off the drum, would study the, to-me-meaningless curve, and nod his head wisely, and mutter something about the valves or eccentric. At any rate, he located the trouble, and repaired it, or had us do it, and sent in a nice little bill, I suppose. It was whispered around that he got five dollars a day, and expenses, for his services, which looked mighty big to an apprentice getting seventy-five cents a day, and paying his own expenses at that.

My experience after going into a railroad shop was somewhat different. Not having served my time, I was considered an apprentice still, and as the other apprentices didn't know that I had had any shop work at all, I was the object of many remarks, when the boss put me on a bolt lathe. When I passed over several others and got this job, there was a good deal of feeling, which gradually disappeared when they found that I could turn bolts to fit, without filing off the last 1/64 inch, as seemed to be the custom. Sometimes I was given a planer job, which was rated as a "snap," because I could sit and watch the machine run, and no one came along and told me to take a heavier cut. Work on the pits was harder and more disagreeable, but the apprentices all got their share of it. That branch of the work was managed a little better as regards supervision, as each pit was in charge of a gang boss, and there was considerable rivalry between them, to see who could turn out the most engines; so they would show the apprentices the best way to do things.

Things are much better in connection with railroad work now, and railroad shops are rapidly being put on a commercial basis; and it is to be hoped that some adjustment of the apprenticeship problem will be reached, which will put railroad apprentices on a footing approaching that in the best manufacturing shops.

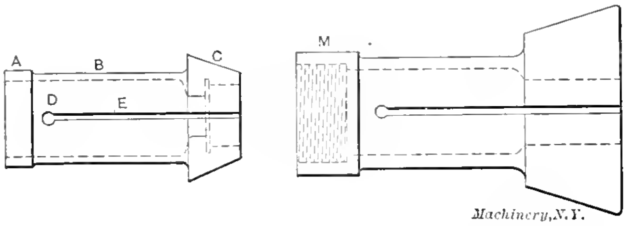
* * *

Do not lose heart and get discouraged. Your success does not lie in the hands of others, but in your own. Do not think that the world is down on you or that, because you merely work hard, you should succeed. The man who works hard building ice ponds in Florida or planting orange groves in Maine is not entitled to victory.—*William F. Forbes, in Stevens Institute Indicator.*

LETTERS UPON PRACTICAL SUBJECTS.

MAKING SPRING COLLETS.

Spring collets are now used in nearly all shops, and there are many varieties, depending on the work they are required to hold, and the machine in which they are used. I will describe how three kinds that are used at our shop are made. The one illustrated in Fig. 1 is the smallest, and this collet is used on a small nut machine, while drilling, facing and tapping small solid cast brass nuts. This collet is closed on the work by being thrust forward into a taper collar. The



Figs. 1 and 2. Showing Collets of the Push-in and Draw-in Types.

collet is made heavier at A, because the plunger strikes it there, and also because it will keep its shape better while being tempered or case-hardened. The collet has three slots, 1/16 inch wide, which allow quite a little spring. These collets are now made of machine steel. They were formerly made of tool steel, but it was found that by using machine steel the original cost was much less, and the wearing qualities were very much better. Tool steel crystallizes from constant springing, and owing to their shape, the collets were frequently broken in tempering.

To make the collet, a piece of machine steel just a trifle larger than the finished collet is chucked, and the end A faced. The smallest size hole of the collet is bored clear through, and the large hole is bored as deep as the head C. The piece is then put on a mandrel, which only fits into the

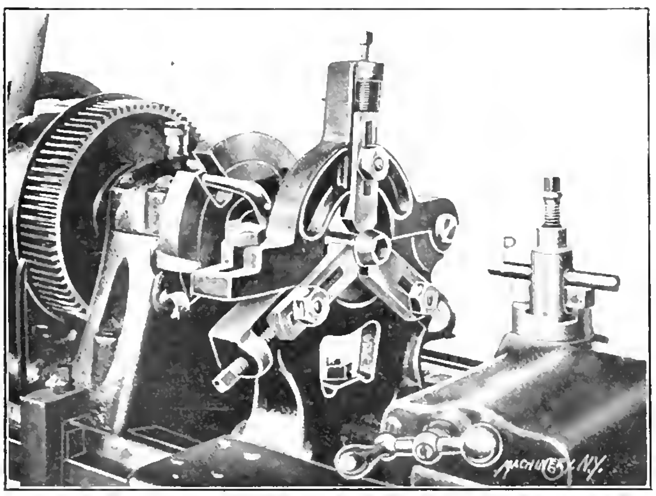


Fig. 3. Method of broaching a Collet in a Lathe.

collet as far as the head C, and the other end is faced. The parts A and B are turned, and then the compound rest is set, and the head C is turned to the required taper. The steady-rest is now placed on the lathe, and adjusted to the work just back of the head C, as shown in Fig. 3. A hole is then bored, the diameter of which is equal to the short diameter of the hexagon nut which the collet is to hold, and the depth about 3/64 inch less than the length of the nut. At the bottom of this hole a narrow recess is cut. The diameter of this recess should be a little more than the distance across the corners of the nut to allow the broaching tool to cut through. The broaching is done in the lathe, and when this is being done, it will be necessary to rotate the lathe through one-sixth of a revolution, as a hexagon is to be formed. This can be done by laying off six equal spaces on the face-plate, and measuring with a pointer from some fixed point on the bed to the spaces; but if the number of teeth on the large gear is right, this will not be necessary. For example, the gear shown in Fig. 3 has seventy-eight teeth. These are divided into six equal divisions, or every thirteenth tooth is marked. A steel stop, which rests on the bed of the lathe, is made to engage with these marked teeth, and in this way the necessary divisions are obtained. The broaching tool is shown at D. The broaching is done by moving the carriage back and forth by hand. Several cuts are taken, then the work is rotated through one-sixth of a revolution, and the operation is repeated. This is continued until the hexagon is nearly to the required size. The tool is then set to make the hexagon the finish size, and the six cuts taken without moving the tool. The back gear should be in when doing this work, in order to steady the spindle. We formerly laid out these hexagons, and cut them in the shaper, but it is very much better to broach them, using the lathe. After the hole is broached out, three 1/8-inch holes D (see Fig. 1) are drilled. These holes are spaced so as to be in line with every other corner of the hexagon. The collet is now driven on a man-

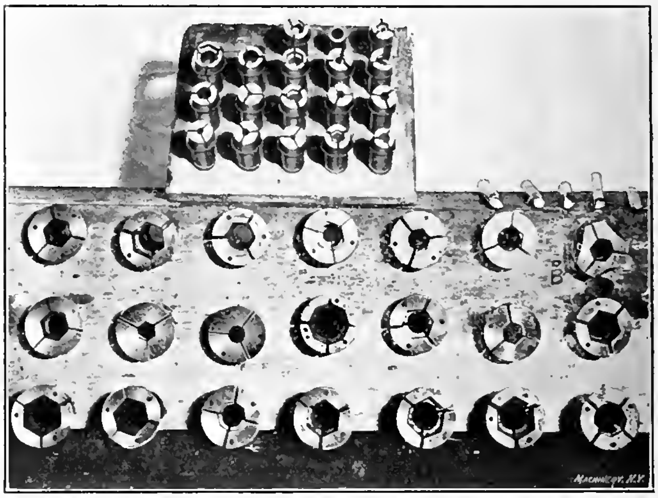


Fig. 4. Collets of Various Sizes and Broaching Tools used in making them.

drel, and the slots E cut. This is done on the milling machine, a 1/16-inch slitting saw being used. After the collet is slotted, the burrs are filed off, and it is ready to be case-hardened. Pieces are then inserted in the slots to spread them open, and they are case-hardened while in this position, which permits the work to be inserted easily.

The collet shown in Fig. 2 has an internal thread at M, and it is screwed onto the plunger or quill. This collet is closed by being pulled into a taper collar. It is used for holding round and hexagon bars, brass fittings, etc. This collet has three holes drilled into its face, and a wrench having three pins which fit into these holes, is used when screwing the collet onto the quill.

The collet shown in Fig. 5 also has an internal thread, and it is much heavier than the other two. It has four 1/8-inch slots, which allow it to spring, and there are four grooves cut into it, which engage with keys, making a positive

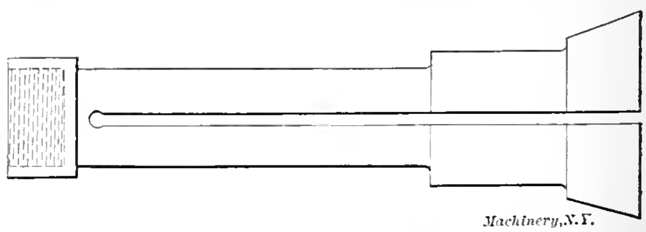


Fig. 5. Large Collet of the Draw-in Type.

drive. The collet is opened and closed by compressed air, and it is used for holding compression cock stems, and similar pieces, while they are being box-tooled and chased with a die. An 8-pitch, square thread is cut on the stems referred to, which shows how well this collet holds the work. That part of the collet which comes into contact with the work, is corrugated to prevent the work from slipping. These corrugations are also made by broaching.

A number of these collets are shown in Fig. 4. The small

collets shown at the top are the same style as the one illustrated in Fig. 1, and the larger ones below, are the same as the one shown in Fig. 2. The collet marked *B*, which is seen in the upper right-hand corner, illustrates the way in which they are sometimes broken in tempering. The tools shown just above this broken collet are the broaching tools. Two of these are used for cutting hexagons, one for squares, and the other two for corrugating the collets.

Decatur, Ill. J. J. VOELCKER.

TOOLS FOR BORING AND TURNING SPACING COLLARS.

The tools shown in the accompanying illustrations are used for the boring, reaming, and turning spacing collars. By using these tools the collars can be bored, reamed, and faced, while in the chuck, which is a decided improvement over the method formerly employed. This method consisted of first boring and reaming the collars in a chuck, and then driving them on a mandrel to be faced. As a rule the width of spacing collars must be within a certain limit, as they are used in strings of from thirty to sixty on one shaft, and any variation in width will be multiplied according to the number used.

When using the tools shown, these collars can be bored, reamed, and faced in a turret lathe. Fig. 1 shows the com-

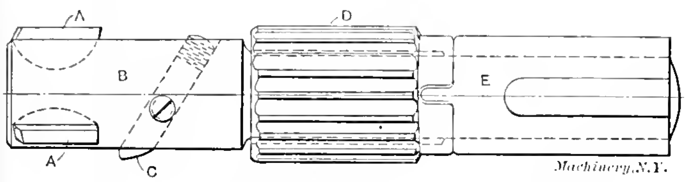


Fig. 1. Combination Drill, Boring Tool and Reamer.

bination drill, boring tool, and reamer used. Three high-speed steel cutters *A* in the shape of a Woodruff key, are set into the soft steel shank *B*, forming a three-lipped drill. The boring tool *C*, which follows the drill, trues up the hole and makes it the proper size for reaming. The reamer *D* is of the "floating" type, and it is kept from turning by the projections on the sleeve *E*. This sleeve, which is split, fits into a socket, and acts as a holder for the drill and reamer. With this arrangement, it is not necessary to swing the turret-head around, as would be the case if three separate tools were used. The only requirement is that the speed be changed when using the different tools. After a collar has been bored and reamed, it is faced to the required width by using the straddle-tool shown in Fig. 2. The shank *F* of this tool fits into the cross-slide of the turret. The cutters *G* fit into a

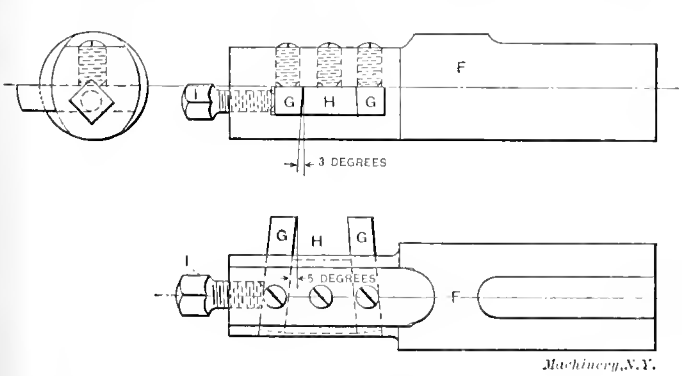


Fig. 2. Straddle-tool for facing Collars.

slot as shown, and the distance between their cutting edges is regulated by the adjusting wedge *H*. The wedge and the cutters are each held by a separate set-screw, to allow independent adjustment. After they are properly set, they are fastened securely in place by the set-screw *I*. A side clearance of 3 degrees, and a back clearance of 5 degrees, is given to each cutter. That part of the shank containing the cutters is made oval, as shown in the end elevation, Fig. 2, so that the tools can have sufficient lateral movement for facing the work.

After the collars have been bored, reamed, and faced, they are strung on a special mandrel (which holds eighteen at one time) and splined. They are now ready to be turned to the required outside diameter. The collars are splined before turning the outside, because the mandrel shown in Fig. 3 is provided with a feather *L*, which acts as a driver. A heavier

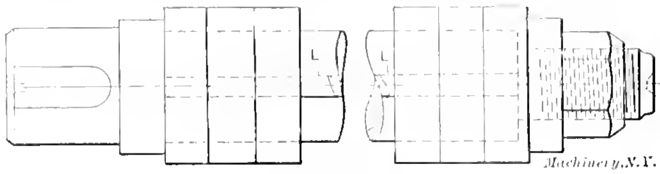


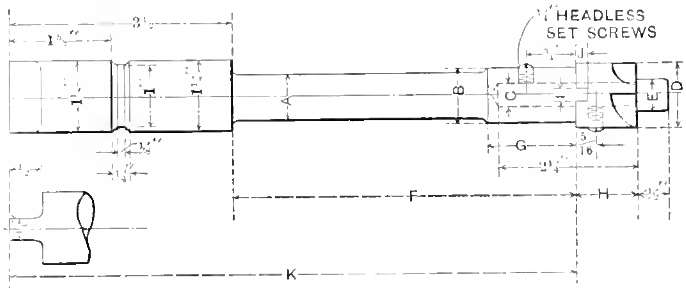
Fig. 3. Mandrel for holding Spacing Collars.

cut and a coarser feed can be taken when driving in this way, and a number of collars can be securely held and turned at one time. CHARLES THIEL.

Lawrence, Mass.

TABULATING DIMENSIONS OF TOOLS.

The cut shown herewith shows an idea which will be very acceptable to all tool designing rooms, and also to all regular drawing rooms making tool-room drawings. The foreman of the tool-room wanted sketches of a number of sizes of counterbores, having various sizes of pilots, and all fitting the same spindle. To save time in drawing, tracing, and blue-printing, I have standardized a sheet, as shown in the cut. All dimensions which are constant are given in their proper places on the drawing itself, while all those which differ for different



No.	A	B	C	D	E	F	G	H	I	J	K		
1	3/4"	3/4	5/16	3/4	3/8	4		1	3/16	3/16	7 1/2		
2	3/4	3/4	5/16	5/8	5/16	4		3/4	1/8	1/8	7 1/2		
3	3/4	7/8	3/8	1	3/8	4	1 3/8	1	3/16	3/16	7 1/2		
4	1 1/4	1 3/8	1/2	1 1/2	5/8	4	1 3/8	1 1/4	1/4	1/4	7 1/2		

Machinery,N.Y.

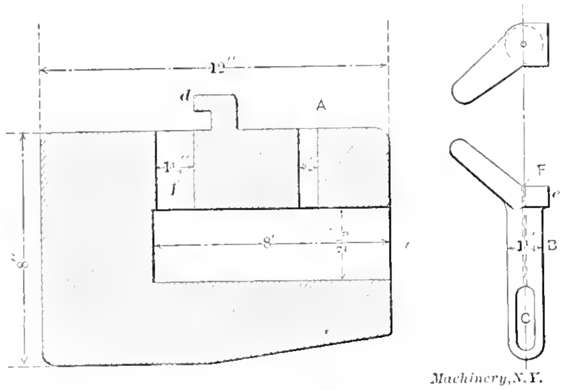
Example of Tabulated Tool Dimensioning.

sizes are indicated by letters, and tabulated. Vacant columns are left in the table of dimensions, and the tool-maker foreman can now supply the required figures for any new sizes he wishes to make, and turn the print over to his workman without waiting for another sketch. This idea can be used for a great variety of tools and fixtures, and we find it a great saver of time. TOOL DESIGNER.

[A system that in some respects is even better than the one mentioned by our correspondent is in use in some drafting-rooms. Instead of inserting letters for variable dimensions and tabulating them, the spaces where the variable dimensions are to be given are marked on the tracing with circles filled in with india ink, thus producing on the blue-print a white spot on which the dimensions can be conveniently and plainly filled in with ink. The work of filling in the dimensions on the various blue-prints is hardly more than that of tabulating; but the advantage gained of having one distinct blue-print for each tool aids greatly in preventing mistakes in the shop, due to reading the dimensions wrong in the table.—EDITOR.]

CANNON FOR SHOP USE.

The cut shows a cannon which is used principally for driving large keys. It is a breech-loader, and because of this, has an advantage over the one shown in September MACHINERY. This device, which has been in use for many years at the Portland Company's shops, Portland, Me., was designed for driving the keys on the paddle wheels of side-wheel steamers. The barrel *A* is of cast iron, and of the dimensions given. There are four ¾-inch eye-bolts tapped into the sides, to facilitate handling. Three ⅝-inch holes are drilled as shown, for the escape of the gases. The powder is placed into the cavity *C* of the breech plug *B*, and covered with a piece of tissue paper which has been moistened to make it



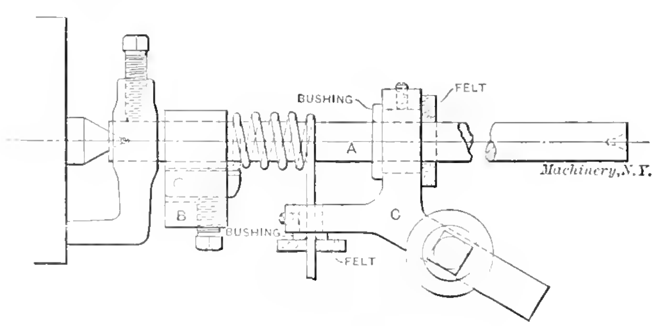
Cannon and its Breech Plug.

stick. The breech plug is then inserted in the hole *f*, and the handle turned so that the lug *d* engages with the projection *e* on the plug, holding it securely in place. The shot, which consists of a hardened piece of steel, about six inches long, is placed in the muzzle, and the cannon is fired with ordinary cannon primers, which are placed in the ¼-inch hole *F*, in the breech plug. A string about five feet long is attached to these primers, and in this way they are exploded. In driving keys, coupling bolts, etc., it is not necessary to chain the cannon, as its weight will take care of the recoil. There is very little danger attached to the use of this device, if the breech plug is cooled before it is reloaded. After firing, the barrel should be swabbed out, first with wet, and then with dry waste. Of course, the usual precautions in handling gun powder should be observed. H. K. GRIGGS.

Portland, Me.

TOOLS FOR WINDING SPRINGS IN AN ENGINE LATHE.

The manufacturing concern by whom I am employed use a great many small compression springs, made of red bronze spring wire, in a variety of sizes and lengths. As it has not been possible to buy springs of sufficiently accurate or durable quality, it fell to my lot to make them on something like a



Tools for Winding Springs in a Lathe.

commercial basis, and at the same time without spending much money for tools, as it was hoped we could buy them outside when the demand became greater. It is necessary that these springs be set, or squeezed together once only, after being wound, since they are never compressed again to that extent in service. It is thought that they will then fill the space they are supposed to occupy for a longer period of time. By referring to the accompanying sketch it will be seen how they were wound and compressed, or set. *A* is the mandrel which is made of drill rod, in a variety of sizes to suit the springs to be wound. Each size mandrel has fastened at one end a piece *B* in which is pivoted a beveled edge tool steel piece, which in connection with the set screw shown holds the end of the wire being wound.

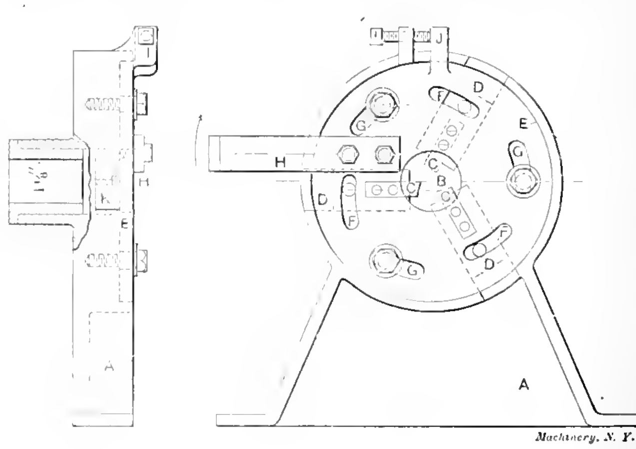
This method of fastening is a great improvement over the usual hole in the mandrel, as the wire never breaks off, as it does with the hole, and the spring can be taken off the mandrel without cutting the wire at that end, as is necessary when a hole is used.

Piece *C* is a forked piece which is held in the tool post of the engine lathe. One end of piece *C* is bored to receive guide bushings for the different sizes of wire to be wound. The other end is bored to receive bushings for the different sizes of mandrels. The end which passes over the mandrel serves a double purpose. It acts as a follower rest, making it possible to use long, slender mandrels. It is also used to compress the springs. By releasing the nut from the lead-screw, the lathe carriage can be moved by hand toward the head-stock until the spring is closed up solid, and then released again and taken off the mandrel, and the operation repeated. The springs are then cut up into short lengths on the punch press, using a stop so that each spring will have the same amount of wire in it. As there was formerly a short piece wasted on each piece wound, the saving in winding as long as possible will be apparent. Eighteen per cent was scrap wire. We now lose less than two per cent. It will be noticed that the holes in the bushings are rounded at the ends, also that pieces of felt kept filled with oil are fastened where the wire and mandrel pass through them to keep from roughing up the wire and mandrel. These little points are very important, as they often spell success or failure for tools.

C. G. H.

CUTTING TRIPLE THREADS.

The accompanying cut illustrates an economical device for cutting triple threads. The frame *A* is bolted to the lathe carriage, and it is of such height that the center *B* is in line



Device for Cutting Triple Threads.

with the lathe centers. The cutters *C* are held in slides *D*, which slide in grooves planed in the circular part of the frame *A*. These slides are held in place by a circular plate *E*, which also serves to move the slides in and out, through the medium of the cam slots *F* acting on pins in the slides. Plate *E* is held in place by bolts in the slots *G*. A handle *H* serves to rotate plate *E*. A set screw *I* in a lug cast on frame *A* bears against a lug *J* on plate *E* and acts as a gage to vary the depth of cut.

The tools or cutters *C* are set in the slides *D* so that the top surface is in line with the center *B*. They are fastened to the slides by screws as shown in section at *K*, and they are all set in the same plane so that each one cuts a different thread. At the head-stock end of the lathe a slide is bolted, which engages with arm *H* and throws it up in the direction of the arrow thus drawing the cutters back at the end of the cut. A removable bushing provides adjustment for cutting threads on rods of various sizes. With this device four feet of triple square thread 1¼ inch diameter and ¾ inch pitch can be cut in twenty minutes. FRED SEABURG.

Chicago, Ill.

GRINDING THREADING DIES.

In the November issue of MACHINERY appeared an interesting article on the subject of grinding threading die chasers. The points brought up in this connection were rather interesting, but the same trouble as met with by the author of that article may be caused in other ways than the one which he mentions. While not disputing the former writer's opinions, or his remedy, my own experience in regard to the grinding of threading dies has been that they cause trouble on account of not being ground or chamfered in a common sense manner. The die may be to all appearances in perfect condition for doing good work and have an equal chamfer on every land, but the chamfer may not be of a kind that actually does much good. In nine cases out of ten, in manufactured dies, one will find that the chamfer is made on the lines indicated in Fig. 1, which is, to any one analyzing the subject, entirely

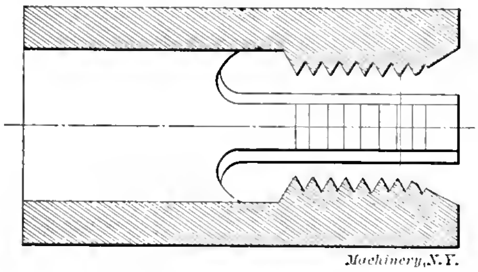


Fig. 1. Die not chamfered properly.

wrong. This die has the appearance, when examined, of having a very liberal chamfer, but the actual fact is that this die has only about 1 to 1½ threads chamfered. Now, whether ground in one way or another, these 1½ threads will have all the cutting to do, and, consequently, will have a tendency to "dig in." The land that digs into the metal first will, of course, leave little or nothing for the other lands to cut. I think that it is right here where the difficulty lies. That would coincide with Mr. Cleverdon's experience, as he says that on dies with a long chamfer, that is, where the chip is distributed over several threads, the difference in the total lengths of the cutting edges becomes negligible, and the remedy he mentions would not be necessary to apply. All his trouble

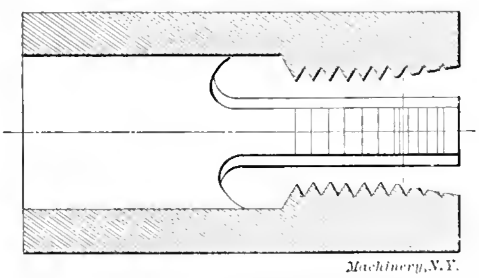


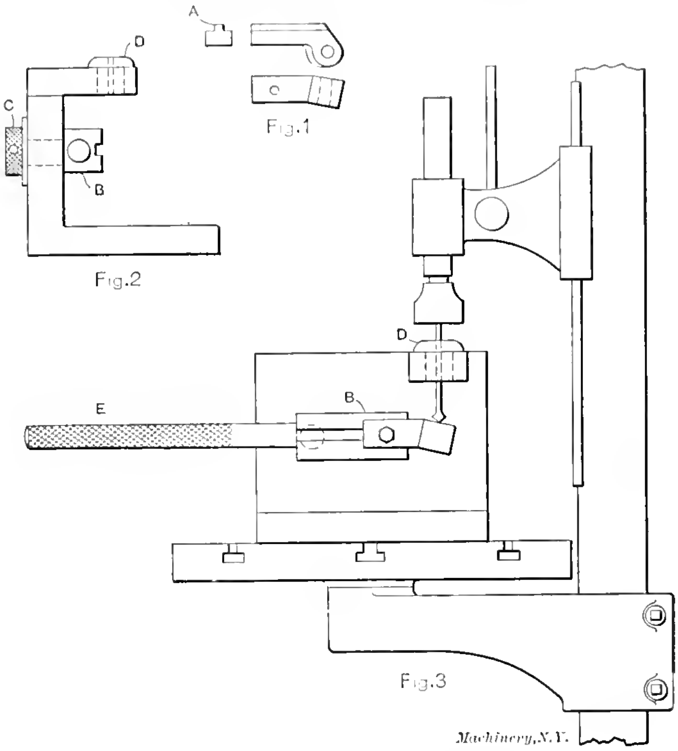
Fig. 2. Die correctly chamfered.

has been met with in dies with but short chamfer. My personal experience indicates that if a die is otherwise well made in all respects, and then has a chamfer like the one shown in Fig. 2, there would be no difficulty. The thread of the die should never be chamfered more than to the root of the thread. Whatever chamfer is made above this line is absolutely useless unless it be that the turret and spindle of the screw machine in which the die is used should be so much out of line that the die would have to act as a guide for the blank, in which case a chamfer like that shown in Fig. 1 would come in quite handy. It might also be argued that a die held in a *loose* die holder must have a chamfer like that shown in Fig. 1, in order to start properly, but even in this case a chamfer as shown in Fig. 2 should be used, and the blank to be threaded should be chamfered before it is presented to the die.

A.

METHOD OF DRILLING CURVED HOLES.

The accompanying cuts illustrate a method of drilling holes through needle guides, the holes following the arc of a circle. Fig. 1 shows the guide after it is finished. The tongue-piece *A* is milled so that it fits into the groove of the holder *B*, Fig. 2. This holder fits closely into a hole in the angle plate, and it is held against the plate by the nut *C*, which is just loose enough to permit the holder being turned on its axis. The drill bushing *D* is located above the work as shown. The hole through the bushing which guides the drill is made to fit the shank of the drill instead of the point. The drill is flat pointed, and its shank is much smaller than the point, so that it will allow the work, when being drilled, to turn without rubbing against the shank. The reamer is of the



Drilling a Curved Hole in a Needle Guide.

ball type, and it is essential that the ball be round, if the hole is to be accurate. The shanks of both drill and reamer are ground and lapped to fit the hole in the bushing *D*.

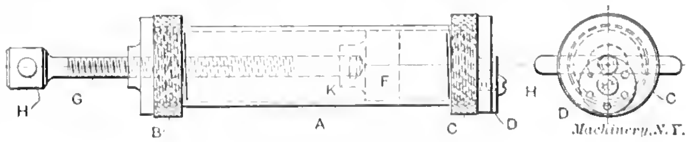
Fig. 3 illustrates the way in which the jig and the work are placed on the drill-press. The work is fastened to the holder by a bolt, as shown, and its position located with a height gage. By pressing down on the handle *E* the work is fed against the drill, and the hole is drilled on an arc, the radius of which will depend upon the distance from the axis of the holder to the drill.

K. R. CROSS.

S. Boston, Mass.

DEVICE FOR MAKING WAX FILLETS.

The accompanying cut shows a device for making wax fillets, which I came across the other day. As a good method of making the various sizes of wax fillets used on wood pattern work, at the time and in the exact quantity needed, I think this tool will be acceptable to any up-to-date pattern shop owner or pattern maker. The device is nearly self-explanatory, but a short description will serve to make its work-



Device for making Wax Fillets.

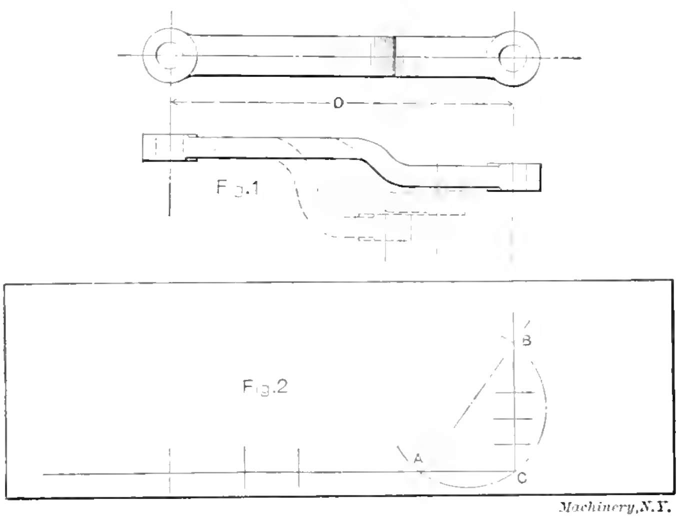
ing more clear. The barrel *A* is a piece of seamless brass tubing. The cap *B* is made of soft machinery steel, tapped to fit the compression screw *G*. This screw is fastened to the plunger *F* by the pin *K*, allowing the screw to turn without turning the plunger, but preventing its withdrawal in backing off. The cap *C*, also of soft machinery steel, has a hole in the center slightly larger than the largest size of fillet it is desired to make. The circular plate *D* is made of sheet steel, and drilled with different sized holes to correspond with the sizes of fillets wanted. It is screwed to the cap *C* so that

the holes will coincide with the central hole in the cap. The working of the device is obvious. By warming the barrel after filling it with odd pieces and scraps of wax, and setting the plate *D* for the size wanted, the fillet is made by turning down the compression screw with the handle at *H*.

Detroit, Mich. M. R. KAVANAGH.

LAYING OUT OFFSET LEVERS.

During my stay with an automatic machinery company in the East, I had a number of cast iron levers with various offsets to lay out. These levers were made as shown in Fig. 1, and the distance between centers was given on the blue-print as indicated. It was important to get these dimensions within close limits, so I went about the work as follows. I took a piece of sheet iron, Fig. 2, and with scale and scriber drew a base line. With the dividers I erected a perpendicular at the end of this base line, in the manner shown, and stepped off on this perpendicular the offsets of the different levers. Then, from the intersection of the perpendicular and the base line, I measured off the distance between the centers of the levers. It now only remained for me to set the dividers on the proper center dimension on the base line, and the corresponding offset point on the



Offset Lever, and Method of making Lever to Required Dimensions.

perpendicular, and transfer this to the right lever, estimating with my eye the location of the center of the bosses at the same time. E. R. SEITER.

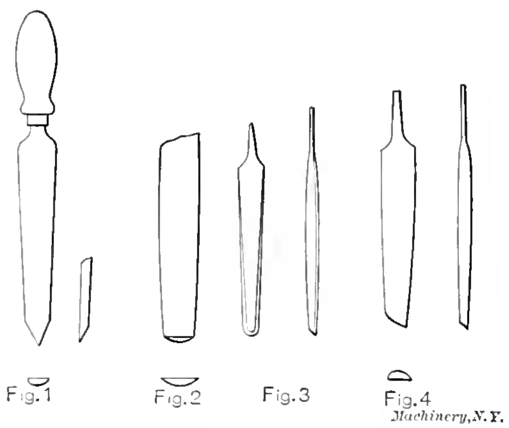
Chattanooga, Tenn.

[The manner in which our correspondent erected a perpendicular to the base line may not be clear to all readers of MACHINERY. The detailed procedure is as follows: Draw any circle with its center outside of the base line, so that its periphery intersects the base line. From one of the intersecting points *A* draw a diameter through the circle, intersecting the periphery again at *B*. From *B* draw a line to *C*, the other intersecting point between the circle and the base line. The angle *A C B* is then a right angle, or, in other words, *B C* is perpendicular to the base line.—EDITOR.]

TOOLS FOR SCRAPING.

Every once in a while it becomes necessary to scrape out a hole in order to true up a certain surface, or clean up a bearing and leave it as large as possible. Almost everything from a chisel to a file is used with varying degrees of satisfaction. The proper tool is a half-round file, ground on the flat face and pointed to an angle of about 60 degrees. One edge is sharp, and the other rounded slightly, as shown in Fig. 1. All the pressure that is put on the end of the handle goes to the cutting edge, and the hole is not marred nor does the tool slip. Another job is the scraping of semi-cylindrical holes in steel, such as drop forge dies, etc. The ancient hook or draw scraper is generally used, in spite of the fact that one cannot see the cutting edge. The proper tool to use is an end-cutting scraper made of a half-round file, Fig. 2, ground to a smaller radius than the work. The great fault with most scrapers, in steel work especially, is too great a length of cutting edge, requiring too great a pressure to keep it cutting. Therefore, slightly round the face and edge of the tools, and keep them always sharp, and stone as soon as they slide or tear. A coarse India stone and a bit of waste soaked in turpentine is often as essential on fine steel work as the scraper itself.

For plane surfaces, sharp corners, etc., the tool shown in Fig. 3 is handy and useful. This is also made of a half-round

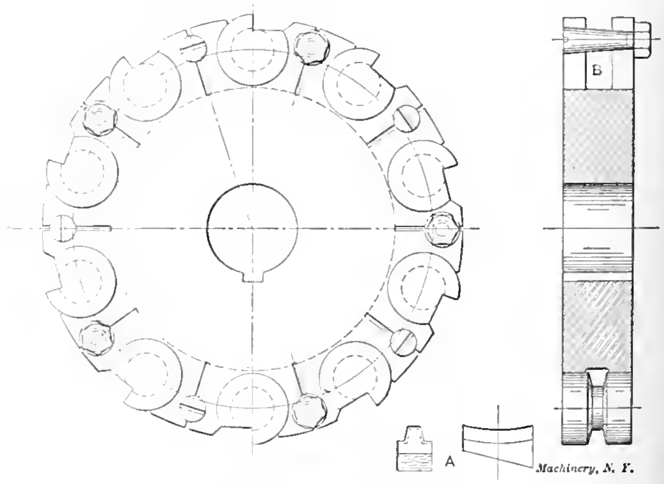


Scraping Tools of Various Kinds.

file. It is sometimes given quite a relief, as compared with the usual end cutting tool, the cutting edge being ground to about 70 degrees. These tools will stand up for a long time on unannealed tool steel and saw steel. Fig. 4 shows a half-round scraper used for the last thousandth in cylindrical work in the lathe, especially steel, and for smoothing out holes. The back edge is rounded so as not to mar the work and the long curved edge avoids chatter from too long a cutting edge, and permits cutting where it is needed. SIRIUS.

INSERTED TOOTH MILLING CUTTER.

The accompanying cut shows an inserted tooth milling cutter, designed to manufacture the brake shoes shown at *A*, in which it is necessary to keep both the form and the radius of the cut to gage. The principle of the inserted teeth is the same as that of the circular forming tools used on screw



Inserted Tooth Milling Cutter.

machines, the teeth being sharpened radially. The taper studs are used to secure the teeth in place by forcing the slots open and binding the body of the cutter on the teeth. The cutter-holding body is grooved in the center to reduce the body of metal to be sprung out in order to bind on the outer edges of the teeth or cutters. As the teeth become dull, they can be ground while in place a few times, before being loosened and again set radially. The advantage of this form cutter is that the teeth can be ground to shape after being hardened (because they are circular) which is impossible with the ordinary form cutter, but often very necessary when the pieces milled have to be correct within small limits. This permits the use of Novo or other high-speed steel, which

ordinarily cannot be used for form cutters, as the outside is burned in hardening. Broken teeth can be easily replaced. No backing off machine, or fixture, is needed for making the formed teeth, which will appeal to small shops which get an order to make a few thousand duplicate parts. The cost of material is considerably reduced as compared with a solid form cutter. Within its limits different kinds of teeth can be used in the same body, but this is only recommended when the removed cutters are of no further use.

Candiac, Canada. S. A. McDonald.

[One weak point in this design of cutter seems to be the cutting of the central groove *B*, which naturally permits the outer edges of the cutter body to bend inward when the nut on the tapered pins is tightened for binding the blades. Another objection is the projection of the nuts outside of the cutter body, as it is never good practice to have projections of this kind on rotating bodies if it can be avoided. These objections, however, are mere details, and can easily be overcome. The principle of the cutter itself is very commendable, and may also be of value as suggestive of similar adaptations for a multiplicity of work.—Editor.]

FACING WORK BETWEEN CENTERS.

After reading in the October issue of Machinery the criticisms of my article on facing work, I called on an expert machinist and tool-maker and inquired as to his practice. He stated that his practice had been for some years past exactly in line with what I stated in the article, and that he had never considered the half-center necessary in lathe work. Mr. Simonds wants to know how I would cup the center of an arbor. Well, if only one arbor was to be cupped I might use the same side tool that was being used to face the end of the arbor. To demonstrate that there is no difficulty in doing this, the expert referred to, in my presence, faced and cupped an arbor with a side-tool without slackening the tail spindle; and he used less time than Mr. Simonds would probably use to change centers and do the work. When there are a considerable number of arbors to center and cup, it is better to use a universal chuck and steady rest. By this method, each center may be drilled, reamed, and cupped, at one setting of the work. The material that arbors are usually made of is nearly enough round to be run in the steady rest. Lapping the centers after hardening the arbors corrects minute irregularities.

I admit that a side-tool used in connection with a half center may be of such a shape as to stand more crowding than will the side-tool I described, and I am glad that Messrs. Simonds and Allan pointed out the advantages of the half center. But Mr. Allan is certainly far from the truth in intimating that the tool I advocated would fail after facing one piece. If he got such poor results, possibly the fault was in the quality or temper of the steel. In using poor steel we have the same trouble with the point of a V-thread tool.

Anticipating questions as to the method of cupping the arbor, it may be explained that the side-tool used in the example cited was of a sufficiently sharp angle to admit of setting the tool around to the right for cupping. To get a smooth job, high speed and fine feed were used. While the tool is stronger than it looks in the sketch accompanying my previous article, for ordinary facing its strength could be increased by making the angle at the point just a little less than 60 degrees, a center gage being used to test it by. The tool should not be used for end cutting, except for a light finishing cut. W. S. Leonard.

Atlanta, Ga.

The letters written by Messrs. Leonard and Allan which have appeared in recent issues of Machinery are timely. They bring up a subject which, though simple, is well worth consideration. I differ with Mr. Allan as regards the efficiency of the tool described by Mr. Leonard. I find that it does all that he claims for it. Allan says this tool does not hold its edge. I gave a tool, ground as Mr. Leonard describes, a month's trial, and I am well pleased with the results. One reason that the tool dulls quickly, in common practice, is due to improper care in feeding the tool toward the lathe center. The work at the center is turning very slowly in comparison to its outer edge. For this reason the speed of travel of the tool should be decreased as the tool comes nearer the center of the work, else the tool will be moving faster lineally than the work is revolving. This will cause the work to tear, spoiling its finish, as well as dulling the point of the tool. It is also essential to the life of the tool that its point be in line with the lathe center. Should it be above or below the center, it will be subject to a rubbing or scraping action that will quickly dull the tool. It may be well to say, that the test I gave the tool described by Mr. Leonard, was made on high-grade carbon steel. Wm. H. Addis.

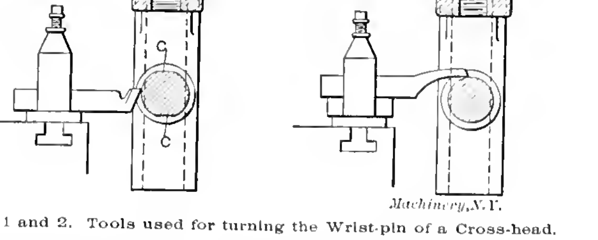
Decatur, Ill.

I have noticed several suggestions in the August, October and November issues of Machinery about facing work on lathe centers. Why face the work on centers at all? This is my method: One end of the work is held in the chuck and trued up roughly; the other end is put in the steady rest. Then the end is faced with an ordinary diamond point tool. A tool shaped like a flat drill, with an angle of 60 degrees, is clamped in the tool post and brought up to the center of the shaft where a slight cut is made for the center drill to enter into. After drilling the center hole to a sufficient depth, the flat drill-shaped tool is again brought up, and the center is cut to the right size, using only one cutting lip. A center formed in the foregoing manner is bound to be perfectly true with the periphery. G. E. Daniell.

Augusta, Ga.

TURNING THE WRIST-PIN OF A CROSS-HEAD.

Turning a wrist-pin which has been cast solid with the cross-head is a job that a few years ago was much more common than at present, although even now it is sometimes necessary to do work of this kind. To turn the pin, and get it round and smooth, requires considerable skill on the part of the one doing the work. Before the wrist-pin is turned, the cross-head should be bored and planed. It should then be carefully centered in such a way that a line passing through the centers will be at right angles to the hole for the piston



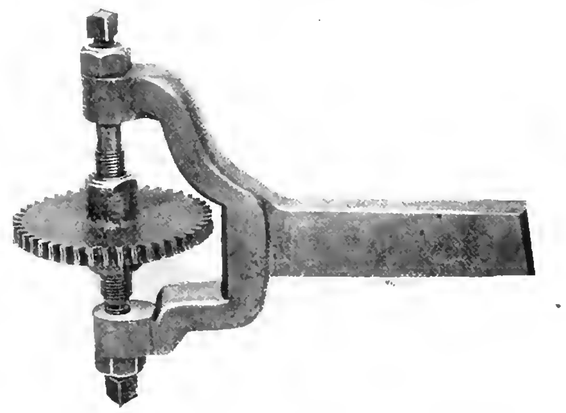
Figs. 1 and 2. Tools used for turning the Wrist-pin of a Cross-head.

rod. After the cross-head has been placed between the lathe centers, a wooden handle should be inserted in the piston rod hole. This handle enables a man behind the lathe to turn the cross-head back and forth on the lathe centers, while the operator feeds the tool for every forward stroke. For the first cut an ordinary round nose tool is used, as shown in Fig. 1. Of course it is necessary to take light cuts. From 120 to 180 degrees of the circle can be reached with this first turning. The position of the cross-head is then reversed, and a cut taken over the opposite side of the pin. It is well to cut clearances *C* for the tool at the beginning and the end of the cut. These clearances can be chipped by hand, but if there is much metal to remove, a slotter should be used. After as much of the pin's surface as can be reached with the ordinary tool, has been roughed out, another tool, shown in Fig. 2, is used to remove the remaining metal. The tools are now ground for finishing cuts, and the above operations repeated. The rough spots, which will be found at the points where the tool marks intersect, can be smoothed off with a fine file. If this part of the work is done properly, the job will be entirely satisfactory. W. L. McLaren.

Ottawa, Ont.

WORM-CUTTING TOOL.

The half-tone herewith illustrates a worm-cutting tool which does away with a great amount of work. When using this tool, the worm thread is first roughed out in a lathe, so that the depth of the thread is about one-quarter of the depth of thread wanted in the finished worm. The worm is then put on an arbor and finished with the tool shown, which is held in the tool-post and permitted to revolve freely. The advantage of this method is the ease of sharpening the cutter,



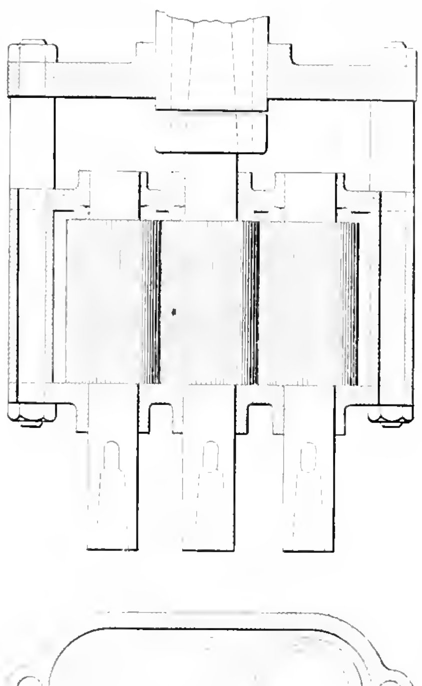
Worm-cutting Tool.

combined with the true shape obtained in the worm thread, it being cut by the generating process. The method of making the cutter is exactly the same as that used for hobbing an ordinary worm-wheel, except that the edges are not beveled off as in a worm-wheel. Instead, the upper side of the cutter is slightly concaved, so as to produce a better cutting edge on the teeth. ALBERT ANDREWS.

Chicago, Ill.

MULTIPLE SPINDLE DRILLING DEVICE.

In a large number of gears three pin holes were to be drilled through one of the arms, comparatively close together, too close, in fact, to permit the use of an ordinary multiple spindle drilling machine. For this reason, the device shown in the cut was designed to be attached to an ordinary drill press. The three pinions are made of steel, and drill sockets and pinions are made in one piece. Ball bearings at the end of the pinions take the end thrust. In order to prevent the device from revolving with the drill press spindle, a yoke clamped to the spindle sleeve is secured to the gear case by short, stiff tie rods. The drills used with this device are of the inserted blade type, having soft steel shanks with four high speed steel blades, one of the drills cutting right-hand, and the other two left-hand. Y. Z.



Multiple Spindle Drilling Device.

SHOP LIGHTING.

It is announced regarding the construction of a certain new manufacturing plant that the windows will *not* be frosted, and that the workmen will be able to see the beautiful park adjoining by simply looking up from their work. Such a view is not obtainable from every shop, but the adverse effects of the translucent pane are much more clearly realized now than when this style of glazing was first installed. A man may work in front of a blank wall without serious protest, but there is something peculiarly irritating in being compelled to stand day in and day out before a window, with a mental realization, but not a visual perception, of the view without. If the human interest to see the world outside is not satisfied, there seems to be a deadening influence which has its effect in reducing efficiency. Of course, there are conditions where only distraction can result; when the view becomes a motion picture, a sort of continuous show. Broadly speaking, however, experience has shown the unwisdom of setting the entire sash in translucent glass, and the advantage of the shop in the open country, with its touch of nature in the view. In so far as ribbed or prismatic glass may be essential to the better illumination of the interior, it may be set in the upper part of the sash, leaving the lower portion clear, but the idea of the prison cell should be removed from the mind of the workman. Incidentally, the difference in lighting value between a clean and a dirty window should not be overlooked. In a certain shop, lighting up was not necessary for an hour later in the day, after the windows were washed. W. B. S.

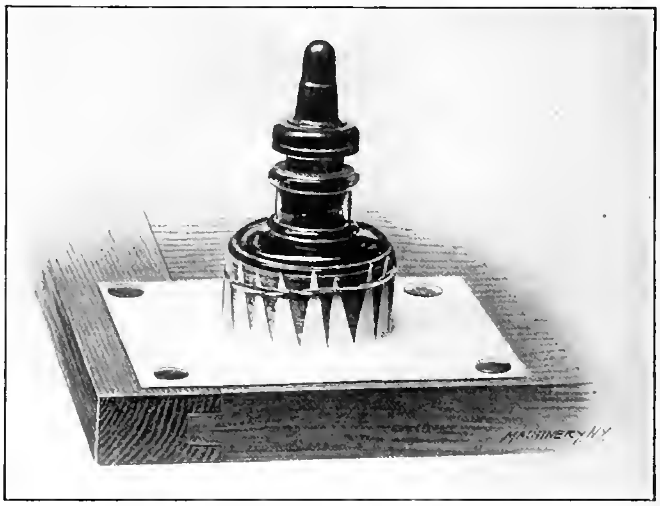


Fig. 1. Securing the Ink Bottle.

SECURING THE INK BOTTLE.

The greatest efficiency often lies in the greatest simplicity. The illustration, Fig. 1, shows one of the most effective means of preventing what has always been a source of great annoyance to the draftsman, *viz*, the overturning of the ink bottle. In the center of a four-inch square of ordinary drawing paper, scribe a circle equal to the diameter of the ink bottle. Divide the circle into about twenty-four parts, as shown in Fig. 2, then with a sharp knife, cut the paper from each of these twenty-four points to the center, following a radial line. Press the paper down over the neck of the bottle. Around the paper points, which stick up around the bottle like a picket fence, put six or eight ordinary elastic bands. Thumb tacks in opposite corners will securely hold the entire outfit to any part of the board desired. C. H. RAMSEY.

Paterson, N. J.

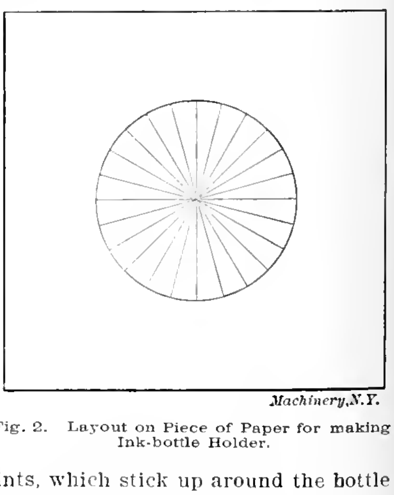


Fig. 2. Layout on Piece of Paper for making Ink-bottle Holder.

CONTOUR GAGE.

The accompanying cuts illustrate a special tool which we have found of great value in certain classes of work. The need of some such device became apparent when patterns and core boxes were required to be accurately checked with the drawings of a certain brass specialty concern. The tool

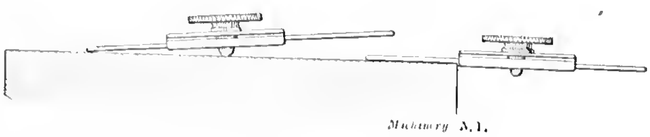


Fig. 1. End View of Contour Gage.

is applied to the work, and the wires pressed down onto the contour by using the side of a lead pencil. Of course, patterns parted on the center could have their halves laid directly on the drawing without using the contour gage, but our patterns were carded and inseparable. Such a tool proves a relentless check upon the patternmaker, who, by

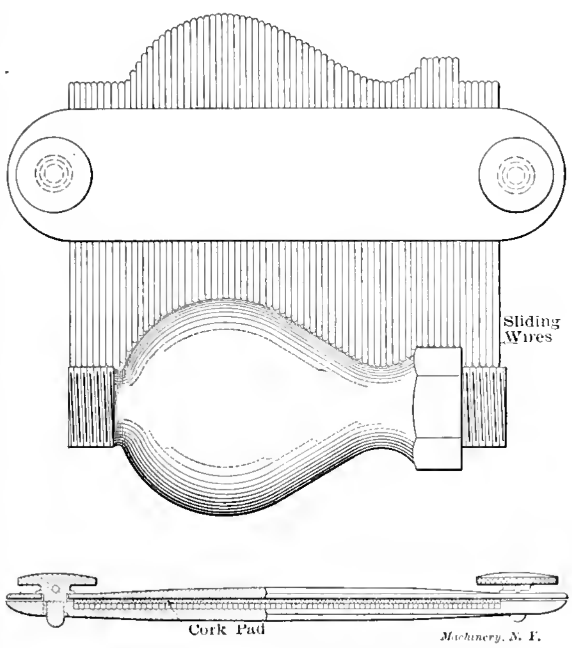


Fig. 2. Setting Gage to Turned Semple.

making the patterns larger than necessary, can cause a considerable loss in a business where thousands of casts are made yearly from the same patterns. As a ready and universal templet it is the best I have seen. Howard D. Yoder.

GALLING OF METALS.

There is rarely any little mishap in shop practice that will cause more annoyance than the galling of a shaft, or mandrel, in its enveloping piece. This is most likely to happen when the inner and outer pieces are of the same material, but it occasionally occurs when the materials are different. Such a mishap is nearly always due to the lack of oil. When cutting a thread in a casting, which is to be fitted to a screw by the cut-and-try method, oil should be used on the screw very sparingly, because it would otherwise be transferred to the internal thread, making it difficult to dislodge the fine chips. For this latter reason, a certain machinist in making a new face-plate, tried it on the lathe spindle without any oil. He succeeded in screwing it up against the collar, but on unscrewing the plate, it galled to such an extent that it became necessary to split the plate in two parts to save the thread on the lathe spindle. When trouble of this kind is caused by the fine chips which are apt to adhere to the threads of a face-plate, it can be almost entirely eliminated by cutting two shallow key-ways, one through the hole in the face-plate, and the other on the threaded part of the spindle. These key-ways scrape the thread clean, and they are also a receptacle for the dirt.

A peculiar example of galling, and one which the writer has observed but three times during a long experience, is that of the lathe center galling in the work. A case of this kind happened in connection with a "hurry-up" job, which a certain man had charge of a few years ago. He was very nervous, and impatient, and generally underestimated the time required to do any piece of work. Being dissatisfied with the progress of some lathe work that was being done for his job, he requested the foreman to let him do the turning, declaring that "he could do the work while Jim Slowcoach was getting ready to do it." He was given a lathe and told to go ahead. He started in with a heavy cut, and coarse feed, and

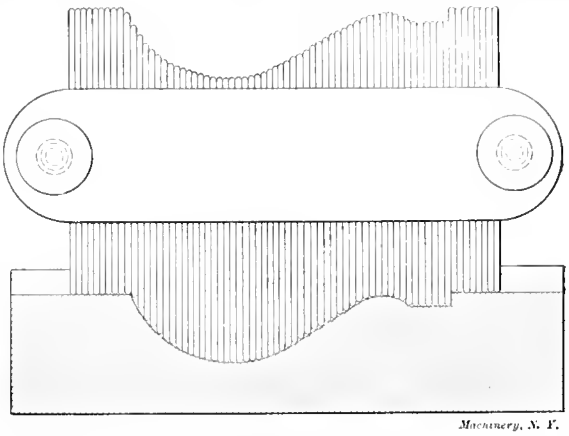


Fig. 3. Testing Core-box with Gage.

was so busy in trying to keep the belt from slipping, that the insignificant matter of oiling the lathe center was overlooked. Suddenly the work dropped to the floor, and he was surprised to find that about half of the conical part of the right-hand center had been sheared off. On examining the work, he discovered that the end of the center had galled in the work so tightly that it appeared to be welded. This could not have been the case, however, as the heat caused by the lack of oil was certainly below that of fusion. Nevertheless, the center had to be cut out with a chisel.

A large boring bar or mandrel should have an oil hole drilled from the periphery to the extreme end or bottom of the center, and this hole should be tapped and fitted with a small plug. If, in addition to the oil hole, three equidistant shallow oil grooves be cut in the conical part of the center, without extending quite to the outer end, the combination would make a perfect self-oiling arrangement. A single groove in the conical part of the lathe center will enable the workman to oil the center without slackening the tail-spindle, but the plugged oil-hole has an advantage, as it provides a reservoir of oil, and a continuous feed. One objection to slackening the tail-spindle for oiling is that oil thus applied is likely to wash fine chips between the lathe center, and the work center, and cause the work to run out of true.

For heavy lathes, a very efficient center oiling arrangement may be made by drilling a small hole axially in the outer end of the dead center, and then drilling a larger hole at right angles to, and meeting the small hole. To insure an ample supply of oil, the large hole might have an oil tube or an oil cup. W. S. Leonard.

Atlanta, Ga.

* * *

Pure putty is usually made in what is known as a "chaser," of whiting and linseed oil. The proportions are about eighty-five pounds of whiting and fifteen pounds of raw linseed oil. Bolted American paris white is commonly used in this country for the purpose, though imported whiting may also be used. Of course these proportions are only tentative, and must be varied according to the consistency of the mass produced. For quick drying putty, boiled linseed oil is used instead of raw, and about ten per cent of dry white lead is added to the whiting. This is the old receipt for pure putty. At the present time, however, very little commercial putty is made according to this formula, large proportions of crude cotton seed oil (known in trade as "putty oil") being substituted for some of the linseed oil, and boiled linseed oil being used instead of raw to counteract the slow drying qualities of the cotton seed oil. Instead of fine paris white, common whiting with varying proportions of fine marble dust is used. G. R. Heckel in *Trade Press List*.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

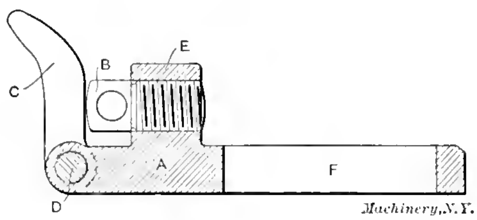
SUBSTITUTE FOR THUMB-TACKS.

It is very exasperating to have a triangle or T-square catch on the head of a thumb-tack, when making a drawing. In the drafting room where I am employed, we have the regular thumb-tacks, but very few of them are used. We use instead a very small iron carpet tack, being the size used to fasten window shades to the rollers. A magnetic tack hammer is employed to drive them. These tacks can be driven in until the head will not catch on the triangle or T-square, and, being very short, are easily extracted. Five cents' worth of these tacks will last as long as a dollar's worth of thumb-tacks, and they have the additional advantage of *not* standing point upwards on the draftsman's stool. A DRAFTSMAN.

[In some drafting rooms small copper tacks are used as a substitute for thumb tacks. The copper tacks, being softer than iron carpet tacks, have the advantage of flattening out entirely to the surface of the paper, presenting no projection whatever. They, of course, are at a disadvantage as compared with the carpet tacks as they cannot be handled with a magnetic hammer.—EDITOR.]

HANDY PLANER DOG.

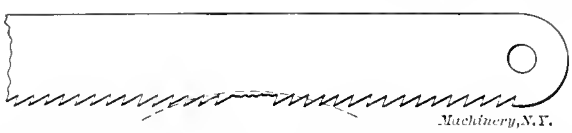
The accompanying cut shows a simple planer dog, which can be used to advantage on almost any class of work. On very heavy work, however, the relative proportions of the body *A* are rather light, and should be increased. The design of the appliance is very simple, and is plainly shown in the



cut. A body *A* is provided with a lug *E*, into which is threaded screw *B*, the other end of which bears against the binder *C*, swiveling around pivot *D*. The body *A* is clamped in the T-slots in the planer table, a long slot *F* being provided for adjustment. A drilled hole in screw *B* makes it easy to turn the screw when binding the clamp *C* against the work. O. G.

SAVING A HACK-SAW BLADE.

Most machinists have doubtless noticed that when one or two teeth break from the blade of a hack-saw others soon follow. This is especially true when the piece being sawed is narrow, because the saw drops when the space made by the

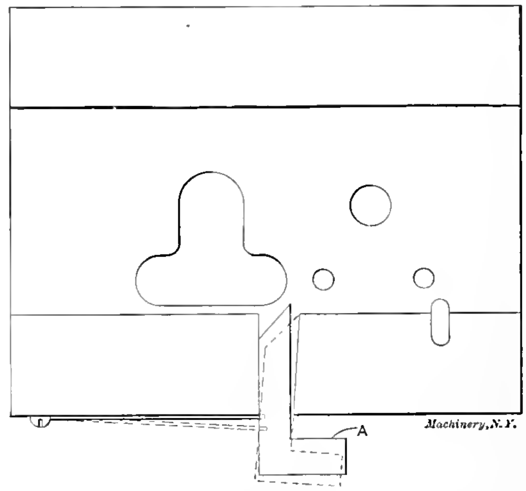


broken teeth passes over the work. Other teeth can be prevented from breaking out, by grinding two or three teeth on each side of the broken part, as shown by the dotted line in the cut. This will prevent the teeth which are next to the broken part from striking abruptly against the work. This kink may not be of interest to the man in a large shop where saw blades are plentiful, but it may be useful to those working in small jobbing shops, where very often the blade being used is the last one on hand. A. E. FISH.

Denver, Col.

STOP FOR STOCK IN BLANKING AND PROGRESSIVE DIES.

The stops which we use on all blanking and progressive dies are of the automatic type. The cut shows a die with stripper removed, but with guide plates and stop in place. The stock is fed up to the stop, which is so located as to give a whole blank the second stroke. As the punches descend, a pin engages the stop at *A*, and forces it out, but not until the pilot pin in the blanking punch has engaged the perforated hole in the stock. On the up stroke, the stop is released and is resting against the edge of the stock in a position indicated by the dotted lines. When the stock is pushed forward by the operator, the point of the stop engages a notch cut

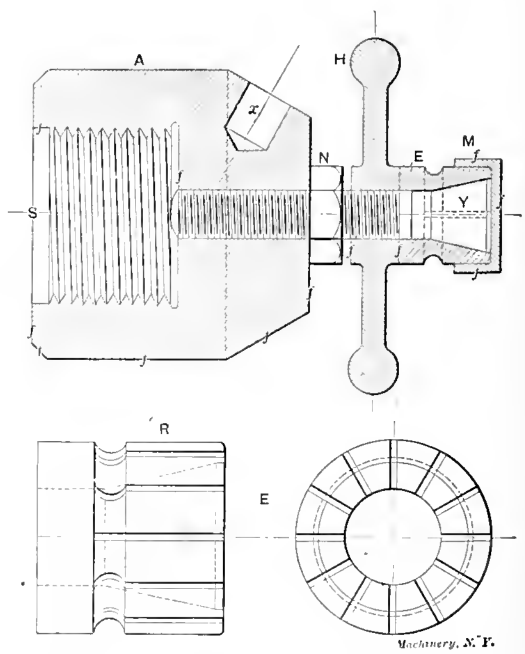


in the side of the stock, bringing it to a full stop when the back of the stop gets a bearing against the side of the slot in the die in which the stop is placed. As the punches descend, this performance is repeated. The pin, which acts as a trip, is made of ¼-inch cold rolled stock, filed to an angle on the end, and case-hardened. K. L. ROSS.

St. Louis, Mo.

EXPANDING CHUCK.

A simple, but very effective, expanding chuck can be made as shown in the accompanying cut. The part *A* is made of machinery steel, and screws onto the lathe spindle at *S*. A rod of suitable diameter is inserted in the hole *x* when it is desired to screw the part *A* on or off. A lock nut *N* and a hand-wheel *H* are screwed on the expander *Y*. The expanding chuck *E* fits over the expander *Y*, and is made to expand by being forced against the taper part of the expander by



the hand-wheel *H*. The expander *Y* and the chuck *E* should be made of tool steel, and hardened. The surface *R* (see enlarged detail) of the chuck can be roughened for small, smooth work. This simple arrangement can be varied to suit any case where work must be held internally. The small piece *M*, which is to be finished as indicated by the finish marks *f*, is an example of the kind of work held by this chuck.

TOOL DESIGNER.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

TO LOOSEN PULLEYS WHICH ARE RUSTED FAST ON THEIR SHAFTS.

Referring to the "How and Why" question in the October issue asking how to remove pulleys rusted fast on their shafts, I would suggest heating the hubs and melting beeswax into the joints. Then drive the pulley with a heavy sledge, while hot. In this way I have been able to loosen pulleys and gears which could not be loosened in any other way. JOHN M. KUPEL.

Peoria, Ill.

In answer to N. M.'s inquiry in "How and Why" department of the October issue for a practicable method of removing pulleys rusted fast on their shafts, when a hydraulic press is not available, I would suggest that the hubs be wet with kerosene oil, and then fired. The quick heat will cause the hubs to expand sufficiently to loosen the rust and permit the pulleys to be driven off with a sledge. I have followed this method with success. WM. DAVIS.

Philadelphia, Pa.

In your October issue, under "How and Why," N. M. asks how to loosen some 48-inch pulleys which are rusted fast on their shafts. If he will heat the shaft and hub of a pulley to a temperature, say, that will turn the shaft blue and then place beeswax around the joint and let it run well, the pulley will loosen "as slick as grease." Beeswax congeals at a comparatively high heat, but when melted it is very thin and will run into any place that oil can reach, and is a better lubricant for a condition like this. E. W. NORTON.

North Tarrytown, N. Y.

In the October issue, under "How and Why," the question of how to loosen a pulley on a shaft was considered. If the shaft is mounted horizontally, I would build a wooden box around the hub, using as many pieces A as there are spokes, less one to leave an opening on top, and four pieces B clamped together (See Fig. 1.) I would heat the hub by pouring this box full of hot babbitt. The small pieces C, Figs. 1 and 2, serve to part the babbitt. Chalking will make the wood fireproof. This is the quickest way of heating, and therefore the one that leaves the shaft cool. Instead of forcing the pulley endways only, I would also apply a turning force. I once had to remove heavy bolts on a marine engine. The sledge alone would not make them budge. I then thought of how, when moving a loose-fitting pulley along the shaft, we nearly always turn it at the same time. Acting on this idea, I applied a wrench to the head of the bolt, and this time the combined efforts of sledge and wrench made the bolt move. It seems to me this action can be explained by a parallelogram of forces, but there may be a better explanation. J. SCHURING.

Bangor, Pa.

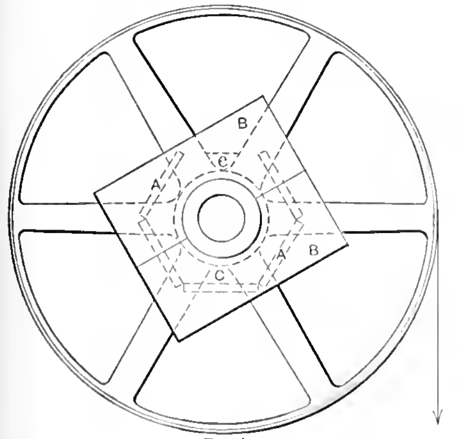


Fig.1

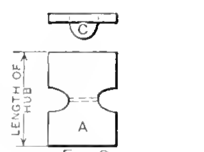


Fig.2

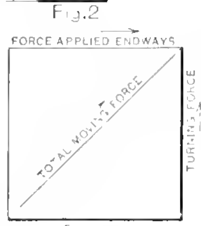


Fig.3

Machinery, N.Y.

FITTING KEYS IN KEYWAY.

N. R. T.—How should keys be fitted on engine cranks, flywheels, gears—especially gib-head keys? Is it not best practice to use gib-head keys where there is nothing else to keep the part from shifting endwise on the shaft, and to give it an ordinary sideways fit in the keyway, and a *good, strong driving* fit top and bottom?

A.—A key should be fitted first on the sides, as the sideways fit is the most important, but it should fill the keyway and bear lightly top and bottom. It is a mistake to fit top and bottom in preference to the sides. A key strongly driven, which fits on top and bottom only, tends to spring the hub and reduce the contact with the shaft. A key is much more likely to work loose when fitted thus than when fitted sideways, and it is in a far less effective position to resist the twist of the shaft. The use of a gib-head key is simply to facilitate removal when the inner end is not "get-at-able." It has no greater holding power because of the shape of the head.

TO OBTAIN THE HEIGHT OF THE MIDDLE ORDINATE OF AN ARC.

G. C.—Tell me how to find the height of an arc at its middle ordinate, having given the number of included degrees and the length of its chord.

A.—The height of the arc may be found by simple arithmetical calculations, if a table of sines is at hand. All engineers' handbooks, and many other books on engineering subjects as well, contain a table of sines. Inasmuch as we know the number of degrees in the arc, we know the angle subtended at the center. Suppose that the arc is 36 degrees, then the angle is that measured by 36 degrees. Half the chord is the sine of half the angle. Half the chord is to the radius of the circle as the sine of half the angle (ratio as given in the table) is to 1. From this proportion the radius is calculated, using the given numerical value for half the chord length. Suppose the length of the chord is 10 feet, then half the chord length is 5 feet. Also suppose that the angle is 36 degrees. In a table of sines we find the sine of 18 degrees (half of 36 degrees) is 0.30902. Then $5 : R = 0.30902 : 1$; or $0.30902\ R = 5$. Then $R = 16.55$. The cosine of 18 degrees is 0.95106, and the difference between it and 1, or 0.04894 is the versine or height of the middle ordinate with a radius of 1. We have found the radius of this circle to be 16.55; hence, the height of the middle ordinate for a radius of 1 must be multiplied by 16.55 to obtain the middle ordinate for a radius of this length. $0.04894 \times 16.55 = 0.81$ foot, the height of the middle ordinate on an arc of 36 degrees, having a chord length of 10 feet.

* * *

By the way, we are all excited over the records of the high-speed steels. But a glance around us seems to show that most of it ends in excitement. Is it the fault of the new steels, the machines, or the men that handle them? After the noise and smoke clear away, we find that things have a tendency to settle back into the easy-going run of ordinary practice. The machine tool manufacturers, however, are always ready to give to the trade any advantage that their long experience shows is worthy of serious attention. So we have to-day become so used to what were called new-fangled devices a few years ago, that few buyers would consider any machines not fitted with all these latest improvements, that have shown their value as cost-reducing elements in the manufacturing plant.

* * *

In our June, 1906, issue, engineering edition, we referred to the evil of employing female labor in foundries, and we now find that the delegates of the Iron Molders' Union, at their session in Philadelphia this summer, pronounced themselves as opposed to the employment of women and children in core-rooms and foundries, as being detrimental to the health, and contrary to the station in life for which they are intended. Here is a territory where upright employers and fair-minded employes may well coöperate, for it certainly is, in the long run, but a loss and a disgrace to the country, if the standard of our women is permitted to be lowered so as to be required to perform such work as is in the highest degree incompatible with American ideals.

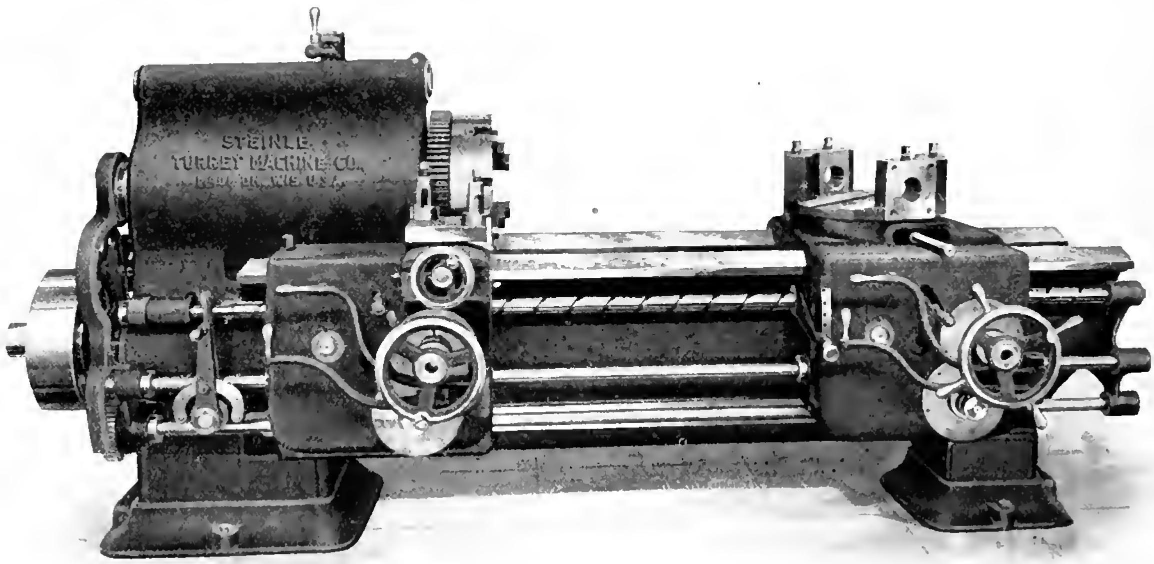
NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

THE FULL SWING SIDE-CARRIAGE TURRET LATHE.

The principal innovation in this interesting tool is indicated by its name. It was the experience of the designer of the tool, who has been connected with turret lathe work for more than twenty years, that the greatest objection to the two-carriage type of turret lathe has been excessive over-hang of turret tools required to reach the chuck over the width of the tool carriage. This great length of tool has resulted in weakness and vibration as well as inaccurate indexing. In the machine shown in the half-tone, this difficulty has been overcome by making the carriage of such a form that it may be in under the chuck, entirely out of the way of the turret slide, when it is necessary to bring the latter close to the face of the chuck.

This cross-slide carriage is supported at the front of the bed instead of extending across the top of the vees. It is speeds. The doing away with the bolted connection between the head-stock and base allows these speeds and feeds to be used even with multiple broad shaving cutters fastened in the turret. Another advantage resulting from this one-piece design is the arrangement for driving mechanism it is possible to obtain with all the shafts and gearing beneath the spindle. This brings the driving shaft as close to the base of the machine as possible, and overcomes the vibration which is prevalent in the type drive belt mechanism. The spindle mechanism is transmitted through a gear mechanism giving thirty changes of speed, arranged in geometrical progression with a maximum ratio of 80 to 1. This insures ample driving power at the proper speeds for all work. The power is taken directly from the line shaft, through a constant-speed pulley with a friction control and reversing motion. All the changes of speed which may be obtained without stopping the countershaft are controlled by interlocking levers conveniently



Full Swing Side-carriage Turret Lathe.

supported at the upper vee, and has a bearing on a planed surface at the lower edge of the bed near the floor, thus giving as wide a bearing to resist the cutting strain as possessed by the ordinary form. The tool-post of this cross-slide is arranged on a turret base with facilities for holding four regular tool-posts, like the ones shown in the cut, or straps for flat cutters, if it is desired to use them.

Another novelty in construction will be noted in the shape of the main turret. The turret is hexagonal in form, four sides being finished with bored center holes and clamping surface for holding boring bars, etc., while the remaining two sides are open to receive universal facing heads for holding any form of facing and turning cutter. The turret is equipped with a rotating stock bar with a dead stop for each face.

Both turret and cross-slide carriages are provided with both turning and screw-cutting feeds. These feeds are entirely independent both as to rate and direction, and simultaneous cuts can be taken with each in the rate and direction desired. Owing to the weight of the slides necessitated by the heavy work for which the machine is designed, the plan has been followed of giving a power control for each of them, operated by handles within easy reach of the operater. This makes it unnecessary for him to tire himself by the rapid handling of these parts.

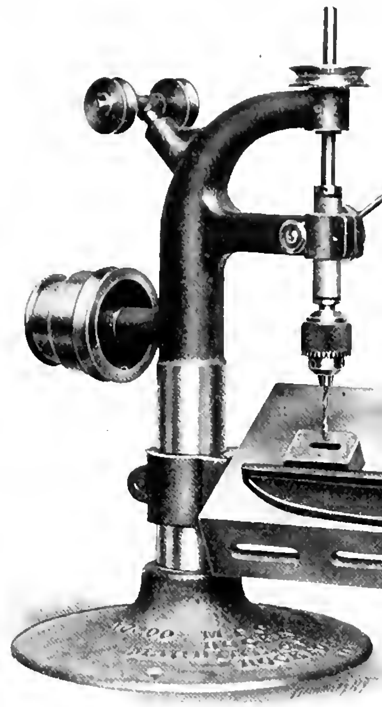
It will be noted that the head-stock and bed are made in one piece. This is an unusual construction for a machine as large as this, but it has several important advantages. It gives a strength and rigidity to the frame work which meets the exacting requirements of high-speed cutters, allowing them to obtain their maximum efficiency at the proper feeds and located, thereby preventing disastrous results through carelessness on the part of the operator. When desired, the lathe is equipped with motor drive. Any constant-speed motor may be used.

The lathe has a swing of 22 inches over the vees and 18 inches over the carriage. The spindle is bored to 3½ inches in diameter, and has a front bearing of 6⅝ inches in diameter. The turret, which has a width of 20 inches across the flats, has 3-inch holes for tools, and a maximum traverse of 52 inches from the face of the chuck. The lathe is fitted with an extra heavy three-jawed universal chuck. It weighs, complete, 8,000 pounds. It is built by the Steinle Turret Machine Company, Madison, Wis.

ROCKFORD SENSITIVE BENCH DRILL.

A sensitive bench drill, having a capacity of ¼-inch holes as a maximum, is manufactured by the Rockford Machine & Shuttle Co., Rockford, Ill. As will be noticed from the accompanying cut, one of the prominent features of this tool is the arrangement of the table, which can be swiveled around a horizontal axis, and can be set to any position and locked in any angle, thus greatly facilitating the drilling of holes at an angle to the locating or bottom surface of the piece in which the holes are drilled. The table has, of course, also a vertical adjustment for a considerable distance, as is plainly shown in the cut. The spindle, which is made of tool steel, is driven by means of a round belt running from a grooved pulley cast in one piece with the 2-step cone pulley constituting the main drive. The belt runs over idlers to the grooved pulley on the

spindle. The lower end of the spindle is fitted with a taper, and takes any 5/16-inch drill chuck. The counter-shaft has a 2-step cone pulley for a 1⅛-inch wide flat belt, and, of course, tight and loose pulleys, as usual. One feature worth mentioning is the adjustable angle plate shown in place on the table. This angle plate is intended for use when the table



Rockford Sensitive Bench Drill.

is tilted, to support the work on one side, when being drilled on an angle. This angle plate can be moved as desired, and locked at any place to the side of the table by means of the binding screw shown. The side of the table is provided with slots making it adaptable for work which can conveniently be clamped in this position. The size of the table is 8 x 8 inches, and its vertical adjustment is 5 inches. The greatest distance between the spindle and the table is 7¼ inches, and between the spindle and the frame 4½ inches. The lever feed of the spindle is 2¾ inches. The weight of the machine, including counter-shaft, is 83 pounds.

DEGEN'S ELLIPSOGRAPH.

The accompanying cuts show an interesting instrument for the drawing of ellipses and hyperbolas, recently patented by Mr. Julius Degen, of Trenton, N. J. The most interesting feature about this tool is its adaptability for drawing an

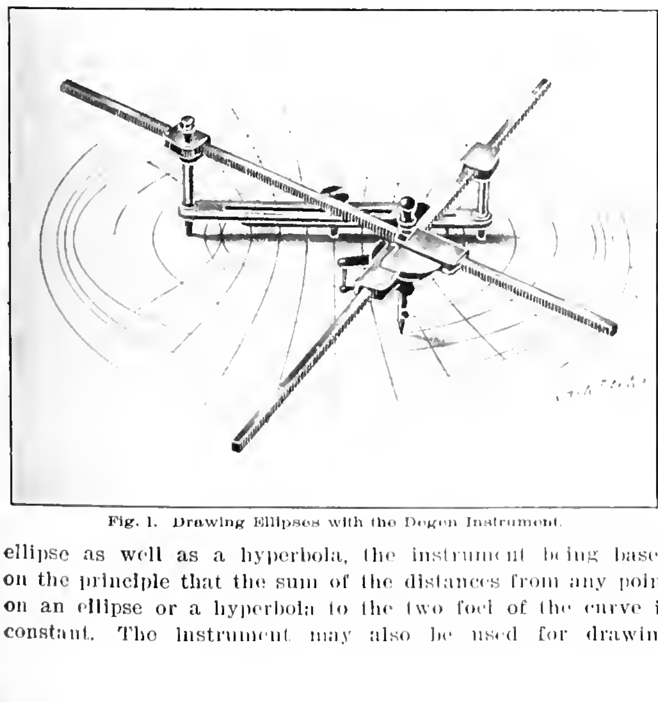


Fig. 1. Drawing Ellipses with the Degen Instrument.

ellipse as well as a hyperbola, the instrument being based on the principle that the sum of the distances from any point on an ellipse or a hyperbola to the two foci of the curve is constant. The instrument may also be used for drawing parabolas. In such a case an attachment not shown in any of the cuts takes the place of one of the posts shown at the foci. This attachment is permitted to slide along a T-square, and the pen or pencil then describes a parabola, so that, in fact, all the curves for conical sections may be drawn mathematically correct by this instrument.

The mechanical construction of the instrument is as follows: Two posts, provided with points, are connected by two slotted beams clamped together by a thumb screw. These slotted beams permit an adjustment of the distance between the two posts, the points of which, when the instrument is in use, are placed in the foci of the curve to be drawn. On the top of each of the posts is a stationary pinion, about the axis of which a head or casing swivels. Through this casing each of the two racks shown are passed, an easy sliding fit being permitted. The teeth of these racks are engaged with the tooth of the stationary pinion. These two racks cross each other, and engage at the crossing point with a traveling pinion, the vertical shaft of which is extended, and at the bottom of which a pencil or pen holder is attached. Around the traveling pinion there is a casing made as a guide for the racks. When the instrument is used, and the pen is moved by holding the knob at the upper end of the vertical shaft, the traveling pinion will revolve, moving inward on one rack exactly the same distance as it moves outward on the other, thereby causing the pen to move along a curve, every point on which is so located that the sum of the distances from any point of the curve to the foci is constant. When it is wanted to describe a hyperbola, the pen is

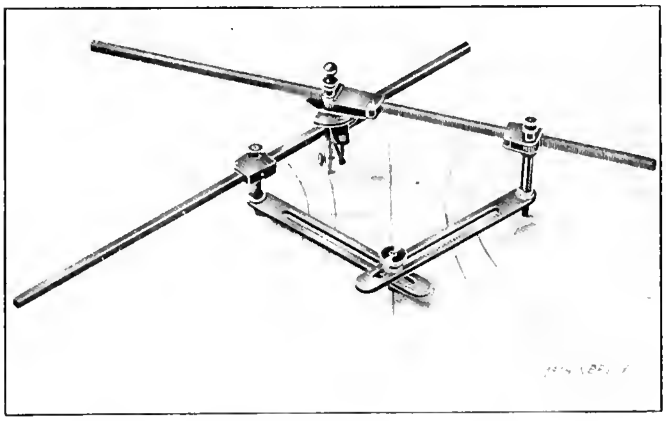


Fig. 2. Using the Ellipsograph for drawing Hyperbolas.

passed in the direction toward the center of the mechanism, and, as the same condition will obtain, the pen evidently will describe the desired curve. When the curves are drawn with ink, it is necessary that the pen always travels tangent to the curve being drawn, and the pen has to be guided around the vertical shaft continuously. A special mechanism is contained in this instrument for accomplishing this purpose. This mechanism is based on the fact that the tangent in each point to an ellipse or hyperbola bisects the angle between the two lines connecting the point in question with the foci of the curve. Each of the traveling heads or casings is provided with a flange in which is cut a spiral groove. Between the two flanges a steel plate swivels around the axis of the traveling pinion, having a slot running in a radial direction. A pin engaging both of the grooves previously referred to and also the slot in the plate between the two flanges, causes this plate to revolve around the vertical shaft whenever the instrument is put in motion. The steel plate has an extension at a point opposite the radial slot, to the end of which is riveted a small vertical pin engaging a hole at the end of a small horizontal arm, which is threaded into the head carrying the pen. By this arrangement a revolving motion is conferred upon the pen which keeps it constantly in the proper direction.

G. E. CENTRIFUGAL AIR COMPRESSORS.

After an extensive series of experiments, covering a number of years, the General Electric Co. is now producing a line of direct connected centrifugal compressors for supplying air in large quantities at moderate pressures. They are built

for a number of capacities, and, for each capacity, in three sizes for the nominal pressure service of 0.88, 1.7, and 2.7 pounds per square inch, respectively, though they may be used at pressures greater or less than these by varying the speed at which they are run. They may also be arranged to act as "exhausters" for pressuress within 3.25 pounds per square inch or 6.5 inches of mercury below atmospheric pressure. They are not adapted to low pressures, which field is satisfactorily filled by the ordinary fan blower. Their range of work covers more nearly that of the pressure blower, and therefore they are especially adapted for air blast for burning fuel, as in oil, gas or other furnaces.

Design.

This centrifugal compressor is a modified fan blower designed for high efficiency at pressures that are high for this

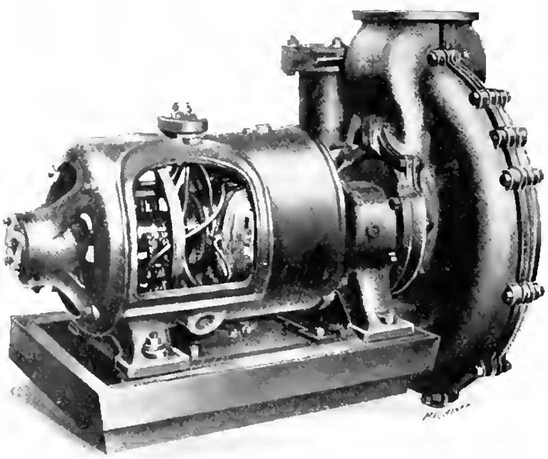


Fig. 1. Centrifugal Air Compressor driven by Direct-current Motor.

form of apparatus. It consists simply of an impeller of improved design rotating in a case. The impeller receives the air on both sides so as to avoid the end thrust. The general internal arrangement of the machine bears a close resemblance to that of the so-called turbine pump, so that the term "turbine compressor" or "turbine blower" has been aptly applied to this apparatus.

An important feature of the design is the fact that the compressor and its motive power are designed for each other,

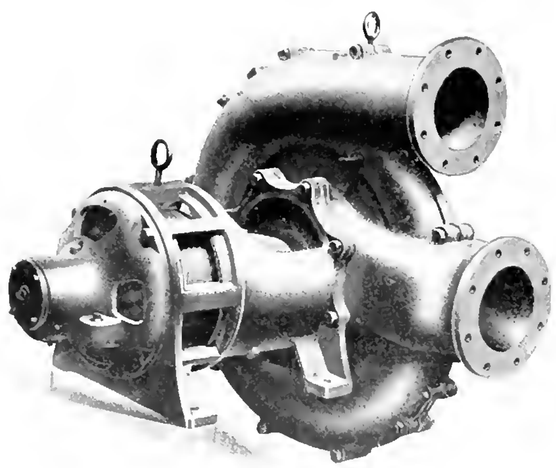


Fig. 2. Centrifugal Air Compressor driven by Alternating-current Motor.

and sold as a single unit. The compressor may be driven by a direct-current motor, an induction motor, or a non-condensing steam turbine. Under these conditions there is no belting, gearing or other transmitting device requiring attention and repair, the driving and driven members being mounted on a single shaft. On sizes below 50 horse-power, the frames of the two members are bolted together and stand on feet cast integrally with them. The larger sizes have a base or bed plate on which the frames, casings, and bearings are mounted.

Comparison with High-Pressure Fan and Positive Blowers.

This turbine compressor fills the field at present occupied by the high-pressure fan blower and the positive pressure blower. As compared with the ordinary fan blower design for the same service, it need only to be said that the efficiency is about one-third greater, while the new machine at the same time retains all the advantages of the older machine, such as its simplicity and the low cost of maintenance. There are also many points in which this rotary compressor shows superiority in comparing with the positive pressure blower. One of these is in the matter of pressure regulation

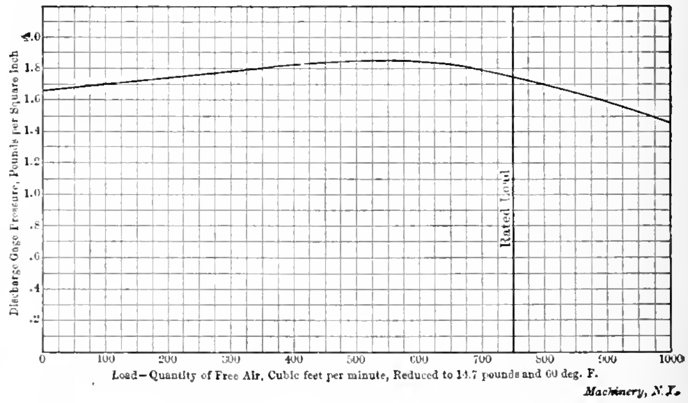


Fig. 3. Pressure Curve for Centrifugal Compressor, with Varying Load.

and consequent economy. With the positive pressure blower the machine normally receives a certain number of cubic feet of free air per minute which is forced into the main at the desired pressure. Ordinarily the means taken to regulate this pressure is the installation of a safety valve set at the reqnired number of pounds per square inch. When the demand for air falls off, so that the blower is furnishing more than is needed, the pressure rises, and the excess escapes through the valve. All of this lost air involves waste of power. On the other hand, if the demand for air is somewhat in excess of the capacity of the machine the pressure drops below that desired for the use to which it is applied. As compared with this, the rotary compressor resembles the high-pressure fan blower in furnishing the air at a nearly constant pressure, practically independent of the amount furnished, within the capacity of the machine.

The characteristics of the apparatus in this respect would be appreciated by referring to Fig. 3, which shows the variation in pressure of one of these machines running at high speed, and with the outlet pipe throttled to various degrees. It will be seen that the variation in pressure is about 10 per cent within the full range from zero to the rated load, while

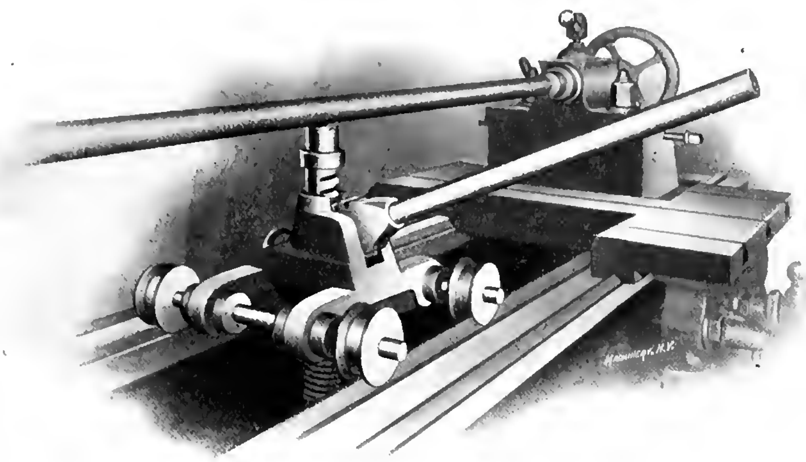
TABLE OF STANDARD SIZES, SINGLE STAGE CENTRIFUGAL COMPRESSORS FOR INDUSTRIAL AIR BLAST.

Drivers may be 220 volt, 60 cycle, 3 phase induction motors, either Form M or K, 125 or 250 volt D.C. motors or non-condensing steam turbines.

SERVICE.	Rated Pressure, pounds per sq. in.	Nominal Capacity, cubic feet Free Air per min	Diameter of Discharge Pipe, inches.	Nominal H P.	Max. Press. D C. or Turbine Drive, pounds per sq. in.
Foundry cupola or low press. air blast.	0.88	2600	12	20	1.5
	0.88	3600	16	30	1.5
	0.88	7000	20	50	1.25
	0.88	10000	28	75	1.25
Moderate pressure air blast.	1.7	750	8	11	3.7
	1.7	1400	10	20	3.7
	1.7	2000	12	30	3.7
	1.7	3600	16	50	2.5
High pressure air blast.	2.7	1200	8	30	4.2
	2.7	2400	12	50	4.2
	2.7	3400	14	75	3.0

the drop is not alarmingly great even with an overload of 33 per cent in cubic feet of free air furnished per minute. This constancy of pressure is, of course, obtained without regulating devices of any kind, being inherent in the design of the machine, the only requirement being that the speed of the impeller be kept constant.

The turbine compressor also invites comparison with the positive blower on the score of rating and capacity. A positive machine is often rated from its mechanical displacement, no allowance being made for the heating of the air and the drop in pressure while entering the machine, not to mention the leakage around the moving parts. Actual tests have shown a loss of 50 per cent or more in capacity as measured by theoretical displacement in the case of a positive pressure blower. The builders of this device state that their centrifugal compressor will deliver as much air as a positive blower having a rating 33 per cent greater.



Johnson & Bassett Shaft Straightener.

A further point in which this apparatus invites comparison is in its remarkable simplicity, there being only two moving parts, the rotor of the driver and the impeller of the compressor. There are no parts other than the two supporting bearings where wear can possibly occur. The bearings being self-oiling, the only attention which the machine requires is the renewal of oil in the reservoir at intervals. A number of machines have been in service for long periods without renewal or adjustment of any kind, and without attention, except the monthly renewal of oil.

Rating and Capacity.

As shown in the accompanying table, these compressors are built in standard sizes comprising a number of capacities for each of three pressures. They are made of such capacity as to permit the use of a single machine in a central location in a factory rather than installing a number of small blowers scattered in various places. Even the smallest machines listed are too large for small gas furnace installations, only comparatively large installations being provided for. For gas furnaces, an air blast capacity of about ten times the quantity of gas supplied is ordinarily required. For this work a machine rated at 1.7 pound per square inch should be used. For furnaces requiring a concentrated and positively directed jet, a machine rated at 2.7 pounds pressure should be used. The first four sizes on the list are especially adapted for supplying air blast and foundry cupolas.

The rated pressures given are at the beginning of the pipe line, and with the inlet full. Provision must be made for any pressure drop through the inlet supply pipe or in the main. All sizes are provided with inlet pipe flange connection, and the supply of air should be taken from a cool place out-of-doors to get the most efficient operation. The pressures given are for an air supply at a temperature of about 60 degrees. If the supply is hotter than this, or if the barometer is abnormally low, there will be a slight decrease of pressure. For an average case where the inlet air is heated somewhat, and where there is sufficient length of inlet and discharge pipe to give an appreciable drop, the three groups listed may be usually depended upon to give actual pressures in the mains at a distance from the machine of about 0.625, 1.25 and 2 pounds per square inch respectively. Extremely small pipes will give lower pressures. With direct-current motor drive, the rated pressure is merely nominal, and may be set by hand adjustment of the field rheostat up to the maximum value given.

JOHNSON & BASSETT SHAFT STRAIGHTENER.

The straightening of shafts in the machine shop is often accompanied by more or less difficulty, because of the lack of proper appliances for doing this kind of work. Realizing that there is a demand for a good, and at the same time inexpensive, tool in this field, Johnson & Bassett, of Worcester, Mass., have placed upon the market the shaft straightener shown in the accompanying cut. This illustration shows what the makers call a No. 1 shaft straightener for use in lathes having from 14 to 24 inches swing. The cut shows the device applied to a 14-inch swing lathe, but its adjustable feature permits it to be used for the larger sizes as well. The capacity of the device is 1½-inch; that is, it will straighten shafts of any diameter up to this dimension. The wheels with which the device is provided can be run either on the vees or on the flat part of the bed, and are easily adapted to different sizes and makes of lathes. The device is not heavy, and can be transferred from one lathe to another with comparative ease. The advantages of this device are the simplicity and ease of application and adjustment, and the enormous leverage obtainable, due to the design. The device will undoubtedly be found a convenient and handy tool in many machine shops.

GAS OR OIL HEATED SODA KETTLE.

The Gray & Prior Machine Co., of Hartford, Conn., developed the soda kettle shown in the cut, for its own use. The peculiarity of this construction lies in the fact that it is heated by a Bunson gas, or a blue flame kerosene burner, instead of by the usual steam heated jacket, making the apparatus available for places where steam cannot be used, such as garages, and machine shops driven by motor or oil engines, where the steam heating plant is shut down during the summer. This provision makes the apparatus portable as well, so

Gray & Prior Soda Kettle.

that it may be moved from place to place in the shop as necessity may require. The use of permanent steam pipe connections and steam trap for taking care of the drainage is also obviated. The burner used has an inner and an

outer ring flame, either or both of which may be used. The double flame needs to be used only when warming up the cold bath in the morning.

THE SCHMIDT DRIVING CHAIN.

The transmission chain herewith illustrated is manufactured by the Schmidt Drive Chain Co., 265 Broadway, N. Y. These chains are adapted for high speeds, silent action, and automatic compensation for lengthening of the links due to wear.

As may be seen from Fig. 1, this chain differs from others of this class in having the contact lugs formed midway of the links between the pivots. This gives a straight path for the links to follow, so that they are practically in simple tension and are not liable to bend and change their pitch under excessive or suddenly applied loads. For this reason the makers claim that for a given load the chain is lighter, giving less dead weight and a higher efficiency.

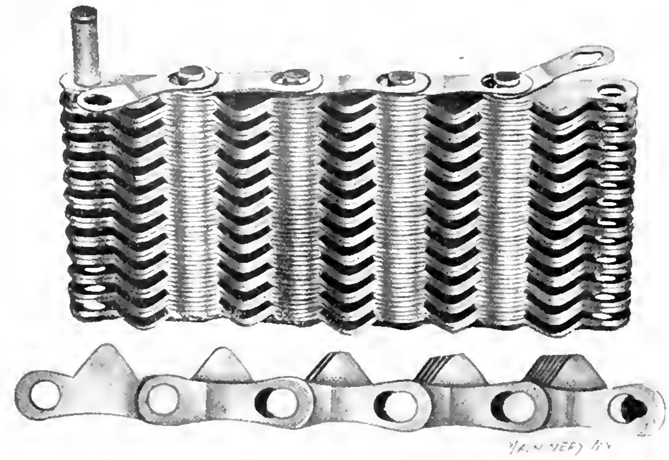
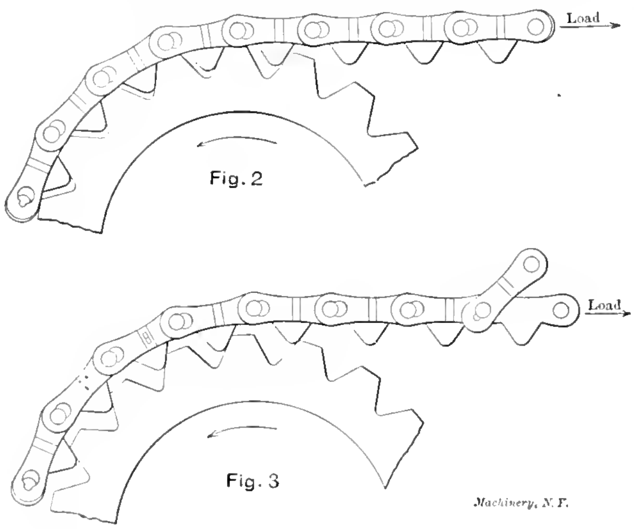


Fig. 1. The Schmidt Driving Chain.

Its action when new, and after elongation, may be compared by the diagrams shown in Figs. 2 and 3. As the pitch is elongated by wear, the beveled driving lugs on the links climb up the inclined faces of the teeth until they have found the proper pitch. For this reason the chain may be used until the pitch has elongated ½ inch per foot, or more, without the action losing its smoothness and accuracy. The teeth of the wheels have a considerable angle, and the lugs on the driving chains are so rounded as to prevent interference on sprockets having a small number of teeth. Very large gears may also be used, the number of teeth being limited only by the capacity of the cutting machine. Speed ratios as high as 20 to 1 are well within the capacity of this drive.

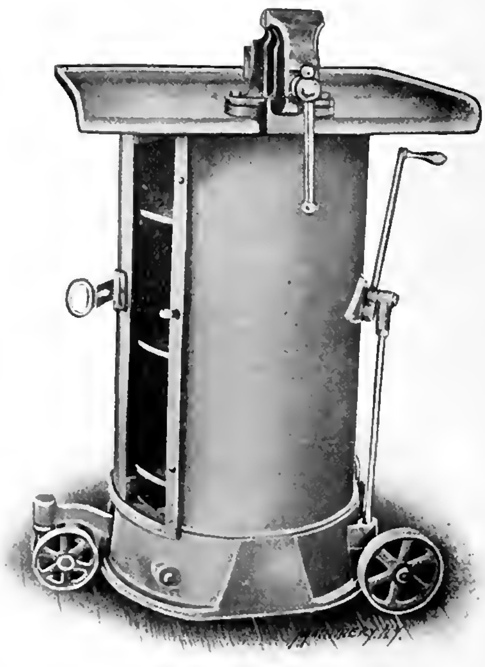


Condition of Chain when New, and when the Links have elongated One-half Inch per Foot due to Wear.

The construction of the chain is new. The outer end of each pin orifice in the links has the same radius as the pins. The links, therefore, always have full bearings on the pins, giving a large bearing surface, and doing away with the excessive wear in a new chain resulting from the use sometimes met with of a circular hole of larger diameter than the pin, which gives only a line bearing until the metal wears and forms a seat for it. The method of retaining the pins is novel and interesting. They are not riveted, but are held in place by means of special edge or retaining links, having a key-shape hole which passes over the end of the pin and enters a circular groove. These retaining links are offset and over-lap, and lock each other, as well as the pins, in place. One of them on each side of the chain, however, is made so that the chain may be disassembled for general overhauling, or for changing its length, without the use of tools.

PORTABLE VISE STAND.

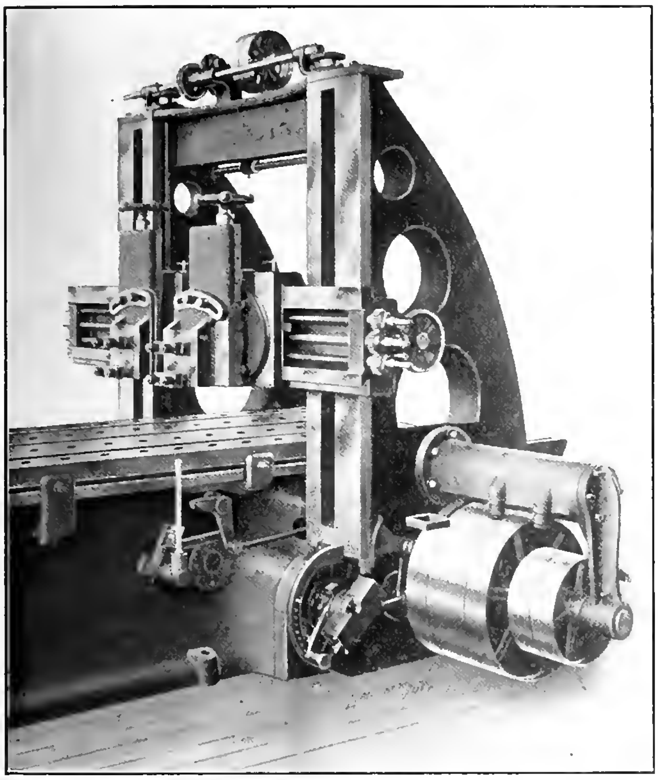
The portable vise stand, while it has not as yet become very much used, would undoubtedly fill a need, because in every shop there are a number of occasions arising almost daily where a portable work bench or vise stand, which can be easily moved from one place to another, is required. This need, having been recognized by the New Britain Machine Co., New Britain, Conn., has caused the design of the portable vise stand shown in the accompanying cut. This stand consists of a circular column of rolled boiler plate to which is fitted a cast-iron top so shaped that tools or work may be conveniently placed upon it without danger of falling off when moving the device from place to place. The bottom of the column rests on a cast iron base plate, being large enough to give ample floor support, and on the vise side far enough back from the working line so that, when standing by the vise, nothing is in the way of the workman's feet. The interior of the column is provided with three shelves, two of which are adjustable, intended for the storing of tools, the column having a sliding door. The door is so placed that the workman can easily open it and see the contents without moving from his working position. No truck is required for transporting this vise holder from one place to another. All that is necessary is to raise the self-locking handle to the position shown in the cut. This raises the stand from the floor and makes it bear on three wheels, one of which is mounted on a swivel. The stand can then be easily pushed across the floor, and when the desired point is reached, the lowering of the lever drops it upon its base, ready for use. These stands are equipped with a standard make of vise, but may be equipped with any vise desired, or even without the vise, if requested. The stand is built in two sizes: one in which the top tray is 20 x 26 inches, carrying a 3½-inch vise, and one with the top tray 24 x 32 inches, provided with a 5-inch vise. The height of the vise in both cases is 41 inches.



Portable Vise Stand.

IMPROVEMENTS IN THE CHANDLER PLANER.

The readers of MACHINERY are familiar with the Chandler planer, built by the Chandler Planer Co., Ayer, Mass., which was first described in our issue of July, 1904. As will be remembered, the most striking feature of this tool is the fact that it is driven by three belts from the counter-shaft—of which three, one is the regular forward motion belt, while the other two control the return, one of them giving a much higher speed than the other, and a much higher return than has been accomplished by any ordinary means. In operation, when the table is to be returned for the next stroke, the moderate speed backing belt is first thrown on, momentarily, thus quietly reversing the planer platen and the gears and pulleys which drive it; then the continued movement of the belt shifter throws off this moderate speed, and shifts on the high-speed reverse, which rapidly returns the table to position for commencing a new cut. In shifting back to the cutting stroke again, the sequence is reversed. First the moderate speed belt is engaged, slowing down the platen until it is under control; then the forward motion belt is shifted onto the tight pulley. It will be seen that the moderate speed reverse belt stands midway in operation between the forward and fast reverse belts, and serves to make the transition between the two extremes quiet and controllable.


Improved Features of the Chandler Planer.

Other features of the tool are: the use of case-hardened and ground journals for the bearings of all high-speed shafts; a device by which the high-speed return can be disengaged and only the moderate speed used; a back-gear incorporated in the machine which can be used when a slow-cutting speed and high-belt ratio are required; and a feed mechanism which can be varied while the machine is in operation without requiring the clumsy and dangerous adjustment of moving parts. Besides these features there have been a number of recent improvements which will be understood by reading the following paragraphs, and referring to the accompanying cut.

The arrangement for throwing in or out of action the third or high-speed reversing belt has been much simplified. As now made, this is effected by simply manipulating a little tappet, pivoted to the lever operated by the platen dog on the left. When this is thrown up, the lever is carried clear over, and the third belt is brought into use. When this is turned down the platen dog can only shift the lever far enough to engage the moderate speed return.

The orthodox slotted plate cam for operating the belt shifter has been replaced by a set of circular cams, contained within the tubular arm by which the outboard bearing of the driving shaft is supported. The circular cams are much easier to machine than the plate variety, the mechanism is less exposed, and the mechanical connections with the reversing lever are much simpler, consisting merely of a gear on the cam shaft, meshing with a rack which is joined to the reversing lever by a connecting-rod.

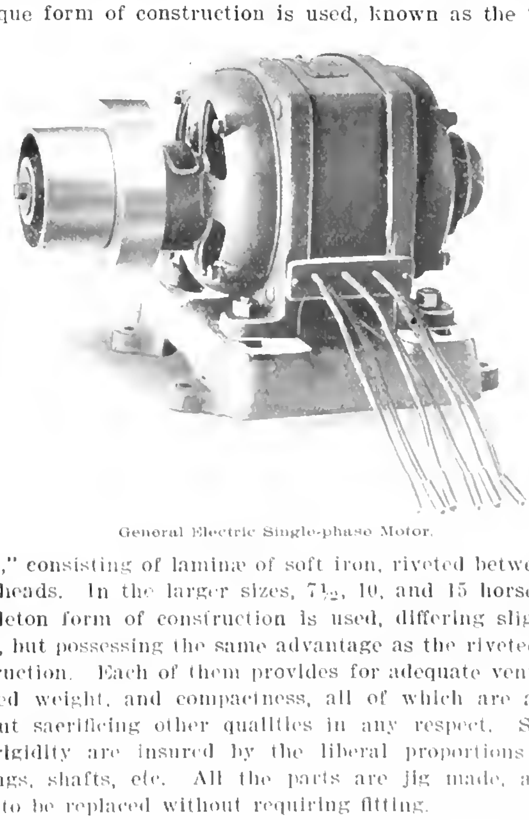
A friction feed-box has been designed which is not radically new in principle, but which is so well proportioned that it is able to work under severe conditions where a positive arrangement is ordinarily deemed necessary. This device is of the type in which the arresting of the friction member against the positive stop which limits its motion, serves to relieve the friction almost entirely. This design has been successfully applied to the severe service of operating heavy feeds on a 48 x 48-inch four-head planer, one feed-box driving all the heads, at the greatly increased cutting and return speeds of which the machine is capable.

Perhaps the neatest and yet the simplest of the new features is the means provided for altering the feeding from the commencement to the end of the stroke, or *vice versa*. As every planer hand knows, this is ordinarily done by shifting the crank-pin to the other end of the slot in the face of the feed-box. This is a ticklish job, especially if the planer is a large one with heavy feed mechanism, and more especially if the planer is in action. The method used on the Chandler planer is clearly shown in the cut. As usual, a slip pinion is used to connect the feed gear on the end of the cross-rail with the cross and vertical feed screws and shaft. The improvement consists simply in providing an extra stud above and below the central stud on which the pinion is ordinarily located. When it is placed on either of the other two studs, the train of pinions on the feed screws is rotated in the opposite direction, and the time of feeding is changed.

It might be mentioned that the planer shown is a special one, in which the back gear mechanism is omitted. For this reason the lever controlling it does not appear.

GENERAL ELECTRIC SINGLE-PHASE MOTOR FOR MACHINE DRIVING.

The General Electric Co. has placed on the market a single-phase motor for direct-connected machine driving, to fill the demand for a machine that would be rugged, compact, easy to operate and ample in capacity. As may be seen in the cut, these motors are similar in general appearance to the polyphase motors produced by the same makers. In the small sizes, such as that shown, up to and including 5 horse-power, a unique form of construction is used, known as the "riveted frame," consisting of laminæ of soft iron, riveted between cast steel heads. In the larger sizes, $7\frac{1}{2}$, 10, and 15 horse-power, a skeleton form of construction is used, differing slightly in detail, but possessing the same advantage as the riveted frame construction. Each of them provides for adequate ventilation, reduced weight, and compactness, all of which are attained without sacrificing other qualities in any respect. Strength and rigidity are insured by the liberal proportions of the bearings, shafts, etc. All the parts are jig made, allowing them to be replaced without requiring fitting.


General Electric Single-phase Motor.

The machine possesses all the simplicity of the polyphase

type, including the absence of rubbing contact and complicated internal mechanism. The rotor is of the well known high resistance "squirrel cage" type, while the stator windings are similar to those of the three-phase motor. By shifting the bearing head brackets, the motors are adapted to either floor, wall, or ceiling use.

Starting devices are provided which require a comparatively small starting current, varying from 2 to 3½ times the full load current throughout the whole line. The maximum starting current is required only on small motors in which a slightly different starting apparatus is provided, hence it does not assume abnormal proportions. When connected with lighting circuits, they can be thrown on without appreciably affecting the line, provided proper transforming capacity is installed, as usually provided for normal conditions. Clutch pulleys are provided with motors of 1½ horsepower size, or larger. These are so arranged that when the rotor has attained the given speed the friction band of the clutch, actuated by centrifugal force, engages the outer shell and the load is assumed. All the motors of the line can be directly connected to all kinds of machinery where moderate starting torque is required, as is the case with fans, blowers, generators, etc. With machinery required to be started under full load, as in the case of pumps, etc., clutch couplings are employed which are thrown in when full speed has been reached. Devices to start and stop the motor, automatically can be supplied when regular attendance is not required, as when used in isolated pumping stations, refrigerating plants, etc.

The fact that these motors can be run from an ordinary alternating-current light circuit makes them easily adaptable to the needs of the small power user. Their compactness and small weight per horse-power, due to the riveted frame form of construction, makes them applicable to special cases where heavy or bulky machines could not be used.

NEWTON GEAR HOBBING MACHINE.

The Newton Machine Tool Works, Inc., Philadelphia, Pa., has had in operation in its own works for the past five years a machine for hobbing worm, spiral, and spur gears. This

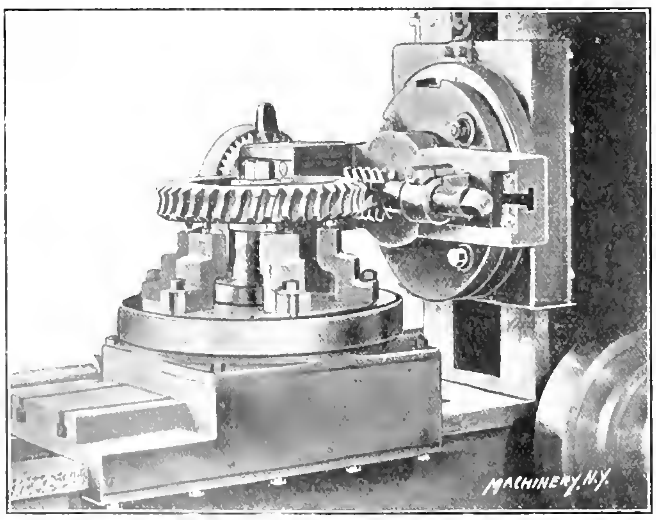


Fig. 1. The Machine arranged for Hobbing Worm-wheels.

has been so successful that another has recently been built for its own use, and the firm is prepared to build them for the trade as well.

The machine as arranged for cutting spur gears is shown in Fig. 2. The principle is well known to our readers and needs not to be minutely described. A hob, having teeth of the same shape as a rack, is used, set at an angle to the gear equal to the angle of the spiral on which its teeth are cut, so it can be fed straight down through the blank without interference. The hob and work are connected with each other by change gearing to rotate at the same ratio as that between the number of teeth in the gear and the number of threads on the hob. The machine being started up with the members

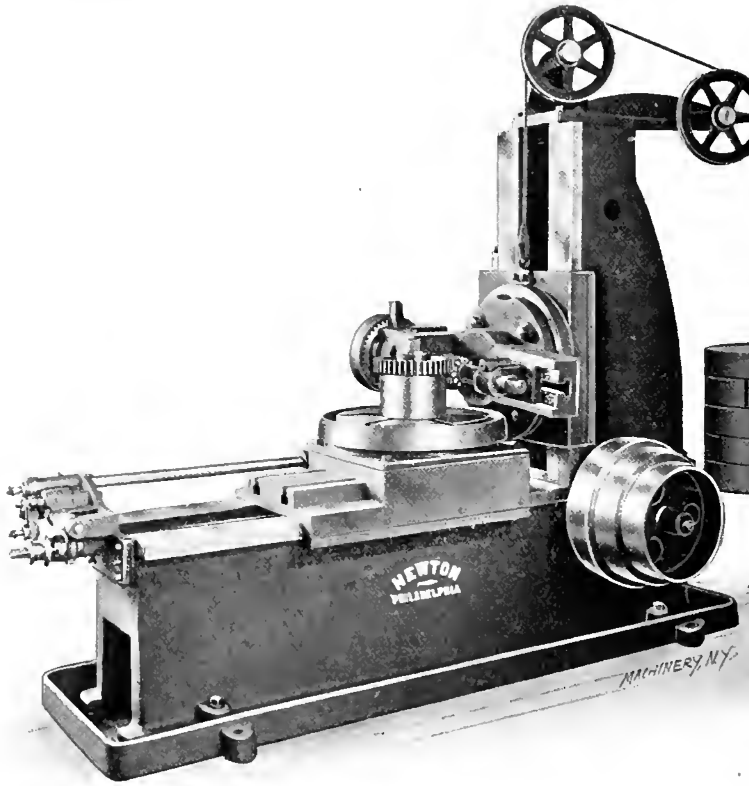


Fig. 2. Newton Gear Hobbing Machine at Work on a Spur Gear.

rotating at this ratio, and the hob being set to cut the proper depth, it is fed steadily down through the work, completing all the teeth at one feeding of the slide.

In Fig. 1 the machine is shown set up for hobbing worm gears; in this case the head is set, of course, to have the spindle horizontal. The blank and hob are geared together at the proper ratio as when cutting spur gears, but the work table with the blank is fed in toward the cutter until the proper depth has been reached, instead of having the cutter head fed down the face of the slide as in Fig. 2.

All the feed movements are by power, and are obtained by change gearing. The change gearing, for the feed of the table on the bed in hobbing worm-wheels, is located at the outer end of the bed, in the position indicated in Fig. 2, the feed movement for the screw being obtained from the splined shaft which drives the dividing worm. The dividing wheel of this machine is 20 inches in diameter, and the machine is of such dimensions as to take in blanks up to 40 inches in diameter. As will be noted, the head is counterbalanced. The machine has every appearance of strength and rigidity.

R. W. SPEED VARIATOR.

This device, made by the R. W. Speed Variator Co., Singer Building, New York City, is capable of transmitting power positively with a variable velocity with small gradations, a change being made without stopping the movement and without shock or jar. The way in which this is accomplished will be understood from a study of the accompanying cuts and description.

Fig. 3 shows a general view of the apparatus, while the line cuts Figs. 1 and 2 explain the mechanism. The driving member of the device is normally pinion A, Fig. 1, while cone B is the driven member. Obviously their functions may be reversed as occasion requires. The cone is formed with a

series of recesses, or "pits," as the builders call them, of suitable form to mesh accurately with the conoidal pin shape tooth on pinion *A*. These several rows of pits are arranged around the circumference of the cone at equal distances apart, and their number for each row varies in geometrical progression from one end to the other. One of the holes in each row is arranged in a straight line on the vertical plane of the axis of the cone, as shown in Fig. 1. This row of holes is formed in a tongue *C* adapted to have a limited sliding movement in a corresponding T-slot cut in the periphery of the cone, as shown in Fig. 2. This tongue furnishes means by which the pinion may be shifted from one row of pits to another without requiring it to be disconnected from the cone. If it is desired to move it to a larger diameter, for instance, as soon as the tooth in the pinion has engaged with the hole in the tongue, the latter is shifted to the left, carrying the pinion with it just far enough, and in time, for the next tooth to engage with the next larger row of holes on the cone. If it is desired to move it still further, the shifting is repeated as many times as may be required to bring the pinion to the desired point on the cone. The process may be reversed by shifting in the other direction, the tongue being moved a step to the right at each revolution, carrying the pinion with it from one row of pits to the next succeeding.

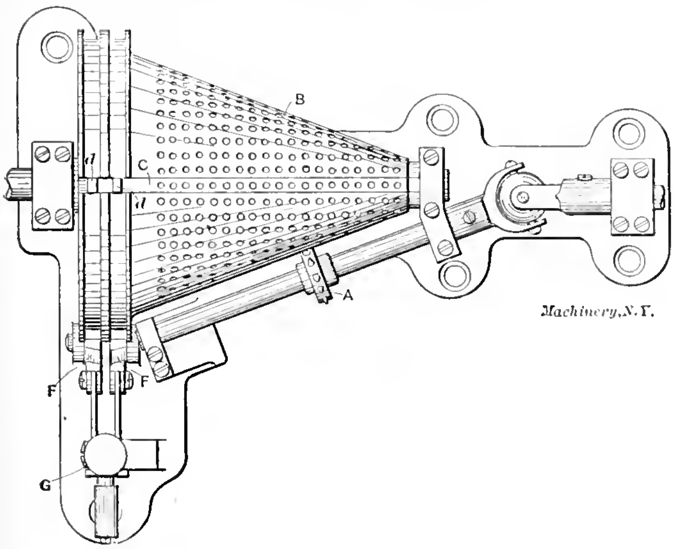


Fig. 1. Plan View of Variable Speed Mechanism of Ingenious Design.

Tongue *C* is moved automatically, the mechanism at the large end of the cone being provided for this purpose. Two lugs *d* are formed on the left-hand end of the tongue. At

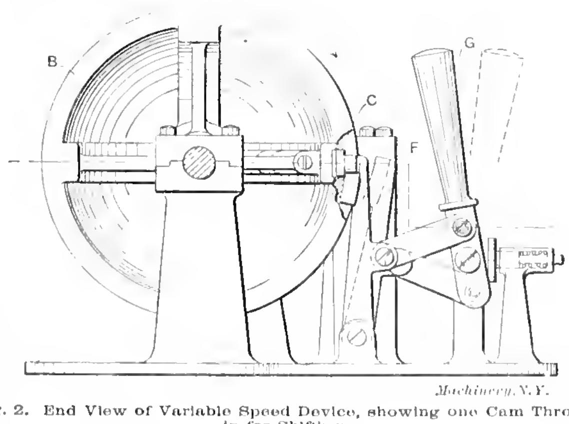


Fig. 2. End View of Variable Speed Device, showing one Cam Thrown in for Shifting.

the larger periphery of the cone, two grooves are turned and lugs *d* normally stand midway on these grooves. This normal position is maintained by spring connections, which return the tongue to this position whenever it has been displaced longitudinally. Two cams *F* are pivoted at the base of the device, and are connected with handle *G* in such a way that either of them may be thrown into the corresponding groove, it being impossible for both to be thrown at the same time. When one of these cams is thrown in, its point enters the space between the lug *d* and the flange, forcing it outward against the pressure of the constraining spring, and carrying

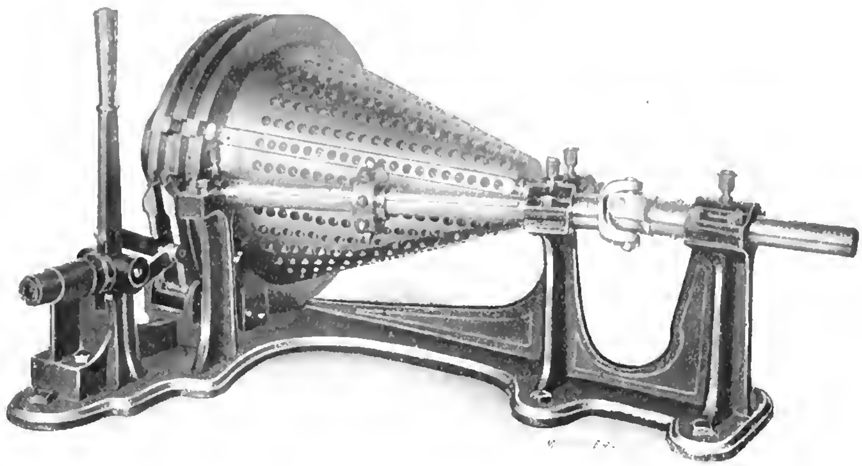


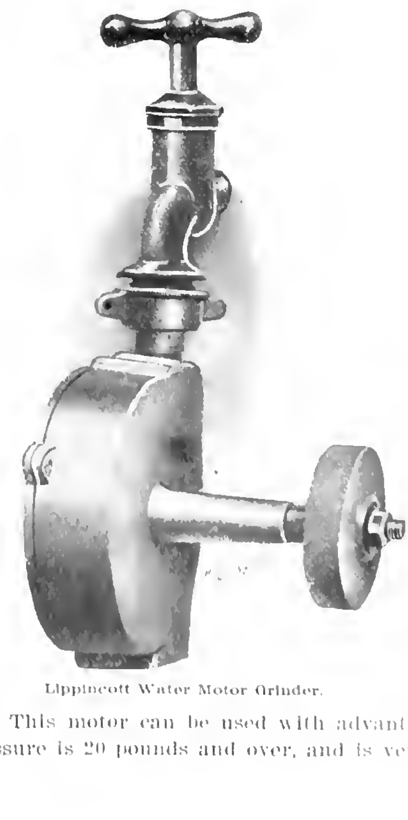
Fig. 3. General Appearance of Variable Speed Mechanism.

the pinion with it to a new row of holes. After the cone has turned a short distance, the lug passes the cam and drops back into the neutral position. If lever *G* is still held in the same position, the cam will act as before, on the next revolution of the cone, shifting the pinion another step to a new row of pits. This action will continue as long as the lever is operated, or until the last step on the cone has been reached, in which case an automatic mechanism throws the cam out against the force applied to it by the operator. When the handle is moved in the opposite direction, the reverse motion takes place, and the pinion is moved down step by step toward the opposite end.

This device finds its application as a counter-shaft mechanism in driving machinery of various kinds; in textile machinery where slight variations of speed are required, as in driving rolls on which cloth is wound; and in feed change mechanisms and other devices of a similar nature.

LIPPINCOTT WATER MOTOR GRINDER.

In the accompanying illustration is shown a water motor mounted directly on a faucet, and provided with a small



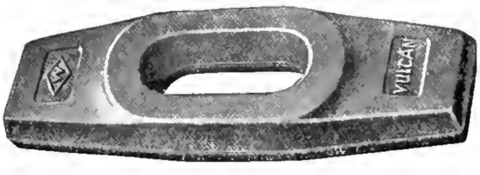
Lippincott Water Motor Grinder.

emery wheel. This motor can be used with advantage where the water pressure is 20 pounds and over, and is very service-

able for grinding all kinds of small tools. At 20 pounds pressure a motor makes 4,000 revolutions per minute, and at 50 pounds pressure, which is, perhaps, about the average water supply pressure, the speed averages 5,000 revolutions. These motors are very handy both in machine shops and elsewhere, an advantage being that belting aud counter-shafts are done away with, and that the speed and power may be instantly regulated by the admission of water through the faucet. The stream of water issuing from the motor is made useful in cooling the tools. The motor may be attached to any faucet in less than a minute, and emery wheels may be interchanged in a very short time. A suitable rest may be provided to give the proper angle for the grinding of twist drills. This water motor is manufactured by the Lippincott Motor Griuder Co., Newark, N. J.

WILLIAMS DROP-FORGED PLANER CLAMP.

The half-tone herewith shows a stiff, substantial, drop-forged clamp intended to be used on the planer or milling machiue, or, in general, on any machine tool where clamps of this description may be required. The advantage of clamps manufactured in this manner is the possibility of having an assorted and uniform supply of clamping devices, and as such these clamps are likely to prove valuable additions to the machine shop equipment. These clamps are made from a



Williams Drop-forged Plauer Clamp.

strong, tough grade of steel, and are submitted to a case-hardening process after forging, so as to enable them to stand hard usage. This clamping device is made by J. H. Williams & Co., Brooklyn, N. Y., and may be had in three sizes ranging from 4 to 8 inches in length, and 1⅝ to 2⅛ inches width at the ceuter, the thickuess varying from ¾ to 1⅛ inch. The oval hole in the clamp permits of considerable adjustment, the length of the slot varying from 1⅜ to 2 13/16 inches, according to size. The width of the slot is from 11/16 to 13/16 inch.

BEVEL GEAR CUTTING ATTACHMENT FOR AUTOMATIC SPUR GEAR CUTTER.

E. J. Flather Mfg. Co., of Nashua, N. H., has recently designed an attachment which may be applied to its automatic spur gear cutting machines, and used for cutting bevel gears. As may be seen in the cuts, the attachment is bolted to the front face of the work spindle head. The attachment comprises a body on which is mounted a head carrying a supplementary spindle. This supplementary spindle may be adjusted at any augle from the vertical to the horizontal. It is connected with the work spindle for indexing the blank by meaus of a bevel gear on its inner end meshing with a second bevel gear mounted on the axis by which the supplementary head is adjusted for the required angle. This latter bevel gear, in turn, meshes with a third attached to the work spindle. It will be seen that with this provisiou the index wheel of the machine controls the supplementary spindle on which the bevel gear is mounted at whatever angle the supplementary head may be set. The bevel gears of this connection are carefully cut, and are provided with adjustmeut for reducing the back lash to zero.

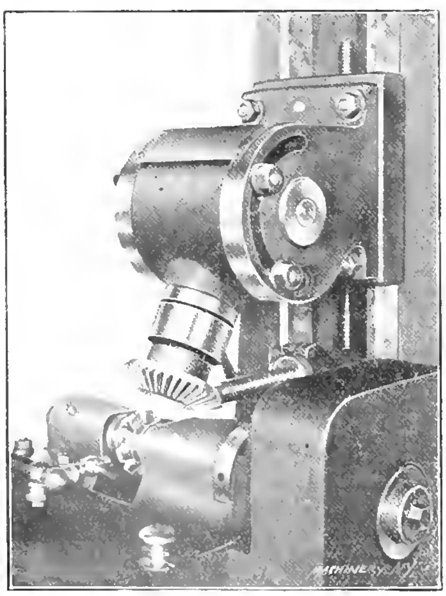


Fig. 1. Detail View of the Attachment.

In cutting bevel gears with this attachment, the head is set to the cutting angle, and the cutter set central as usual, if it is thought best to take a central cut through the teeth previous to the finishing cuts. For the finishing or side cuts, the blank is rotated the proper amount by the provision made for this in the mounting of the index worm, while the cutter is shifted sideways to correspond with the rolling movement

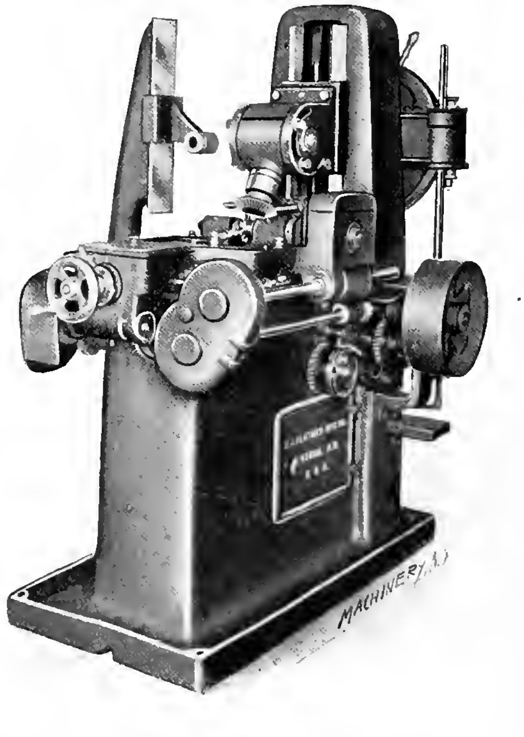


Fig. 2. Bevel Gear Cutting Attachment applied to an Automatic Spur Gear Cutter.

by the regular sidewise adjustment provided with the machine. This latter adjustment is effected by a spanner wrench acting on the nut encircling the spindle sleeve, seated in a recess on the inboard cutter spindle bearing as shown in the half-tones. This attachment has proved to be perfectly satisfactory with the small and medium size gears which constitute the great portion of the work done on a machine of this size.

DIAL GAGES FOR ACCURATE MEASUREMENTS.

The accompanying half-tones illustrate a number of interesting dial gages made by B. C. Ames & Co., of Waltham, Mass., who make a specialty of fine watch and clock making machinery. The gage shown in Fig. 1 is termed a jaw gage, and it is intended for the measuring of diameters of small

Fig. 1. Jaw Gage for Accurate Measurements.

work, particularly those occurring in watch or clock manufacturing, or for any small and fine measurements like wire, paper, sheet metal, etc., where extreme accuracy is required. The device works on the rack and pinion principle, and the reading is made to 0.001 inch, although, of course, much

finer sub-divisions can be estimated between the comparatively large graduations of the dial. The capacity of this gage is 0.2 inch. The dial is provided with two hands, the long hand indicating the number of thousandths, while the small hand shows the number of revolutions that have been made by the large indicating hand. The case enclosing this gage is made particularly strong so as to be able to withstand the hard usage of a machine shop without injuring the mechanism contained, and is provided with feet to stand on the bench.

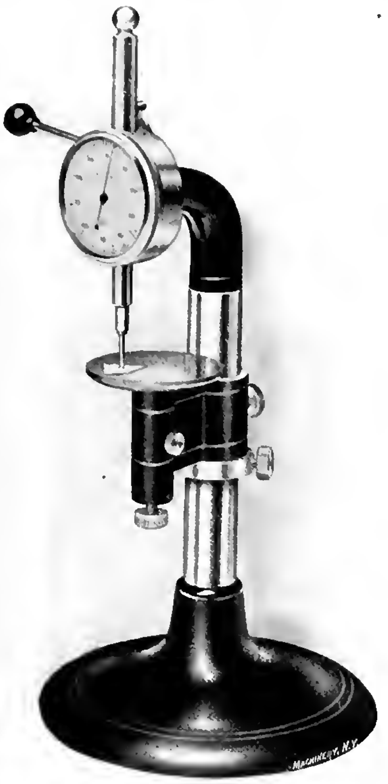


Fig. 2. Upright Dial Gage of the Rack and Pinion Type.

In Fig. 2 is shown what is called an upright fine gage, which is also graduated to 0.001 inch and made on the rack and pinion principle. The platen or table of this gage is made to turn around its center, and is provided with a fine adjusting screw used for bringing the platen up to such a height that the hand of the gage will indicate at zero when the end of the measuring rod rests against the platen itself, or against the surface of any standard gage with which it may be desired to compare when testing work. The bracket carrying the platen is fitted to the upright portion of the stand

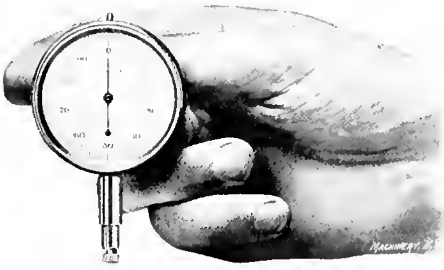
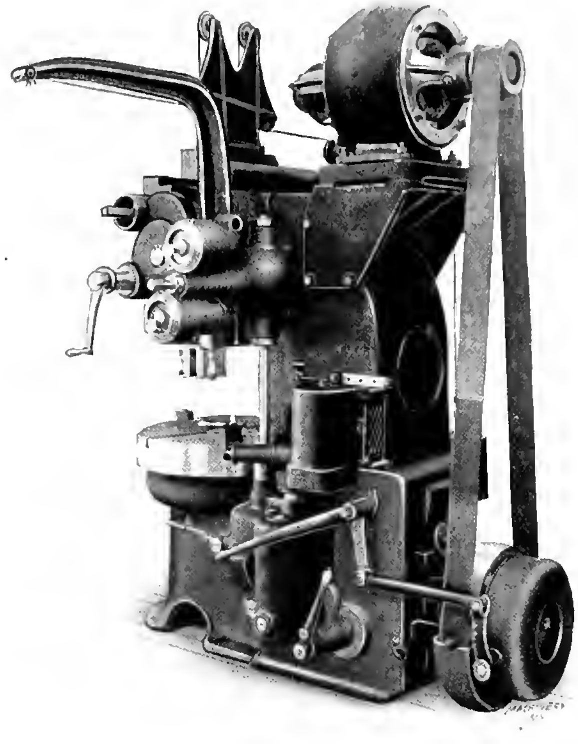


Fig. 3. Dial Gage Head.

as shown, which gives a long range to the gage. In Fig. 3 is shown a gage head which is of the same construction as that used in the upright gages. This head is provided with a back suitable for attaching to it any kind of mounting. The many varied uses to which this gage may be applied will readily suggest themselves to the toolmaker who is required to make accurate measurements. The gage can also be used as a center indicator, snap gage or limit gage. It is well adapted for being applied to fine measuring devices for the lead of screw threads, and for gage testing.

THE GISHOLT BORING AND TURNING MILL.

The boring and turning mill illustrated in the accompanying cut is one of the latest products of the Gisholt Machine Co., 1316 Washington Ave., Madison, Wis. The machine is motor driven, a 5-horsepower variable speed motor being provided, the speeds ranging from 400 to 1,600 revolutions per minute. A single friction pulley is substituted for the three-step cone pulley ordinarily used on belt driven machines, and the machine is gear driven. The friction pulley is controlled by a lever, as shown, and the table is under absolute control of the operator, and can be conveniently moved any fractional part of a revolution. The machine is provided with eight feeds, and, on account of its friction device, the danger of stripping the gears through careless handling is reduced to a minimum. An automatic feed tripping device permits any of the feeds to be positively stopped at any predetermined point. The dials for the feed trip may be plainly seen in the cut at the end of the cross rail. The tripping arrangement will also throw out the feed at either end of the traverse movement



Gisholt Boring and Turning Mill.

whether the dials are set or not. All feed screws are provided with index dials graduated to 0.001 inch. The machine is furnished with either a plain table or chuck, and the extreme swing of the machine is 36½ inches. The motor of the machine, being mounted as shown, does not require any additional floor space, and the machine is fully self-contained.

ONE-BELT REVERSIBLE COUNTER-SHAFT.

A new counter-shaft has been brought out by the Smith Counter-shaft Co. of Boston, Mass. This counter-shaft gives two forward and one reverse speed, using but one belt from the line-shaft to the counter-shaft. The half-tone, Fig. 1, and the line cut, Fig. 2, show the general appearance and

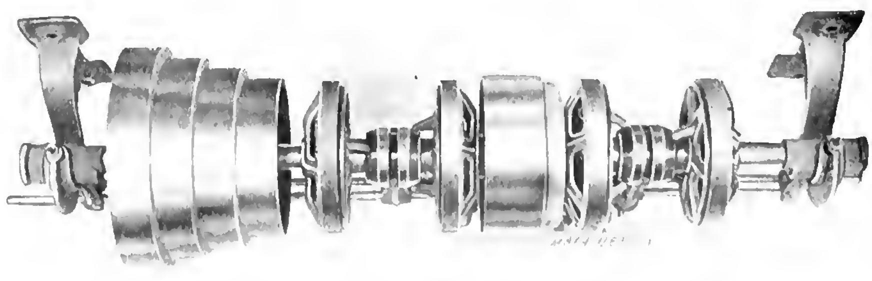


Fig. 1. Smith One-belt Reversible Counter-shaft.

construction of this counter-shaft. From Fig. 2 it will be seen that the device consists of a pulley with a spur gear attached to the hub, an internal gear connected with frictions *A* and *B*, and a three-arm spider carrying intermediate pinions meshing with the spur gear and the internal gear. The three-arm spider is connected with the frictions *C* and *D*. The

operation of the device is as follows: Friction *C*, when engaged, keys the spider to the shaft, while friction *D*, when engaged, holds the spider stationary, preventing it from rotating; friction *B* keys the internal gear to the shaft, and *A* holds it stationary. The female members of frictions *C* and *B* are keyed to the shaft, and those of *A* and *D* are fastened to the over-head beams, preventing rotation. The clutch operating arrangement acts as follows. When the shifting rod is moved to the left frictions *C* and *A* are engaged. This gives a slow forward speed. When the shifting rod is thrown to the right, frictions *B* and *D* become engaged, which gives

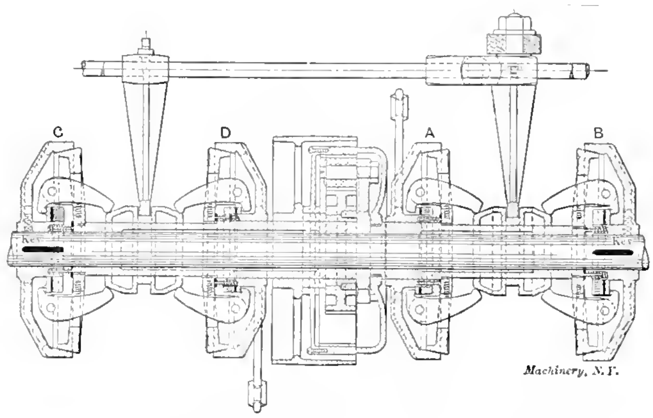


Fig. 2. Section through Smith One-belt Reversible Counter-shaft.

the reverse drive, the three-arm spider being held stationary and the internal gear being keyed to the shaft. A high forward speed is obtained when the shifting rod is first thrown to the left, and then, at the same time gripping a latch lever operating a disengaging mechanism, is again thrown to the right. This causes a connection between the pulley itself and the shaft, thereby driving the shaft with the same speed as the pulley. In this case frictions *B* and *C* are both engaged, the mechanism permitting the engaging of friction *B* without disengaging friction *C*. A neutral position of the shifting rod will stop the counter-shaft regardless of which frictions have been engaged.

COMBINATION FOOT AND POWER PRESS.

The machine shown herewith, made by the Automatic Specialty Company, Cincinnati, Ohio, is constructed with a view of supplying the demand for a small, quick-acting punch press for the manufacture of light sheet metal and brass goods. It has the advantage of being useful in cases where power is not available, as well as in shops where it is. This makes it adapted to the use of tinners, stove and cornice workers, and other manufactories, where foot power is the only motive power in use. As a belt driven fly wheel press, the makers believe that it will compare favorably with any other machine in the market of 50 per cent greater weight, since especial care has been taken to distribute the metal so as to give the greatest strength and power obtainable. The wearing surface and bearings are simply constructed and accurately

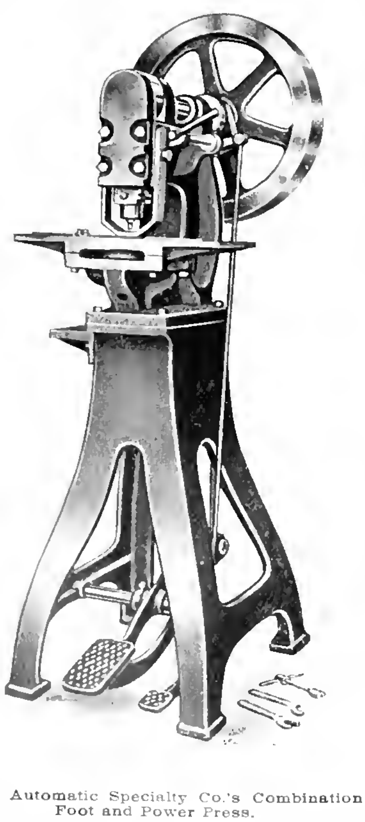


Fig. 1. Automatic Specialty Co.'s Combination Foot and Power Press.

fitted, and are made of suitable materials, and of such proportions as to give durability under the severest service to which a press of this size and character should be subjected. The ram is fitted with an adjustable gib to take up the wear, though this would be reduced to a minimum owing to the large area of bearing surface provided. The automatic clutch may be operated either by the hand lever shown at the right of the spindle, or by the right-hand foot lever. The fly-wheel is bronze bushed, and can readily be replaced at small cost.

When being used as a foot press, the treadle beneath the machine is connected with a crank-pin on the fly-wheel which is revolved by the foot of the operator in this way. For light work, a working stroke can be made at every revolution of the fly-wheel by this method. For heavy work, beyond the range of the usual foot press, the fly-wheel may be speeded up for several revolutions and the automatic clutch thrown in, as when working with power, when the stored momentum will punch a hole well up to the full capacity of the machine.

The machine, as shown, is regularly provided with a front and side gage on the bolster plate for guiding the stock to the punch when duplicate pieces are wanted. A stripper, as shown, is fastened to the sides of the column. The equipment includes a set of three wrenches and a choice of three punches of standard sizes ranging from 1/8 to 3/4 inch. The full capacity of the machine is for holes up to 7/8 inch in diameter through 1/8 inch brass or soft iron. The distance from the center of the slide to the back of the throat is 5 3/4 inches; from the bed to the bottom of the slide when up, 4 1/2 inches. The fly-wheel, which is 19 inches in diameter, weighs 105 pounds and should run from 175 to 200 revolutions per minute. The weight of the machine is 500 pounds.

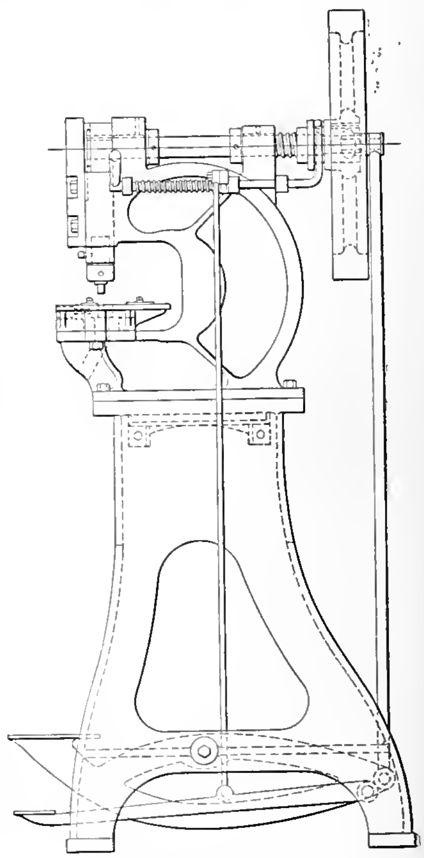


Fig. 2 Design of Combination Foot and Power Press.

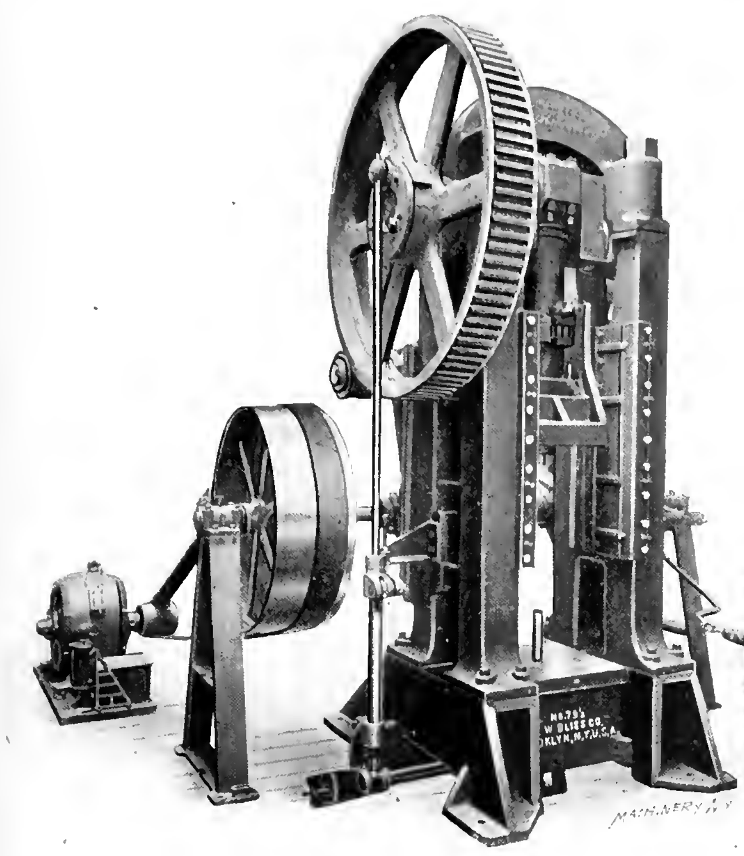
BLISS SINGLE CRANK PRESS OF UNUSUAL SIZE.

This press, built by the E. W. Bliss Co., 5 Adams Street, Brooklyn, N. Y., is stated by its builders to be the largest machine of this type the company has ever built, if not the largest ever built by any one. It can be used for a variety of purposes, such as heavy blanking, trimming and shearing, and it is in addition provided with a long enough stroke (24 inches) to make it especially suitable for the work of drawing cold from heavy sheet steel, such articles as automobile pumps, cream separator bowls and deep drawn seamless shells. It can be applied to such of this work as does not require the blank holder that is essential in the manufacture of parts drawn from thin sheet metal. With the thicker metals for which the press is intended, no blank holder with attendant toggle or cam action is required or provided.

The machine is provided with a base of suitable foundation area for a machine of its size. Double frame columns on each side connect this bed with the arched crown piece on the top, which binds them together and furnishes the bearing

for the crank-shaft. The crown piece is solid with the bearing box, and the caps are so formed that the crank-shaft can be removed or replaced in its working position without disturbing the crown piece.

Four vertical tie rods, each six inches in diameter, pass through the frame columns connecting the bed and the crown piece, and receive all the tensile stress due to the pressure exerted by the machine, thus relieving the frame columns of all working tension. The frame columns themselves are of cored section, of ample dimensions to impart rigidity to the entire structure, and to support the bearings of the back gearing and driving shafts. The bed is provided with a cored opening 12 inches in diameter, and a bored recess 16 inches in diameter, into which a heavy plate may be inserted when the work is such that it is preferable to dispense with the opening in the bed.



Bliss Large Size Single Crank Press.

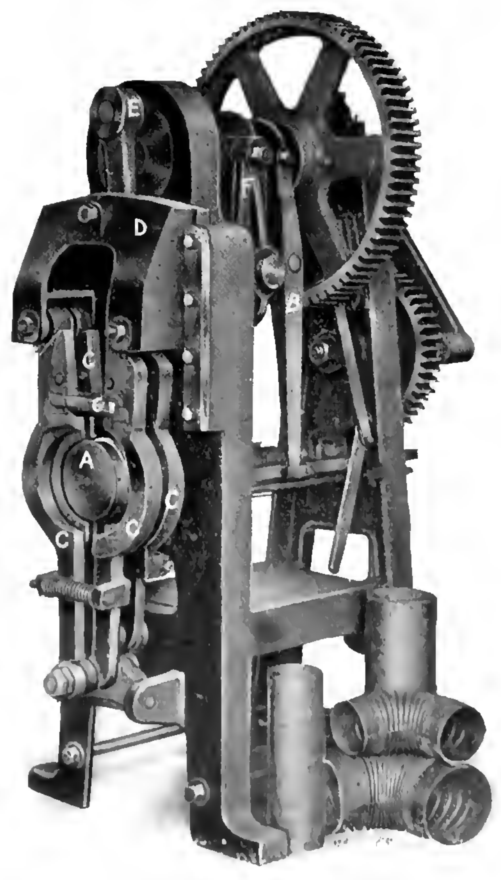
The driving and intermediate gears and pinions are made of steel, the main gear and pinions having specially designed short teeth shrouded, thus attaining unusual strength without any undesirable enlargement of the pitch. The press is started and stopped by a single hand lever, operating an unusually powerful friction clutch and brake. The press can be readily stopped at any position of its stroke up or down. The main shaft is of high carbon open-hearth steel. The Pitman is of cast steel, provided with a 6-inch forged steel adjusting screw, whose adjustment is effected by means of a ratchet, as may be seen in the cut. A powerful knock-out is provided, operated by a crank-pin in the hub of the main driving gear as shown. This may be easily adjusted for various strokes, or may be rendered inoperative when its use is not required. The parts of the knock-out beneath the bed may be readily removed to make way for work which it may be desired to pass through the bed instead of being extracted from above.

The following dimensions will serve to give an idea of the size and capacity of this machine. Stroke of slide, 24 inches; adjustment of slide, 8 inches; depth below floor line, 30 inches; total height above floor line, 16 feet 7 inches. The fly-wheel is 62 inches in diameter, 10½ inches face, and weighs 2,500 pounds. The gearing ratio is 58 to 1. The total weight of the machine is 75,000 pounds.

MACHINE FOR FORMING RIBBED ELBOWS IN STOVE PIPING, ETC.

This tool, built by the Toledo Machine & Tool Co., Toledo, Ohio, is an example of the ingenious special machinery, designed from time to time to perform seemingly complicated operations that occur in large-scale manufacturing. The operation to which this machine has been applied is the manufacturing of ribbed elbows in sheet metal piping. The ribbed elbow was invented to do away with the cost of the operation of cutting out and assembling segments of which the ordinary curved pipe angle was constructed. This further improvement in the method of making it should result in a further cheapening of the cost of this article. As has been stated, and as may be seen from the cut, the machine is highly specialized. The work is done over a "horn," as it is technically called in press work. This is seen at *A*. It is supported from the rear of the machine by a backwardly-extending shank. On this shank slides a work-holding chuck by which the tube to be pressed is grasped by the turning of a small hand-wheel. The tube need only be rolled to the proper diameter. When the machine is started up, a cam on the counter-shaft operates lever *B*, which by a ratchet movement advances the chuck and the work step by step for each rib formed. At the conclusion of the required number of ribs, an automatic stop arrests the movement of the machine.

In forming ribs, the first movement after the work has been fed to a new position on the horn is the closing down over it of the 4-hinged clamping arms *C*. These are closed by an engagement with the cam surface at their upper ends on rollers carried in hood *D*, which locate the material downward by the motion of the crank *E*. The work being thus firmly held to the horn, an expander, seated in a recess in the upper surface of that member is pressed outward,



Toledo Press for forming Ribbed Elbows

and a ridge formed in the upper side of the work. When this has been done, lever *F*, actuated by a cam on the main crank-

shaft, through its connection with strap *G*, draws in toward the frame of the machine the two outer of the four clamping arms *C*, these being hinged at the bottom for this purpose. By this means the rib previously formed is pressed tightly together between the faces of the four arms, the expander having meanwhile withdrawn into its seat again. The continued movement of the crank-shaft opens out the clamping arms, feeds forward the stock another step, continues the previous operations, and forms a new rib. These ribs being formed to full depth on one side of the piping only, a curve is formed in the work. The line of this curvature is regulated by the number of ribs pressed.

It will be seen that the operation of the machine is practically automatic. The work is ejected from the holder at the completion of the required number of ribs, and the parts returned to position for commencing the new operation, the only attention on the part of the operator being the clamping in of new cylinders. The work is formed at the rate of 60 or 75 ribs per minute, making it possible to form approximately 200 elbows per hour. The labor cost of making the elbows is still further reduced from the fact that it is not necessary to rivet or close the seams prior to this operation.

ZEH & HAHNEMANN ARMATURE NOTCHING MACHINE.

Zeh & Hahnemann of Newark, N. J., have recently completed the design of a line of armature disk and segment making machinery, of which we show one example here. This machine, known as the No. 3, is intended primarily for notching disks of moderate size, from 3½ to 30 inches in diameter. As may be seen, it is built along the general lines of the ordinary punch press, but with the bed and work-holding mechanisms specialized for the work it has to do. The bed is in the form of a bracket clamped to the face of the column, and adjustable for height to suit the tools to be used. The thrust of the cut is taken by a screw jack directly in line with the compressive strain. This jack serves also as a means of adjusting the bracket vertically. On two arms projecting forward from the bracket is supported the work-holding and indexing mechanism. The work is clamped between disks by the operation of the cam lever shown at the top of the clamping arm. The lower disk is connected with the vertical spindle whose lower end carries the notched indexing wheel. A slotted disk on the end of the crank-shaft operates through the bell crank and connecting-rods shown, an arm swinging about the axis of the work spindle and carrying a dog by means of which the disk is indexed. A cam on the crank-shaft just alongside the slotted disk, by similar connecting mechanism, operates the lever by which the index wheel is locked and released for each operation. The work is securely locked before the punch enters the material. The automatic stop on the index ring is adjusted to throw out the clutch at the completion of the work. All the reciprocating parts of the feed mechanism are light and are given a motion which starts and stops them gradually, thus insuring smooth action at all speeds. The adjustments for different diameters and different numbers of notches are easily made. If it is desired to hold the work in some other way, the clamping arm may be readily removed. This machine weighs complete about 1,600 pounds.

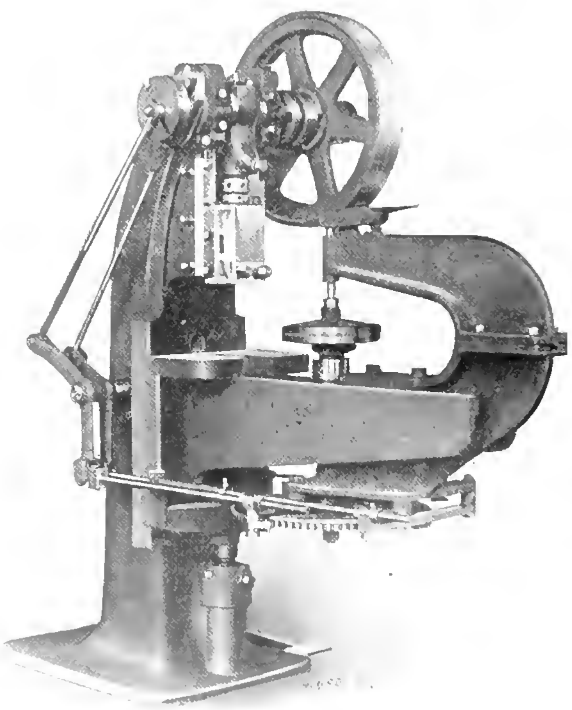


Fig. 1. Zeh & Hahnemann Armature Notching Machine.

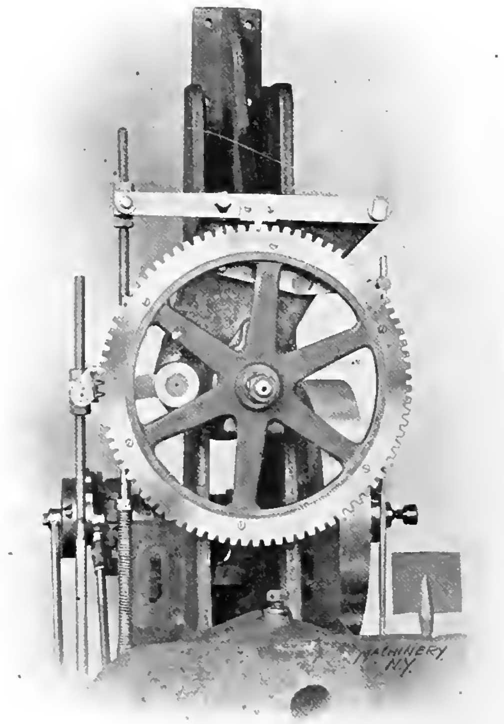


Fig. 2. View of Indexing Mechanism, Zeh & Hahnemann Armature Notching Machine.

FISCHER INSTALLATION OF WOOD TURNING LATHES.

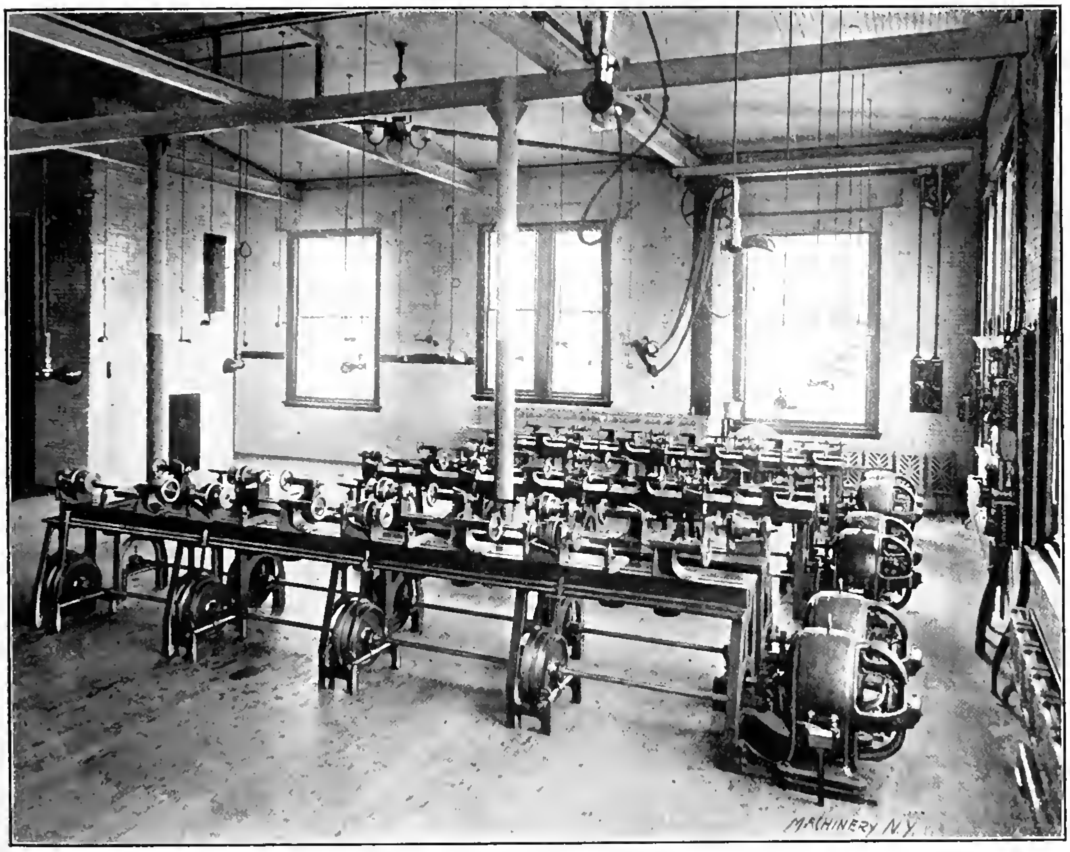
The accompanying half-tone illustrates a rather novel installation of machine tools containing many interesting features. The tools shown are wood turning lathes, but of course the principle involved could be applied in every case of light turning. As seen from the cut, there are four individual head-stocks and tail-stocks mounted on one long bed, the four units all being driven by one motor at the end of the bed. The motor drives the shaft shown under the lathe beds, which may properly be termed the line-shaft. At the left of the operator on each machine there is a lever connected to a clutch which engages a friction drive by means of which the power from the motor is transferred to the three-step cone pulleys shown. This arrangement permits each operator to throw in or out his power independently, and makes his machine a complete unit. Installations of this kind are especially intended for use in trade schools and manual training schools, the arrangement involving a great saving, as it does away with all overhead belting and ordinary counter-shafts. It is evident, however, that the principle involved, as well as the identical arrangement here shown, would be of value even for other installations than trade schools. The half-tone shows an installation made by the Fischer Machine Co., of Philadelphia, Pa., in the new Southern Manual Training School of Philadelphia. The view given in the photograph shows 24 lathes in six batteries of four lathes each. At the same school 24 more lathes working on the same principle have been installed in the floor above. The length of each lathe bed is 17 feet for 12-inch lathes, and 14 feet for 10-inch lathes.

NEWTON COMBINATION COLD SAW CUTTING-OFF MACHINE.

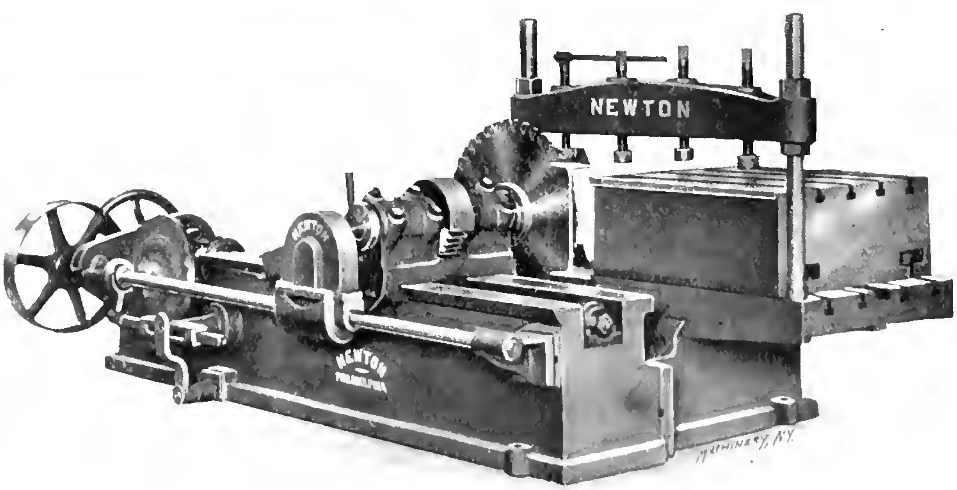
In the cut herewith is shown a cutting-off machine built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., known as its No. 2 Combination Cold Saw Cutting-off machine. This machine is fitted with an inserted tooth saw, and is specially adapted for cutting I-beams on a square or miter cut.

The table of this machine is adjustable for convenience of setting the work, and it is so designed that the top of the table can be easily removed, as indicated in the cut, and the machine can be fitted with a cutter head and used as a rotary planer, this provision being in particular desirable in small bridge building and structural shops. The carriage has a continuous automatic feed with quick return by power. The inserted teeth of the saw are of different widths, and one wide and one narrow tooth is inserted alternately. They are set very close together and are held in place by means of an inverted wedge and a set-screw. The drive of the machine is through spur gearing, driving a hardened steel worm working with a phosphor bronze worm-wheel. In the cut the saw is shown cutting through a 15-inch I-beam, the lineal feed in this case being 1¼ inch per minute. This feed was obtained without any strain on either the work or the blade, and without any "jump" when the saw passed from the heavy to the light cut. This steadiness is due to the rugged construction of the spindle drive and feed mechanism with which the machine is provided.

This cutting-off machine has a capacity for round stock up to 7 inches in diameter and for I-beams placed in a vertical position up to 15 inches high. Any section 7 inches high by 24 inches long may be cut by being placed on the side, so that 24 inch I-beams may be cut by laying them flat on the table. The weight of the machine is about 8,000 pounds.



Fischer Machine Co. Manual Training Lathes.



Newton Combination Cold Saw Cutting-off Machine.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The fifty-fourth annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building at 29 West 39th Street, New York, December 3-6, 1907.

Symposiums on foundry practice, giving the experiences of prominent men in that work, have been arranged. The specific heat of superheated steam will be taken up, an important and exhaustive work which will be presented by a professor of engineering at Cornell. The utilization of low grade fuels in gas producers, combustion control in gas engines, tests of producer gas engines, etc., will be given a session. Other live topics, such as industrial education, power transmission by friction driving, cylinder port velocities, etc., will be discussed. Following are papers to be presented: The Rational Utilization of Low Grade Fuels, by F. E. Junge; A Foundry for Bench Work, by W. J. Keep and Emmett Dwyer; Patterns for Repetition Work, by E. H. Berry; Foundry Blower Practice, by W. B. Snow; Molding Sand, by A. E. Outerbridge; Cylinder Port Velocities, by Jacob H. Wallace; Industrial Education, by W. B. Russell; Power Service in the Fonndry, by A. D. Williams; Foundry Cupola and Iron Mixtures, by W. J. Keep; Specifications for Iron and Coke, and Method of Testing Foundry Output, by R. Moldenke; Control of Internal Combustion in Gas Engines, by C. E. Lucke; A Volumetric Study of Cast Iron, by H. M. Lane; Duty Test on Gas Power Plant, by J. R. Bibbins; Some Limitations of Molding Machiues, by E. H. Mumford.

The usual entertainments will be provided, and the excursions to various points will include certain notable engineering works now open for the first time to semi-public view. Among them will be the great twin tunnels under the Hudson and East Rivers. The three libraries of the Founders Societies are now open evenings until 9 o'clock.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

Though the returns of the principal British imports and exports still show increases as compared with previous years, the ratio of the increases are diminishing, and things generally are coming to a more everyday level. Coincidentally with the general prosperity, conditions are not very encouraging with some of the less prominent branches of the metal working trades, particularly in those sections where these are conducted on what may be called semi-domestic lines. In certain Midland districts a good deal of brass work is produced in small workshops contiguous to the dwellings of the owners, a melting furnace and a few lathes often forming the whole plant. Wonderfully cheap work is turned out of some of these shops in the way of plumbers' and brewers' brass work, such as cocks, valves, unions, etc. Some will confine themselves to goods intended for water service only, others, in a larger business, will give attention to steam work also. Locks and hinges are other goods manufactured on this system, as also a great deal of art metal work. In fact, in the latter class, shops classed as "brass finishers" may prove to be without machinery with the exception of a polishing head or two. Methods employed in the brass trade generally are in a transitional stage, the low fixed costs involved in the home system of production preventing a more general adoption of modern methods. For some time there will probably be a field of machine tools occupying an intermediate position, which will assist both the smaller employers and their workmen to adapt themselves to the changing conditions with as little loss as possible. A method of finishing the conical bore of brass and iron cocks, very generally employed, involves the use of square tapered reamers which are held in a chuck in the lathe, the casting being held in a handle while the cored hole is rough reamed out. A taper fluted reamer is then used for finishing, the teeth being finely pitched to minimize chattering. In some shops square reamers are used both for roughing and finishing, the finishing reamers being "packed" by wood segments, fastened to the reamer by string or wire. These reamers are produced at a very low price by Birmingham makers, who also supply screw threading tools at low rates. When dull, the reamers are usually softened, and filed up by the users, a cutter grinding machine being an almost unheard of luxury; and in fact, it will be rather a problem to supply modern tools for this work, at an attractive price. The taper plugs of the cocks are turned to suit the barrels, and the final process consists of grinding the two together with emery, etc., no attempts being made to secure interchangeability, as more metal may be taken out of one casting than another when turning up, so that the workman keeps each set comprising body plug, washer, and nut, together as he goes on. Of course, there are also large works where work is produced on modern tools, but the small shops have still a fair chance of existence.

Other work produced in quite small shops includes the stamping and piercing of metal work. Women and girls are employed to a considerable extent in several departments of these trades, a remark also applying to bolt and nut making. In the latter branch the work is often subdivided amongst small shops, some making the smaller sizes on hand-bellows-blown forges, and sending them to other small shops to be threaded. The weird-looking tools to be seen in some of these shops, and the quite passable work produced on them, would be a surprise to those accustomed only to modern refinements. One is inclined to wonder if the existence of such establishments is to be commended or deprecated. At any rate they indicate an amount of self-reliance on the part of their owners or founders, which the factory system tends to eliminate, and a certain proportion of these works develops into large factories with more or less well equipped tool-rooms.

Wrought iron and steel fittings, for steam and gas pipes, is a line, the production of which is distributed between large and small works. Tees, elbows, crosses, etc., are cut out from the strip, scarfed, welded, and swedged at a wonderfully quick rate by a smith and a helper. A "shop" will often employ twelve or fourteen men on fittings ranging from 1/8 inch to 2 inches, larger sizes being dealt with at other similar works. In fact, men are known as 1/4-inch, 1/2-inch, or 1-inch "hands," as they confine themselves to one or two sizes only, becoming so expert on these that, when on piece work—the usual system—it does not pay them to change. The forging is often carried out at one shop and the threading at another, the large tube works often subletting contracts for the smaller fittings to the small shops.

Considerable trouble has recently been taken to formulate standard lists and limits for bolt and pipe threads, but the limits have a rather humorous aspect when considered in relation to the threading tackle sometimes used in the "Black Country." We have heard of concerns turning out hundreds of tons of bolts without a lathe even being on the premises. Yet no taps are bought outside the shops. The taps are forged to size in a forging machine, fluted and then threaded with a screw-plate. Similarly, solid dies are used, and when worn are heated, and closed by swedging and then retapped. Machines for the purpose are made very strong and simple, and fool-proof.

Labor Union Topics.

At the time of writing, the shipbuilding and boiler-making workmen have, by accepting the employers' conditions respecting procedure in case of disputes, averted a threatened lockout, but the railway trouble on the question of recognition, by railway directors, of trades union officials as representing the men in matters concerning conditions of labor, is now entering on an acute stage. The directors have flatly refused to acquiesce in the proposition, and a strike on the question appears probable, but in the meantime Mr. Lloyd George, the president of the Board of Trade, is understood to have an eye to the interests of the general public, and will exert all the influence at his command towards the prevention of a rupture. Otherwise an unprecedented disturbance of commercial, industrial, and domestic economy is threatened.

Fraudulent Use of Trade Marks.

Sheffield is taking active steps to prevent fraudulent use of trade marks, etc., long associated with its products. Government assistance is being given as far as possible, and a public prosecution will be instituted in any definite case brought forward. Much injury has been done to Sheffield's trade in edge tools by its trade mark being used on inferior foreign cutlery, such practices not only diverting local trade, but also lowering a well-earned reputation.

Textile Industry.

Considerable discussion has taken place during the last few years, as to the adaptability of the American Northrop type of automatic shuttle feeding loom to British conditions of working, and the classes of goods dealt with. Mr. A. M. Fletcher, of Hyde, recently read a paper before the Association of Textile managers at Manchester, in which he stated that 790 of these looms were now working at the weaving sheds of Ashton Bros., of Hyde. In spite of much opposition, he considered the firm had brought about a revolution in the weaving trade. An advance of 25 per cent in the wages of the weavers had enabled the married men to earn enough money to keep their wives at home in comfort. He claimed that the Northrop loom did not necessitate the use of better cotton than was used before, and that it placed British firms in a position to compete with the American manufacturers for the Chinese trade.

Machinery Trade Topics.

The *Engineering Magazine* is pointing out that American methods of securing South American trade need revision, and this seems to be borne out by the fact that Mirrlees, Watson & Co., Ltd., Glasgow, have secured the order for machinery for a new sugar factory at Porto Rico in competition with the leading continental and American firms. The value of the contract is about $280,000.

In the machine tool trade, the principal current developments appear in the direction of spur gear hobbing machinery, and special tools for the motor car building trade. In the latter case the requirements of the repair shops are being catered for quite as fully as those of the manufacturers.

Not many years ago cut gearing was over here looked on as a luxury, but such is now far from being the case, and the number of concerns specializing in the gear-cutting line is

now so large that the eclat formerly associated with the business tends to diminish, and there is some danger of competition for orders leading to work very little, if any, superior to the best class of cast gears. JAMES VOSE.

Manchester, England, November 1, 1907.

MISCELLANEOUS FOREIGN NOTES.

MESSRS. G. F. SMITH, LTD., Halifax, England, has brought out a new small-sized radial drilling machine. The arm will swing through a complete circle 6 feet in diameter, and the machine is particularly intended for small work, such as met with in automobile manufacturing. The bed is placed on legs and has T-slots on the front and on the sides. The weight of the machine is about 2,200 pounds and occupies a floor space of 6 feet by 2 feet 6 inches.

MESSRS. J. BUTLER & CO., Halifax, England, have placed on the market a boring and turning mill of very small dimensions, primarily intended for motor car works. The machine is designated as a 30-inch boring and turning machine, but will handle work up to 3 feet 6 inches in diameter. The tool carrying slide can also be fitted with a turret head, an improved device being employed for revolving and securely holding the turret. The machine will swing pieces 33 inches deep under the turret, and 29 inches deep when employing boring bars. The vertical feed of the tool bar is 14 inches and that of the turret 24 inches.

RUSSIAN TRADE CONDITIONS.—The German consul at Moscow reports to his government that the imports of machinery to Russia in 1906 were smaller than had been expected, due partly to the unstable political conditions of the country, about which, it seems from his reports, foreign manufacturers have entertained exaggerated opinions, and partly to increased import duties. The refusal of credit to many Russian dealers of responsible standing has caused an uncalled for decrease in the machinery trade. Germany undoubtedly gets the lion's share of the Russian machinery market at the present time, but conditions are favorable for establishing extended trade relations between the United States and Russia, more so since there now are several direct steamship lines between New York and Russian ports on the Baltic.

THE NORTHERN MACHINE TOOL WORKS, Felling-on-Tyne, England, has placed on the market a new horizontal drilling, boring and milling machine, which is one of the largest of this type of machine that has ever been built. The main spindle is 7 inches in diameter, and has both automatic and hand traverse in and out of 5 feet 6 inches. The column will move horizontally along the bed a distance of 12 feet, and the head will traverse up and down the face of the column a distance of 7 feet, so that the machine will operate over an area of 12 feet by 7 feet at one setting. Power motion is provided for moving the spindle in every direction quickly, and a slow feed is also provided for milling in the vertical or horizontal directions. The approximate weight of the machine is 90,000 pounds.

ELECTRICAL INDUSTRIES IN GERMANY.—The electrical industries in Germany are in a satisfactory state, and the great economy of expense and labor obtained by the electric transmission of power has, it is claimed, opened up ever-increasing fields of operation in the mining and iron industry. Last year, an electrically-driven reversible rolling mill was constructed, which enabled the production of energy in the mill where it was installed to be completely centralized, and increased the output of the rolling mills by fully 10 per cent. This success is noteworthy, as reversible rolling mills were heretofore driven exclusively by steam engines. A further interesting accomplishment of the German electrical industry is the construction of a continuous current electromotor for driving a converter blast. This electromotor has a capacity of 2,000 horse-power, and is one of the largest of its kind.

INDUSTRIAL PROGRESS IN INDIA.—There is at the present time an unparalleled industrial activity even in the remotest part of the world. It is reported from Calcutta that iron works and a steel mill will be established in India, and it is intimated that this departure marks the beginning of an industrial era in that country, and that the markets of India will in a near future offer opportunities to machinery builders. Of course, the English manufacturers will have some advantages in this trade over American machinery builders on account of the political tie between India and Great Britain, but it will not be out of the way for our manufacturers and dealers to keep close watch of the industrial development of a country, so rich in natural resources as India. When industrial progress gets a good footing there, the development will be rapid and progressive. The imports for July this year exceeded those of the same month last year by $10,000,000, and the exports by $16,500,000.

BRÖDRENE SUNDT, Christiania, Norway, have placed on the market a new 6-foot vertical boring and turning mill which appears to be an excellent example of modern European machine design. The various details are constructed with a view to surplus of strength so that heavier cuts than those usual can be taken by the machine without fear of failure. The gear box for driving the machine is of friction type with back gears in the ratio of 1 to 7. The vertical and horizontal movements of the heads are independent of each other, and the heads can be swiveled 45 degrees to either side for conical work. The machine can be driven either by countershaft and cone pulley, single pulley or by electric motor, as required. The maximum height of the tool head over the table is 36 inches, the horizontal and vertical movements of the tools being 32 inches. The maximum swing is 73 inches, the table being 57 inches in diameter. A 10 H. P. motor is used for driving, when the boring mill is motor driven.

THE SPREAD OF GERMAN INDUSTRIES.—On account of the increased tariff protection applied by several European nations, a great many large German enterprises have found their foreign trade seriously hampered, and in several instances they have promptly and effectively met the situation by establishing branch factories in the countries where they were most anxious to retain large circles of customers, whose confidence and trade had been slowly gained during years of persistent effort. The tendency to migrate has been most prominently marked by the organization of branch establishments in Austria, and for self-evident reasons it has been most marked among the varied industries of Saxony. Large and successful manufacturing plants, located in the valleys on the north side of the mountain range separating the two empires, have found it a comparatively easy matter to build branch factories on the southern slopes, where climatic conditions are practically the same, and the scale of wages is distinctly lower. Reports from other sections of Germany indicate, however, that the movement is general and widespread, although not so strongly marked as in Saxony.

THE MACHINE TOOL TRADE IN GERMANY.—Recent reports from Germany indicate that there are many persons who believe that the era of prosperity in that country, which has continued uninterruptedly for several years past, is at an end and that business is on the verge of a decline. The more true state of affairs, however, is most probably that the abnormal activity of a few years past is calming down to more normal industrial conditions. The machine shops complain that they do not receive new orders to as great an extent as they have for some time past, but in view of the fact that they could neither cope with the demands on their establishments, nor secure skilled workers, at the time the prosperous conditions were at their height, it was rather to be expected that the amount of new orders would fall off. In general, the iron, steel, and machinery industries are in a satisfactory condition. The export trade is still increasing with considerable acceleration. For the first seven months of the current calendar year there was an increase in exports of machinery amounting to 17 per cent, as compared with the exports of 1906. At the same time the imports of machinery have increased by 11 per cent, plainly indicating that there is no serious reaction as yet. The increase in exports and imports referred to is made on the basis of weight. If value were considered the percentages would be still higher, owing to present increased prices of machinery. In spite of these high prices, however, machine tool builders in Germany complain that the profits earned are not what they ought to be, owing to the cost of raw material and to the increased wages. Though deliveries had to be contracted for

six months ahead and more, the machine tool industry showed no inclination to utilize the state of the market for the extension of the works. In the beginning of 1906 the home orders were shelved in preference to orders from abroad. The industry subsequently continued to work for the home market, which demanded continuous supplies, though the profits in the home market were not what had been expected; but it was argued that the profits abroad, where increased customs rates had rendered exporting more difficult, were just as problematical. Hence, the present apprehensions, which most likely, however, will prove to be of less significance than expected in some quarters.

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THE MAURETANIA.

Rarely are New Yorkers or the New Jersey crowd of commuters, who nightly cross the Hudson to their suburban homes, treated to so striking a sight as that presented by the turbine liner *Mauretania* as she steamed to her pier on the evening of November 22. The *Mauretania* reached Sandy Hook early in the forenoon after having made her first crossing from Daunt's Rock off Queenstown, Ireland, in about 5 days and 5 hours, but a combination of fog and low tide prevented docking until in the evening. As she slowly moved up the river her gigantic hull was silhouetted against the Jersey shore, the four immense smoke-stacks showing faintly above. Seven decks above the load water line were illuminated—some of them brilliantly—by electric lights. The combination of brilliant illumination, dark background and great size made a most impressive spectacle.

Though a sister ship to the *Lusitania* the *Mauretania* is of even greater size and carrying capacity. (See MACHINERY, August, 1906, and October, 1907). She is 5 feet longer, and because of the use of higher grade steel by her builders, Swan, Hunter & Co., Wallesend-on-Tyne, a considerable saving in gross weight was made for the same strength of hull. This saving increases the cargo capacity about 500 tons without increasing the gross tonnage displacement. In most essentials, however, the *Mauretania* and the *Lusitania* are alike. Although she is conceded to be a slightly faster ship than her mate, the *Mauretania* failed to lower the transatlantic record because of severe weather conditions. However, an indication of future possibilities is found in the fact that 624 knots were run in one day of fair weather. This breaks all previous records. Following are some of the principal data: Length, 790 feet; breadth, 88 feet; depth, 60½ feet; boilers, 25; heating surface, 159,000 square feet; grate surface, 4,060 square feet; Parsons turbines, 4; power, 68,000 to 70,000 H.P.; speed, 25 knots.

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LAYING OUT A PROPELLER.

An article on laying out a screw propeller by Mr. J. S. Watts was published in the September issue of MACHINERY, which gave plain, practical instructions for draftsman. Mr. W. J. Goudie, the author of an English work, "The Geometry of the Screw Propeller," attacked the article in a letter published in the October issue of the *Practical Engineer*, London. Mr. Goudie's attack was based on a misconception of meaning of one paragraph of Mr. Watt's article. He quoted as follows "First, on the development of the blade fill in the dimensions at every 12 inches, by scaling the drawing," and then said: "A reference to the end elevation shows that these dimensions refer to the horizontal intercepts between the vertical axis and the leading and following edges of the expanded blade." In reply Mr. Watts says: "There is nothing in my article to lead any one to suppose that. In any case, the horizontal intercepts could not be determined at that stage of the work. If my critic had read my article carefully he would have found I first drew the development of the blade, that is, a view of the blade laid out flat on the paper, and then added these dimensions by scaling the development, afterward finding out what my critic calls the horizontal intercepts from these dimensions. To make it clear to him I will further say that the dimensions of the development of a blade are the lengths from the various points on the leading edge to those on the following edge, measuring *along the blade*. These were the lengths set off on the inclined sections and are not the horizontal intercepts as he wrongly supposes."

It is unnecessary to quote further from Mr. Goudie's letter, inasmuch as the succeeding criticisms were based on the original misconception. Mr. Watts states that the method has yielded satisfactory results on dozens of propellers. The one used as an example in the September issue has been at sea some months, working in an aperture too small to allow for any serious mistake.

* * *

DISCONTINUANCE OF THE TECHNOLEXICON.

We learn with much regret that the Verein deutscher Ingenieure (Society of German Engineers) has discontinued work on the universal technical dictionary for translation purposes, known as the "Technolexicon." This great work was to have been published in English, German and French, and was begun in 1901. In June, 1906, the work had progressed so far that 3,000,000 word cards had been collected, these being the contributions of 2,000 firms and individuals. The work has turned out to be so costly, however, having exceeded all expectations, that if it was completed within the allotted time the cost would exceed the pecuniary resources of the society. All communications for the "Technolexicon" should be addressed, henceforth, to Th. Peters, Verein deutscher Ingenieure, Charlottenstrasse, Berlin (N. W. 7), Germany.

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DUTY ON ADVERTISING MATTER ENTERING AUSTRALIA.

The following information relative to the rate of customs duty applicable in the Commonwealth of Australia to advertising matter received in mails from other countries has been received by the Post Office Department at Washington from the Postal Administration of Australia. All advertising matter is dutiable at 12 cents a pound. Duty at this rate is levied on trade catalogues, price lists, trade circulars, and all similar advertising matter, introduced through the mails, even when forwarded in single copies addressed to individuals, provided that the total weight of such single copies forwarded by any consignor by any one mail to any one State of the Commonwealth is not less than two pounds in weight. It may also be mentioned that duty at 12 cents per pound is levied on the total weight of magazines, etc., containing advertisements to an extent of more than one-fifth of the printed matter contained within the outside covers.

* * *

FREE ENGINEERING LIBRARY TO OPEN EVENINGS.

On and after Wednesday, November 6, 1907, the reference libraries of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the American Institute of Mining Engineers, 29 West 39th Street, New York, will be open evenings until nine o'clock on all week days except public holidays. These libraries, constituting practically one library of engineering, situated near the New York Library, in the new headquarters of the Engineering Societies, are available to members of the above societies, engineers, and the public generally, subject to proper regulations. Strangers are requested to bring letters of introduction from members or to secure cards from the secretaries of the respective societies.

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CASSIER'S GAS POWER NUMBER.

The November issue of *Cassier's Magazine* is a special gas power number containing 212 pages of reading matter on the general subject of gas power. Among the articles is a historical review of the internal combustion engine by H. H. Suplee (the editor) and discussions upon large gas engines by E. T. Adams, W. H. Booth, and F. E. Junge, representing the practice of America, England and Germany respectively. An important article on the utilization of waste furnace gases is contributed by Mr. B. H. Thwaite, the original chief promoter of the use of waste furnace gases for power. The number as a whole is a notable effort to place on record the developed engineering practice of what promises to be the chief motive power. There seems little doubt but that the gas engine will eventually displace the steam engine, because of its superior economy.

AMERICAN MACHINIST CELEBRATES THIRTIETH ANNIVERSARY.

The *American Machinist* celebrated the thirtieth anniversary of its birthday with a special issue, November 7, which eclipsed all its previous birthday issues in point of size, general typographical appearance and editorial work. There are 532 pages, including the cover, of which 433 are advertising. In this we include the description of the publishing plant. On the front cover is a beautiful and striking allegorical group representing Time, Power and Speed with the legend underneath: "With Time came Power and Speed," the whole typifying, of course, general progress and improvement. The special editorial articles include a review of machine tool progress for the past five years which have intervened since the previous birthday issue, advances in factory construction, cutting steels, constructive materials for machinery, pyrometry, electricity in shops, industrial education, industrial betterment, heat treatment of metals, etc. The issue is in itself good evidence of very material mechanical progress in the matters of machine composition, presswork, papermaking and engraving. And it is also fitting to say that there is abundant evidence of progress editorially in selection, arrangement and all that is included in the manifold activities of the editor of a progressive trade journal. The whole trade press should be proud that the advertising patronage and support of its readers make such issues possible, particularly those which are closely concerned in the machine tool business. It is gratifying evidence of the solidity and importance of the art—a basic art, but one which, perhaps, has not been so recognized until comparatively recent years.

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CARROLL D. WRIGHT RECEIVES CROSS OF THE LEGION OF HONOR.

The Cross of the Legion of Honor has been conferred upon Hon. Carroll D. Wright, former United States Commissioner of Labor, in recognition of his distinguished services as a labor statistician, social engineer and improver in general working conditions. The presentation was made by M. Bonzom, acting French Consul-General, at a dinner given in Col. Wright's honor by Mr. Charles Kirchhoff, editor of the *Iron Age*. The event took place on the evening of November 9, at the Engineers' Club, New York, and was attended by the advisory council of the Museum of Safety Devices, and others. The Museum of Safety Devices is a branch of the American Institute of Social Service, Dr. Josiah Strong, president, of which society Col. Wright is a member. It was considered fitting and appropriate that the presentation should be made under the auspices of the society which is laboring to improve the condition of labor and to reduce the terrible roll of accidents resulting from our present industrial system.

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PERSONAL.

Herbert T. Kehew, formerly auditor of the Crucible Steel Co. of America, is now secretary and treasurer of the Pittsburg Automatic Vise & Tool Co. He succeeds to the position temporarily held by Mr. F. D. Blackburn, resigned.

George A. Gallinger has been made manager of the Pittsburg office of the Independent Pneumatic Tool Co. of Chicago, having been promoted from his former position of general salesman.

Albert J. Ott has been appointed general agent in Illinois, Indiana and Wisconsin for the "Lo-swing" lathe manufactured by the Fitchburg Machine Works, Fitchburg, Mass. Mr. Ott was with the Vonnegut Hardware Co., of Indianapolis, Ind., for thirteen years.

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OBITUARY.

Richard D. Hurley, manager of the Pittsburg office of the Independent Pneumatic Tool Co., died in Chicago November 5 and was buried November 7 at his old home in Galesburg, Ill. Mr. Hurley was only thirty-nine years old, and his untimely death will be a shock to a large circle of friends and acquaintances. He was a brother of Mr. John D. Hurley, vice-president and general manager of the Independent Pneumatic Tool Co., Chicago, and Mr. Edward N. Hurley, organizer and former president of the Standard Pneumatic Tool Co.

NEW BOOKS AND PAMPHLETS.

GEOLOGICAL SURVEY OF NEW JERSEY: Annual report of the State Geologist for the year 1906. 192 pages, 6 x 9 inches. It contains an account of the fire-resisting qualities of some New Jersey building stones; the glass sand industry of New Jersey; properties of trap rocks for road construction; notes on the mining industry, etc. Copies may be obtained from Mr. Henry B. Kümmel, State Geologist, Trenton, N. J.

MACHINE SHOP WORK. By Frederick W. Turner. 190 pages, 6¼ x 9¼ inches. Illustrated. Published by the American School of Correspondence, Chicago, Ill. Price, $1.50.

This book on machine shop work treats of tools operated by hand and power driven tools, including the heavy drill press, planing machines, and milling and grinding machines. The matter is prepared in the characteristic manner followed in all the instruction papers of the American Correspondence School, being copiously illustrated and written in simple language. The book will be found of particular interest and value to young mechanics and others who would instruct themselves on the elements of machine shop work.

HOW TO USE WATER POWER. By Herbert Chatley. 87 pages, 4¾ x 7 inches. 23 diagrams and illustrations. Published by the Technical Publishing Co., Ltd., London, and D. Van Nostrand Co., New York. Price, $1.00.

This little book treats of source of power, transmission of power, the hydraulic press, applications of the hydraulic press, water wheels, turbines, pumps, hydraulic engines, tidal power, water supply, sewage disposal and dams. It contains folding plates showing a hydraulic power system, "loss of energy" diagram, guide and vane angles for turbines and section of a reservoir dam.

MODERN STEAM TRAPS. By Gordon Stewart. 104 pages, 4½ x 7 inches. 71 illustrations. Published by the Technical Publishing Co., Ltd., London, and D. Van Nostrand Co., New York. Price, $1.25.

The contents of this book first appeared as a serial in the *Practical Engineer* of London, and it has been reprinted in book form in response to requests. It contains chapters on expansion steam traps, float-operated steam traps, bucket-type steam traps, thermostatic steam traps, differential water pressure steam traps, Bundy steam traps, etc. The book is one that should be of interest to engineers and others connected with steam power plants, and to contracting engineers having to do with the installation of steam power and heating.

MECHANICAL DRAWING. By Irvin Kennison. 142 pages, 6½ x 9¼ inches. Illustrated with numerous examples of drawings, lettering, diagrams, etc. Published by the American School of Correspondence, Chicago, Ill. Price, $1.00.

This work is typical of a large number of published works on mechanical drawing. It is gotten up in the characteristic style of the text-books published by the American Correspondence Schools, and should be a clear, concise and valuable aid to the student who would instruct himself in the elements of mechanical delineation. It describes instruments and materials, gives geometrical definitions, geometrical problems and examples of projections, examples of lettering, instructions for tracing, blueprinting, arrangement of assembled drawings, etc.

PATTERN MAKING. By James Richie. 141 pages, 6 x 9 inches. Illustrated. Published by the American School of Correspondence, Chicago, Ill. Price, $1.00.

Pattern-making is an important part of all mechanical construction, and this work endeavors to give a good elementary knowledge of the tools, methods and general construction of machine patterns. It treats of materials and tools, methods of molding, simple and built-up patterns, and gives numerous illustrations throughout. The style of description is simple and well within the grasp of the average man. The book is one that can be recommended to young machinists and others who desire to acquaint themselves with the general requirements of pattern-making, but have no intention of following the art. By this we mean that they wish to understand the needs of the pattern-maker without actually being one.

HYDRAULICS. By S. Dunkerly. Vol. I. 343 pages, 5¼ x 8½ inches. 269 cuts. Published by Longmans, Green & Co., London and New York. Price, $3.00.

Vol. I of this work treats of hydraulic machinery. The second volume will take up the resistance and propulsion of ships. The notes for the first volume were written at the Royal Naval College at Greenwich. The order of the book, by chapters, is: Flow of a Perfect Liquid; Fluid Friction; Pressure Machines; Reciprocating Pumps; Turbines; Centrifugal Pumps. Details are given of a British hydraulic gun brake. Prof. Osborne Reynolds' four-stage turbine is discussed, and the results of trials given; also full details of Prof. Reynolds' hydraulic brake and four-stage centrifugal pump. A valuable feature of the work is a large number of numerical examples with answers in the appendix.

BALANCING OF ENGINES. By Archibald Sharp. 212 pages, 5¼ x 8¼ inches. Illustrated. Published by Longmans, Green & Co. Price, $1.75.

This work discusses the balancing of steam, gas, and gasoline engines, and is a most acceptable addition to the literature on the subject which is quite meager. The contents, by chapters, are as follows: Primary Phenomena of Motion and Force; Preliminary Theorems in Mechanics; Inertia Forces of Revolving Masses; Masses Reciprocating in the Same Axial Plane—Long Connecting-rods; Revolving and Reciprocating Masses; Inertia Forces of Second and Higher Orders; Transverse Couples Due to Connecting-rods; Engines with Cylinders in Different Longitudinal Planes; Kinetic Energy of Pistons and Connecting-rods; Torque and Crank Shafts; Primary and Secondary Balance; Displacement of Engine Frame Due to Unbalanced Forces and Couples; Engines for Various Purposes; Large Gas Engines

CONSTRUCTION AND WORKING OF PUMPS. By Edward C. R. Marks. 259 pages, 4¾ x 7 inches. 159 illustrations. Published by the Technical Publishing Co., Ltd., London, and D. Van Nostrand Co., New York. Price, $1.50.

This book, which is of the second edition, was first published in 1902. It discusses the elementary principles of pumps, explains their action and shows simple diagrams to illustrate. Various types of pumps are described, including boiler feed, fly-wheel, duplex, Worthington, Mumford & Anthony, Mumford Cameron type, pulsometer compound feed, and a great variety of other types, thus making the work very comprehensive of pumping practice in general, and especially of British practice. Centrifugal and rotary pumps are included, and high-duty pumping engines giving present practice in England and America. The work is one that can be recommended for a concise description of various types and principles involved.

POCKETBOOK OF ELECTRIC LIGHTING AND HEATING. By S. F. Walker. 438 pages, 4 x 6¼ inches. 272 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $3.00.

This book was prepared with a view of presenting in handy form the information required by central station engineers and others in charge of electric power plants. The first chapter is on electrical units, defining the various units used by the electrical engineer and giving tables of resistance of insulating materials, hysteresis tests on iron; laws of electric circuits, etc. The following chapters take up

electric generators, motor generators, alternating current generators, transformers, accessories for generators, etc., accumulators, switchboards, forms of switches, circuit-breakers, fuses, field-regulators, systems of distribution, cables, method of laying cables underground, measuring instruments, lamps, etc. The book contains a great deal of strictly high grade matter in condensed form; its small size makes it convenient to carry in the pocket.

Chemistry of Gas Manufacturing. By Harold M. Royle. 328 pages, 5½ x 8½ inches. Illustrated. Published by Norman W. Henley & Son, 132 Nassau St., New York, and Crosby Rockwood & Son, London. Price, $4.50.

The work is a practical treatise for gas engineers, students, and others interested in gas manufacture. The author has confined himself strictly to certain aspects of the chemistry of gas manufacture, leaving the manufacture of gas aside. The contents by chapters are: Proportion of Standard Solutions; Coal; Furnaces—Testing and Regulation; Products of Carbonization; Analysis of Crude Coal Gas; Analysis of Lime; Ammonia; Analysis of Oxide of Iron; Naphthalene; Analyses of Fire-Bricks and Fire-Clay; Weldon and Spent Oxide; Photometry and Gas Testing; Carbureted Water Gas, etc. A number of valuable appendices are included. The work is one that should have some interest to chemists and engineers outside of gas manufacture, especially those who have to do with the analysis of coal, combustion, economy of boiler furnaces, etc.

Pocketbook of Mechanical Engineering. By Charles M. Sames. 195 pages, 4 x 6½ inches. Illustrated with numerous diagrams. Bound in flexible leather. Published by the author, 542 Bramhall Ave., Jersey City, N. J.

This valuable little pocketbook has passed through two editions, the book in hand being of the third edition. New matter has been added on high-speed steel, superheated steam, reinforced concrete and machine design. The recommendations made for speeds, feeds and cuts in Mr. F. W. Taylor's notable presidential paper presented before the American Society of Mechanical Engineers are given in condensed form; Knoblauch & Jakob's values for specific heat of superheated steam at constant pressure are given; also a table based on other researches giving values for the mean specific heat through the whole range of temperature from saturation up to various pressure temperature conditions ranging from 50 pounds gage to 250 pounds gage. An addition of doubtful value is eight pages of section paper bound in at the back. It is our opinion that most purchasers of the work would prefer to have this space utilized for more engineering matter and to buy their section paper of the stationer. The work as a whole is one that can be heartily recommended to those who desire a condensed handbook of mechanical data.

CATALOGUES AND CIRCULARS.

C. P. Mingst, Evansville, Ind. Circular describing the one- and two-cylinder Mingst marine gasoline engine.

Skinner Chuck Co., New Britain, Conn. 1907 price list of Skinner chucks, containing tables of specifications of lathe chucks, planer chucks, drill chucks, etc.

D. Saunders' Sons, Yonkers, N. Y. Catalogue containing illustrations and descriptions of hand tools and machines for cutting and threading steam and gas pipe.

Brown Hoisting Machinery Co., Cleveland, Ohio. Circular of locomotive cranes for handling ore, coal, limestone, slag, etc. These cranes may be used on any standard gage railway track.

Gould & Eberhardt, Newark, N. J. Catalogues on automatic gear cutting machinery, and Eberhardt's shapers, illustrating and describing the various types of gear and rack cutting machines and attachments, and the "High Duty" shaper with its attachments.

Diamond Saw and Stamping Works, Buffalo, N. Y. Catalogue No. 13, giving specifications for the Sterling hack saw blades, frames, and power hack saw machine. The special features of the power hack saw machine are: driven by milled gears, tight and loose pulleys, automatic shut-off, gravity feed and swivel vise.

Ingersoll Milling Machine Co., Rockford, Ill. Catalogue No. 16 of heavy milling machines, showing milling machines of various types, with one, two, three or four spindles, in sizes from 20 inches wide up to 10 feet wide. These machines are suitable for all kinds of work from very light to very heavy milling.

S. Obermayer Co., Cincinnati, Ohio. Descriptive matter of the "National" iron filler cement for foundry use. This cement filler is a powder that is mixed with water just prior to using. It hardens and expands at the same time, filling blowholes solidly with a metalized compound that can be readily machined.

General Electric Co., Schenectady, N. Y. Bulletin No. 4532, descriptive of direct-current motor-starting rheostats, types SA and SO. Type SA is made for one minute duty with no-voltage release; type SO is similar to type SA, but in addition to the no-voltage release attachment it has an overload coil in series with the motor armature.

Manning, Maxwell & Moore, Inc., 85-87-89 Liberty St., New York. Circular descriptive of the Ashcroft prismatic water gage for locomotives, marine and stationary steam engines. The glass and its casing are so designed that the water shows black and the steam space has a silvery appearance, thus making the water level unmistakable in any light.

Potter & Johnston Machine Co., Pawtucket, R. I. Catalogue of manufacturing automatic chucking and turning machines, and universal shapers. The automatic lathes are made in 5½ x 10-inch and 8½ x 16-inch sizes, and the shapers in 15- and 24-inch sizes. The catalogue gives tooling diagrams and forms for records of tool positions, and other instructions for the operation of the automatic machines.

Westinghouse Machine Co., East Pittsburg, Pa. Catalogue of Westinghouse storage batteries for portable use. The company has been in the storage battery business for several years, but no literature on the portable batteries has been issued until the present publication. Batteries for trucks, car lighting, electric locomotives, railway signaling, etc., are listed.

Electric Controller & Supply Co., Cleveland, Ohio. Booklet entitled "You Can Reduce Operating Costs," which is descriptive of magnetic switch controllers for the operation of electric motors. The booklet illustrates various types of electric controllers, and points out their advantages as compared to manually-operated controllers. Their use undoubtedly has made the electric motor practicable in many services which otherwise would be impossible because of the tremendous electrical overloads temporarily imposed in starting and reversing.

Beaman & Smith Co., Providence, R. I. Catalogue of milling and boring machines built in a great variety of styles to fit individual needs. These include combined vertical and horizontal milling machines, duplex milling machines, four-spindle milling machines, horizontal spindle machines, locomotive port milling machines, boring and tapping machines, cylinder boring machines, engine frame finishing machines, horizontal spindle drilling, boring, tapping and milling machines, pump boring machines, tapping attachments, valve machines, etc.

Fitchburg Machine Works, Fitchburg, Mass. Catalogue of the "Lo-swing" lathe. This lathe is "a single purpose machine for increased output and maximum efficiency." It is built for the one purpose of turning shafts and similar machine parts that require to be trued on centers and reduced to one or several diameters, as the case may require. The catalogue illustrates the construction of the machine and the work that it is adapted to, and is a very interesting example of trade literature. Mechanics unacquainted with the principle of this comparatively new machine will find a study of it well worth while.

Seneca Falls Mfg. Co., Seneca Falls, N. Y. Catalogue illustrating and describing "Star" 9- and 11-inch screw cutting lathes, power and foot driven; "Seneca Falls" screw cutting lathes, built in 12-, 14- and 16-inch sizes; speed lathes; wood-turning lathes; and lathe tools, attachments and accessories. The attachments include an ingenious milling and gear cutting attachment which converts the 9- and 11-inch lathes into fairly efficient gear cutters and milling machines, thus enabling the possessor of a lathe to greatly extend its usefulness.

Sawyer Belting Co., Cleveland, Ohio. "Auto-Calculator" for belts and pulleys, and pocket lumber scale. This handy device is a slide rule made of celluloid and heavy paper board, one side being the slide rule for calculating the revolutions per minute of a driven pulley, having given the diameter of the driver and the revolutions per minute; or for finding the required pulley diameter, having given the revolutions per minute of the driver and driven pulleys, and so on. The opposite side carries the lumber scale, this being a table of sizes of lumber and contents, in board feet. The calculator also gives the belt speed and the horse-power for 4-ply, 6-ply, 8-ply and 10-ply belts for pulley faces 1 to 20 inches.

MANUFACTURERS' NOTES.

Cincinnati Shaper Co., Cincinnati, Ohio, has erected an addition to its factory, 90 x 100 feet.

Arguto Oilless Bearing Co., Wayne Junction, Philadelphia, Pa., has been awarded a gold medal for its exhibit of "Arguto" oilless bearings at the Jamestown Exposition.

Jantz & Leist, Cincinnati, Ohio, manufacturers of motors and dynamos, are now located in their new shop at the corner of York St. and Western Ave.

The Philadelphia Gear Works, Inc., 1120-22 Vine St., Philadelphia, Pa., held a housewarming, reception and dance at its new building, 1120 Vine St., November 22.

Kern Machine Tool Co., Cincinnati, Ohio, has completed a large addition to its shop which doubles the floor space. The product of the company is upright drills.

Niles-Bement-Pond Co., Trinity Building, 111 Broadway, New York, has appointed Mr. A. J. Strong representative of the Pratt & Whitney Co. in Eastern Michigan with headquarters in Detroit.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., has completed a large three-story warehouse which was greatly needed to relieve the congestion in the shops.

Pittsburg Automatic Vise & Tool Co., Pittsburg, Pa., was awarded a gold medal at the Jamestown Exposition for its exhibit of vises.

General Electric Co., Schenectady, N. Y., made public, following a recent annual meeting of its sales managers, an order booked by the manager of the Pacific Coast territory for a Curtis steam turbine unit of 20,000 horse-power.

Ferracute Machine Co., Bridgeton, N. J., manufacturer of presses and dies for sheet metals, lately shipped presses to England, India, Austria-Hungary and France, besides several car-loads to points in the United States.

Independent Pneumatic Tool Co., First National Bank Building, Chicago, Ill., has appointed Mr. George A. Gallinger manager of its Pittsburg office, 1210 Farmers' Bank Building. Mr. Gallinger was the company's traveling man from its Chicago office.

S. Obermayer Co., Cincinnati, Ohio, has published a special edition of the *Obermayer Bulletin* devoted exclusively to the core room of the foundry. It contains a number of valuable articles on core work, and shows certain appliances for producing core work at low labor cost.

Technical Publicity Association, New York, devoted the meeting of October 31 to "The Mailing List," in securing foreign business. A number were elected to membership. Associations modeled on the lines of this body have been started in Chicago and London.

American Locomotive Co., 111 Broadway, New York, had a meeting of its directors November 6, for organization, and re-elected the retiring officers to serve for the ensuing year. Mr. S. T. Gallaway was elected secretary to succeed in that capacity Mr. Leigh Best, who has been secretary of the company since its organization. Mr. Best continues to hold the office of vice-president.

Hisey-Wolf Machine Co., Cincinnati, Ohio, manufacturer of portable electric tools, has moved into new shops on Township St., Cormany Ave. and Canal. The plant consists of three buildings on a lot 145 feet front by 165 feet deep. The main shop is two stories in height, with light on four sides. The offices and power-plant are in separate buildings.

Notice has been received that the International Jury in the section of Social Economy at the International Book Paper and Publicity Exhibition, which closed in Paris last month, made an award of the Grand Prix to the American Museum of Safety Devices and Industrial Hygiene. A diploma of honor, the second highest award, was made to Messrs. Charles Kirchoff and T. C. Martin, respectively, chairman and vice-chairman of the museum's advisory council; also to Dr. L. L. Seaman and Mr. Rudolph Lenz for their active interest in promoting the work of the museum. The museum is now occupying the entire fifth floor at 231-241 West 39th St., New York City, and all inquiries for space, exhibits and other information should be sent to Dr. W. H. Tolman, director of the museum.

Fulton Machine & Vise Co., Lowville, N. Y., which was burned out early last summer, has rebuilt its plant and is now in full working order. The concern is a stock company incorporated with a capital of $50,000. The officers are: A. S. Stoddard, president; C. T. Boshart, vice-president; E. W. Fulton, secretary and treasurer; T. S. Dibble, superintendent. The machine shop is 35 x 110 feet and is built of concrete blocks. The foundry is 35 x 95 feet. The product at the present time is "Star" solid jaw vise and a patent high-pressure valve.

Indianapolis Machine Tool Co., Indianapolis, Ind., builder of the new Libbey turret lathe, expects to be in its new factory and in full operation January 1, 1908. The new shop is located at West 21st St. and the Belt Ry. on a 4½-acre plot. The building is constructed on the unit plan and may be extended at any time in harmony with the existing plan. The main building is 100 x 150 feet. It has galleries on each side 25 feet wide and 10 feet wide across the ends. The main and gallery floors are of concrete. A 48-foot span electric traveling crane, capacity 5 tons, built by the General Pneumatic Tool Co., Montour Falls, N. Y., is provided for handling the work. The turret lathes will be built in large lots.

Niles-Bement-Pond Co., Trinity Building, 111 Broadway, New York. Catalogue of high-duty cold sawing machines built by the High-Duty Saw & Tool Co. These machines are equipped with the "Tindel" inserted tooth saw, which is of the simplest construction. It consists of a saw blade or body and the cutters only, there being no auxiliary parts required to hold the cutters whatever. The cutters are inserted in dovetail radial slots milled alternately on opposite

I.–FORMULAS FOR HORSEPOWER TRANSMITTED BY CAST IRON AND RAWHIDE PINIONS.

The tables of horsepowers transmitted by cast iron cut pinions are calculated by formulas derived from Reuleaux's "Constructor," using the following notation:

- A = coefficient of wear
- b = face or breadth of tooth
- C = circular pitch
- D = diameter of gear wheel, in inches
- H = horsepower transmitted
- N = revolutions per minute
- P = pressure on tooth at pitch circle in pounds
- R = pitch circle radius, in inches
- S = permissible working stress of material of tooth, in pounds per square inch of section
- V = velocity at pitch circle, in feet per minute,

then

$$H = \frac{bCRNS}{1058820} \qquad (1)$$

which is derived as follows:

A relation between the twisting moment PR and the corresponding horsepower is given by,

$$PR = 63025\frac{H}{N} \qquad (2)$$

The formula for strength is,

$$bC = 16.8\frac{P}{S} \qquad (3)$$

Combining (2) with (3) by substituting $\frac{63025H}{RN}$ for P in (3) gives $bC = \frac{1058820H}{RNS}$ which by transposition becomes (1)

The fiber stress S must be made less the higher the speed, and Reuleaux recommends for cast iron:

$$S = \frac{9600000}{V+2164} \qquad (4)$$

which value was substituted in (1) for calculating the tables.

Allowance for wear is not provided in the tables, being left to the discretion of the designer. According to Reuleaux $A = \frac{PN}{b}$ should not exceed 28000

$$A = \frac{126050H}{Db}, \text{ or}$$

b should be greater than, or at least equal to, $4\frac{1}{2}\frac{H}{D}$.

In a pair of cast iron gears the greatest wear comes on the smallest gear. The coefficient A should not be greater than 28000 for the largest gear and may be taken as low as 12000 without obtaining inconvenient dimensions. To avoid excessive wear on the smaller gear, steel or bronze may be substituted.

The table of horsepowers transmitted by shrouded rawhide spur pinions of one inch face is calculated by the same formulas as were used for cast iron pinions, viz:

$$H = \frac{bCRNS}{1058820}$$

in which the notation is the same as before.

The permissible working stress per square inch of material is taken at 2520 pounds up to 2 diametral pitch, and for greater pitches it may be taken at the following values:

D.P.	$1\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$	1
S.	2340	2010	1670	1340

Owing to the elasticity of rawhide pinions, which enables them to sustain shocks without increase of stress, the working stress is made constant for the different pitches at all speeds. Hence the horsepower values in the tables are simple multiples of the first column, throughout.

Contributed by Joseph Holveck.

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II.—HORSEPOWER TRANSMITTED BY CAST IRON PINIONS.

		R. P. M.		100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	950	1050	1150
Pitch		Teeth	Pitch Diam.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.
5 D.P.	0.6283 C.P.	17	3.40	.424	.636	.827	1.01	1.19	1.38	1.54	1.70	1.85	2.00	2.14	2.28	2.45	2.58	2.70	2.83	3.05	3.26	3.51
		18	3.60	.453	.665	.866	1.07	1.26	1.44	1.61	1.80	1.96	2.11	2.27	2.41	2.55	2.68	2.82	2.94	3.18	3.40	3.60
		19	3.80	.478	.702	.915	1.12	1.32	1.51	1.69	1.86	2.03	2.19	2.35	2.50	2.64	2.79	2.92	3.05	3.30	3.53	3.70
		20	4.00	.503	.739	.964	1.18	1.39	1.59	1.78	1.96	2.14	2.31	2.43	2.58	[illegible]	2.88	3.02	3.16	3.42	3.66	3.89
		21	4.20	.528	.775	1.00	1.23	1.44	1.65	1.83	2.02	2.21	2.38	2.55	2.71	2.88	2.97	3.12	3.26	3.53	3.73	3.97
4 D.P.	0.7854 C.P.	17	4.25	.668	.969	1.26	1.62	1.82	2.07	2.31	2.55	2.79	3.01	3.22	3.43	3.57	[illegible]	3.95	4.13	4.46	4.72	5.02
		18	4.50	.701	1.03	1.34	1.70	1.91	2.19	2.45	2.66	2.85	3.13	3.35	3.58	3.78	3.92	4.11	4.30	4.66	5.00	5.18
		19	4.75	.740	1.08	1.40	1.72	2.00	2.26	2.54	2.81	3.06	3.24	3.49	3.90	3.92	4.07	4.27	4.46	4.77	5.12	5.47
		20	5.00	.779	1.13	1.48	1.78	2.09	2.36	2.67	2.90	3.16	3.36	3.60	3.83	4.06	4.21	4.42	4.63	5.02	5.26	5.59
		21	5.25	.808	1.18	1.53	1.86	2.19	2.45	2.76	3.04	3.26	3.54	3.78	3.96	4.13	4.42	4.58	4.72	5.12	5.52	5.71
$3\frac{1}{2}$ D.P.	0.8976 C.P.	17	4.86	.863	1.25	1.64	2.00	2.32	2.64	2.96	3.27	3.51	3.79	4.07	4.25	4.50	4.75	4.98	5.14	5.57	5.98	6.38
		18	5.14	.915	1.33	1.72	2.08	2.45	2.80	3.08	3.40	3.71	3.95	4.23	4.50	4.70	4.95	5.12	5.45	5.73	6.18	6.56
		19	5.43	.955	1.39	1.79	2.20	2.53	2.90	3.26	3.53	3.85	4.10	4.39	4.68	4.88	5.07	5.41	5.57	5.90	6.33	6.75
		20	5.72	1.00	1.46	1.89	2.31	2.67	3.05	3.36	3.65	3.99	4.31	4.65	4.77	5.05	5.34	5.52	5.70	6.21	6.48	6.90
		21	6.00	1.06	1.53	1.98	2.38	2.75	3.15	3.53	3.83	4.12	4.45	4.70	5.01	5.23	5.44	5.63	5.99	6.33	6.62	7.08
3 D.P.	1.0472 C.P.	17	5.66	1.16	1.69	2.18	2.67	3.09	3.47	3.88	4.29	4.62	4.99	5.26	5.60	5.94	6.11	6.38	6.59	7.18	7.82	7.98
		18	6.00	1.23	1.77	2.31	2.78	3.21	3.68	4.05	4.47	4.81	5.19	5.48	5.85	6.11	6.34	6.58	6.98	7.39	7.94	8.20
		19	6.33	1.28	1.87	2.41	2.94	3.38	3.80	4.27	4.65	4.98	5.39	5.69	5.98	6.25	6.69	6.94	7.19	7.59	8.15	8.50
		20	6.66	1.35	1.97	2.52	3.02	3.56	4.00	4.40	4.79	5.16	5.42	5.73	6.30	6.58	6.85	7.10	7.55	8.00	8.38	8.72
		21	7.00	1.42	2.05	2.64	3.17	3.68	4.13	4.57	5.05	5.42	5.77	6.11	6.41	6.71	7.01	7.26	7.71	8.16	[illegible]	9.16
$2\frac{1}{2}$ D.P.	1.2566 C.P.	17	6.80	1.65	2.38	3.08	3.70	4.29	4.90	5.40	5.88	6.31	6.72	7.11	7.47	8.05	8.38	[illegible]	8.98	9.50	10.00	10.67
		18	7.20	1.73	2.52	3.23	3.85	4.44	5.10	5.64	6.11	6.58	7.00	7.53	7.91	8.30	[illegible]	8.95	9.25	9.81	10.30	11.05
		19	7.60	1.83	2.63	3.38	4.06	4.69	5.28	5.94	6.35	6.83	7.29	7.71	8.11	8.52	8.80	9.19	[illegible]	[illegible]	10.88	
		20	8.00	1.93	2.14	3.56	4.27	4.85	5.48	6.03	6.57	7.07	7.67	[illegible]	8.32	8.70	[illegible]	9.42	[illegible]	[illegible]	[illegible]	
		21	8.40	2.00	2.88	3.67	4.41	5.09	5.75	6.33	6.79	7.32	7.81	8.28	8.75	9.14	9.26	9.64	[illegible]	[illegible]		

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Payment will be made for all accepted matter.

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

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III.—HORSEPOWER TRANSMITTED BY CAST IRON PINIONS.

		R. P. M.		100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	950	1050	1150
Pitch		Teeth	Pitch Diam.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.
2 D.P.	1.5708 C.P.	17	8.50	2.53	3.61	4.64	5.58	6.44	7.15	7.89	8.59	9.26	9.88	10.47	10.73	10.94	11.43	11.90	12.64	13.72		
		18	9.00	2.66	3.82	4.80	5.79	6.71	7.57	8.22	8.95	9.51	10.16	10.81	11.36	11.92	12.10	12.60	13.05			
		19	9.50	2.80	4.00	5.07	6.11	6.97	7.84	8.54	9.32	10.04	10.40	11.07	11.67	12.23	12.47	12.96				
		20	10.00	2.95	4.17	5.34	6.32	7.21	8.12	8.84	9.51	10.27	11.01	11.36	11.95	12.56	12.80	13.64				
		21	10.50	3.07	4.38	5.51	6.52	7.42	8.39	9.15	9.98	10.51	11.21	11.58	12.24	12.86	13.43					
$1\frac{3}{4}$ D.P.	1.7952 C.P.	17	9.71	3.28	4.67	5.93	7.02	8.15	9.02	9.98	10.90	11.40	12.23	12.95	13.28	13.95	14.57	15.15				
		18	10.30	3.43	4.90	6.17	7.43	8.47	9.39	10.25	11.17	12.07	12.55	13.33	14.05	14.40	15.03					
		19	10.86	3.48	5.06	6.51	7.73	8.77	9.75	10.82	11.46	12.41	12.90	13.69	14.46	14.80						
		20	11.43	3.78	5.33	6.72	7.99	9.10	10.10	11.05	12.08	12.70	13.59	14.07	14.86							
		21	12.00	3.91	5.60	6.94	8.25	9.40	10.42	11.27	12.36	12.97	14.27	14.40	15.20							
$1\frac{1}{2}$ D.P.	2.0944 C.P.	17	11.33	4.37	6.17	7.39	9.24	10.52	11.69	12.78	13.62	14.68	15.72	16.27	17.20	18.05						
		18	12.00	4.57	6.53	8.08	9.61	10.96	12.21	13.15	14.41	15.14	16.18	16.80	17.76							
		19	12.67	4.82	6.76	8.54	10.14	11.42	12.50	13.87	14.76	15.65	16.66	17.28								
		20	13.33	5.04	7.13	8.84	10.49	11.80	13.16	14.25	15.14	16.36	17.13	18.21								
		21	14.00	5.23	7.35	9.14	10.83	12.21	13.42	14.50	15.45	16.75	17.50									
$1\frac{1}{4}$ D.P.	2.5133 C.P.	17	13.60	6.17	8.57	10.81	12.63	14.23	16.10	17.43	18.51	19.53	20.42									
		18	14.40	6.46	9.23	11.28	13.16	15.07	16.57	17.91	19.07	20.17	21.62									
		19	15.20	6.76	9.36	11.69	13.66	15.42	17.05	18.40	19.65	20.75										
		20	16.00	7.12	9.74	12.30	14.38	15.78	17.41	18.83	20.08	21.86										
		21	16.80	7.32	10.20	12.48	14.66	16.57	18.29	19.30	20.64											
1 D.P.	3.1416 C.P.	17	17.00	9.26	12.90	15.79	18.68	20.96	22.50	24.40	26.10											
		18	18.00	9.80	13.42	16.45	19.02	21.63	23.82	25.20	27.86											
		19	19.00	10.34	13.95	17.08	20.08	22.15	24.46	25.90												
		20	20.00	10.68	14.42	17.68	20.55	22.70	25.13	27.30												
		21	21.00	11.03	14.86	18.32	21.03	23.83	25.73													

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IV.—HORSEPOWER TRANSMITTED BY RAWHIDE PINIONS.

		R. P. M.		100	150	200	250	300	350	400	450
Pitch.		Teeth	Pitch Diam.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.
5 D.P.	0.6283 C.P.	17	3.40	.254	.381	.508	.635	.763	.889	1.02	1.14
		18	3.60	.269	.404	.538	.673	.807	.942	1.07	1.21
		19	3.80	.284	.426	.568	.710	.852	.994	1.13	1.28
		20	4.00	.299	.449	.598	.748	.897	1.04	1.19	1.34
		21	4.20	.314	.471	.628	.785	.942	1.10	1.25	1.41
4 D.P.	0.7854 C.P.	17	4.25	.397	.596	.794	.992	1.19	1.39	1.59	1.79
		18	4.50	.420	.631	.841	1.05	1.26	1.47	1.68	1.89
		19	4.75	.444	.666	.888	1.04	1.33	1.55	1.77	1.99
		20	5.00	.467	.701	.934	1.17	1.40	1.63	1.87	2.10
		21	5.25	.491	.736	.981	1.23	1.47	1.72	1.96	2.21
$3\frac{1}{2}$ D.P.	0.8976 C.P.	17	4.86	.518	.777	1.04	1.29	1.55	1.81	2.07	2.33
		18	5.14	.549	.824	1.10	1.37	1.65	1.92	2.19	2.47
		19	5.43	.580	.870	1.16	1.45	1.74	2.03	2.32	2.61
		20	5.72	.610	.914	1.22	1.52	1.83	2.13	2.44	2.74
		21	6.00	.641	.961	1.28	1.60	1.92	2.24	2.56	2.88
3 D.P.	1.0472 C.P.	17	5.66	.705	1.06	1.41	1.76	2.12	2.47	2.82	3.17
		18	6.00	.748	1.12	1.50	1.87	2.24	2.62	2.99	3.36
		19	6.33	.789	1.18	1.58	1.97	2.37	2.76	3.16	3.55
		20	6.66	.831	1.25	1.66	2.08	2.49	2.91	3.32	3.74
		21	7.00	.872	1.31	1.74	2.18	2.62	3.05	3.49	3.93
$2\frac{1}{2}$ D.P.	1.2566 C.P.	17	6.80	1.02	1.52	2.03	2.54	3.05	3.56	4.06	4.57
		18	7.20	1.08	1.61	2.15	2.69	3.23	3.76	4.30	4.84
		19	7.60	1.14	1.70	2.27	2.84	3.41	3.97	4.54	5.11
		20	8.00	1.20	1.79	2.39	2.99	3.59	4.18	4.78	5.38
		21	8.40	1.26	1.88	2.51	3.14	3.77	4.39	5.02	5.65

		R. P. M.		100	150	200	250	300	350	400	450
Pitch		Teeth	Pitch Diam.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.
2 D.P.	1.5708 C.P.	17	8.50	1.59	2.38	3.17	3.97	4.76	5.56	6.35	7.15
		18	9.00	1.68	2.52	3.36	4.20	5.04	5.88	6.72	7.57
		19	9.50	1.78	2.66	3.55	4.44	5.32	6.21	7.10	7.99
		20	10.00	1.87	2.80	3.74	4.67	5.60	6.54	7.47	8.40
		21	10.50	1.96	2.94	3.92	4.90	5.89	6.87	7.85	8.83
$1\frac{3}{4}$ D.P.	1.7952 C.P.	17	9.71	1.93	2.89	3.85	4.82	5.78	6.74	7.71	8.67
		18	10.3	2.04	3.06	4.08	5.10	6.12	7.14	8.16	9.18
		19	10.86	2.15	3.23	4.30	5.38	6.46	7.53	8.61	9.68
		20	11.43	2.27	3.40	4.54	5.67	6.80	7.94	9.07	10.20
		21	12.00	2.38	3.57	4.76	5.95	7.14	8.33	9.52	10.71
$1\frac{1}{2}$ D.P.	2.0944 C.P.	17	11.33	2.25	3.38	4.51	5.63	6.76	7.89	9.01	10.14
		18	12.00	2.39	3.58	4.77	5.96	7.16	8.35	9.54	10.73
		19	12.67	2.52	3.77	5.03	6.29	7.55	8.81	10.07	11.32
		20	13.33	2.65	3.98	5.30	6.63	7.96	9.28	10.61	11.94
		21	14.00	2.78	4.17	5.56	6.96	8.35	9.74	11.13	12.52
$1\frac{1}{4}$ D.P.	2.5133 C.P.	17	13.60	2.70	4.04	5.39	6.74	8.09	9.43	10.78	12.13
		18	14.40	2.85	4.28	5.71	7.13	8.56	9.98	11.42	12.84
		19	15.20	3.01	4.52	6.02	7.53	9.04	10.54	12.05	13.55
		20	16.00	3.17	4.76	6.34	7.93	9.51	11.10	12.68	14.27
		21	16.80	3.33	4.99	6.66	8.32	9.99	11.65	13.32	14.98
1 D.P.	3.1416 C.P.	17	17.00	3.38	5.07	6.76	8.45	10.14	11.83	13.52	15.21
		18	18.00	3.58	5.37	7.16	8.95	10.73	12.52	14.31	16.10
		19	19.00	3.78	5.66	7.55	9.44	11.33	13.22	15.10	
		20	20.00	3.98	5.96	7.95	9.94	11.93	13.91	15.90	
		21	21.00	4.17	6.26	8.35	10.44	12.53	14.61		

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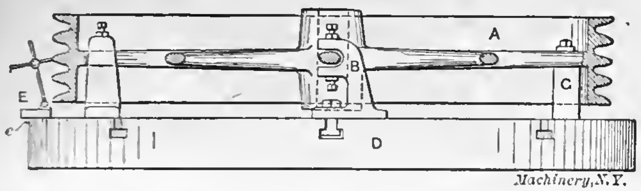
PUNCH PUNCH

SHOP OPERATION SHEET NO. 49.

W. L. McLaren. MACHINERY, January, 1908.



To Set Up a Sheave Pulley Casting for Boring and Turning on a Vertical Boring Mill.

1. Select as many clamp blocks *B* as there are arms to the pulley casting. These clamp blocks should be high enough to raise the casting *A* above the table *D* far enough to allow facing the under side of the rim. Measure the distance from the center of the casting *A* to the inside of the rim, and then fasten the clamp blocks *B* to the mill table, making the distance from the outside of each block to the center of the table about 1/2 inch less than this measurement.

2. Place the pulley casting *A* on the boring mill table *D*, and insert the arms of the pulley into the slots in the clamp blocks *B*. Set the pulley approximately central with the table by shifting the pulley until the distances between the inside of its rim and the clamp blocks are about equal.

3. Set the rim of the pulley parallel with the mill table. This can be done by measuring from the table to various points around the rim, using a surface gage. Adjust the pulley with the lower set-screws in the clamp blocks *B*.

4. Now place the surface gage *E* upon the table in the position shown. Lower the rear pins *c* of the gage, and hold them firmly against the mill table. Set the pointer of the gage about 1/4 inch from the pulley casting, and then move the gage to various points around the table, until the place where the casting is closest to the pointer is found. Set the pointer against the casting at this place, then move the gage to the opposite side of the table and measure the distance between the pointer and the casting. Move the casting toward the pointer a distance equal to one-half this measurement. Again test the casting for height, and if necessary, change lower set-screws in blocks *B* until the rim is again parallel with the table. Tighten the upper set-screws lightly.

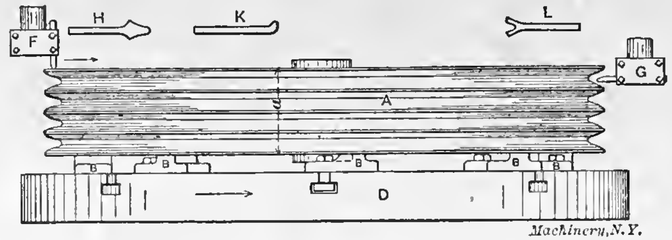
5. Start the machine and hold a piece of chalk against the outside of the rim. If the casting is not central with the table a mark will be made on that part of the rim which is farthest from the center. Adjust the casting if necessary, by hitting it lightly with a soft hammer, until it runs perfectly true.

NOTE.—If clamp blocks *B* cannot be obtained, support the arms by blocks *C*, and adjust the height of the casting by placing thin pieces of iron or brass between the blocks and the arms. Clamp the arms to the table by using bolts and straps. If the blocks *C* are used, it will be necessary to have a block or angle-piece bolted to the boring mill table, and against an arm, to act as a driver.

PUNCH PUNCH

SHOP OPERATION SHEET NO. 50.

W. L. McLaren. MACHINERY, January, 1908.



To Turn and Face a Sheave Pulley Casting on a Vertical Boring Mill.

1. Set the cross-rail of the machine about six inches above the top of the pulley casting *A*.

2. In tool-clamp *F*, place a roughing tool, and take a rough facing cut over the rim, feeding the tool toward the center.

3. In tool-clamp *G*, place a long, round-nosed, right-hand side tool. With hand feed, rough out one side and half the bottom of each channel. Replace this tool with a similar left-hand tool, and rough out the other side and half the bottom of each channel.

4. Reset the roughing tool in clamp *F*, placing it in a horizontal position. Take a down-feed cut over the outside of the casting, the cut being deep enough to clean up the crests on the grooved rim.

5. Replace the tool in clamp *G* with a rough forming tool, similar to *H*. Fasten this tool in a horizontal position, and feed it into one of the grooves until every part of the groove has been trued up. Before withdrawing the tool from the groove, make a depth mark on the face of the tool. This mark should coincide with the trued surfaces of the grooved rim. Machine each groove in the periphery of the rim, feeding the tool into each until the depth mark coincides with the trued surfaces. If a groove does not clean up when the tool has been fed to the depth indicated by the mark, it will be necessary to make the groove deeper, re-mark the tool, and machine all the other grooves to the same depth.

6. Replace the tool in clamp *F* with a bent roughing tool *K*, set horizontal, and face the bottom of the rim, working between the casting *A* and the table.

7. Replace the rough forming tool in clamp *G*, with a finishing tool *H*, which is ground to a gage. Repeat the operation described in step 5, and make all the channels conform to a gage.

8. Replace the tool in clamp *G* with a forming tool *L*. Set the tool in a horizontal position, and, feeding by hand, round off all the crests between the channels.

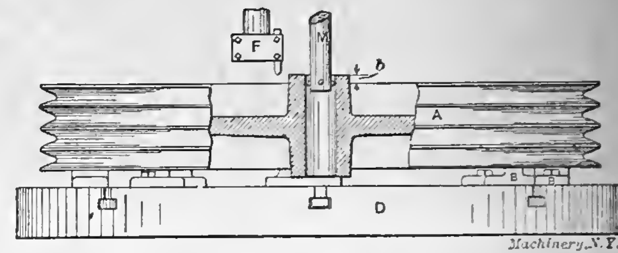
9. Place a broad-nosed finishing tool in clamp *F*, and a bent finishing tool, similar to *K*, in clamp *G*, and finish the top and bottom of the rim to dimension *a*. When taking these cuts a coarse feed should be used, and both the top and bottom of the rim faced simultaneously.

NOTE.—It will not be necessary to stop the machine at every change of tools.

PUNCH PUNCH

SHOP OPERATION SHEET NO. 51.

W. L. McLaren. MACHINERY, January, 1908.



To Bore and Face Hub of a Sheave Pulley Casting on a Vertical Boring Mill.

1. In the tool-clamp *F* place a round-nosed roughing tool, and face the top of the hub within 1/32 inch of the finish dimension *b*. If the hub is to be central with the rim, as is usually the case, the dimension *b* will equal one-half the difference between the distance through the hub and the width of the rim. When facing the hub, the dimension *b* is obtained by placing a straight-edge across the hub and measuring from the straight-edge to the rim.

2. Replace the roughing tool in clamp *F* with a flat finishing tool, and finish the top of the hub to dimension *b*, using a coarse feed.

3. Replace the tool-clamp in opposite head by a boring-bar *M*, provided with a single point cutter, set to fully clean the cored hole. Start the cut, feeding down. Test the hole with inside calipers for diameter at top and bottom. If these diameters are not equal, move the head slightly and take another light cut.

4. Replace the single point cutter with a double end cutter of proper size to bore the exact finish diameter, and take the cut, feeding down.

NOTE.—Boring bars, especially for large boring mills, are often made with an extension which passes down through a bushing in the table. This extension of the bar is a close sliding fit into the bushing, and prevents the bar from springing.

5. Release the casting *A* from the clamp blocks *B*, and turn it over; rest the rim on four to eight parallels, according to the diameter of the casting. Center it roughly by measuring from the edge of table *D*. Clamp to table with three to eight clamps and bolts, according to diameter of casting.

6. Face the hub as described in steps 1 and 2, and to conform to dimension, as at *b*.

NOTE.—If hole in hub is large enough, and the casting is set a sufficient height from the table *D* to permit it, an upwardly bent facing tool may be placed in the boring-bar, which is lowered through the hole for that purpose. The lower side of the hub can then be faced, provided there is room enough in the hole to allow the bar to move far enough in a horizontal direction. The length through the hub may be measured with a "hook scale." When the hub can be faced in this way, considerable time will be saved, as it will not be necessary to turn the casting over and reset it.

MACHINERY.

January, 1908.

DESIGN OF ROTATING DRUMS.

ULRICH PETERS.*

THERE are many materials, such as marls, sand, clay, ore, phosphate rock, gypsum, cement, etc., used for different manufacturing purposes, which require to be either dried, roasted, or calcined, or freed from the water chemically bound. Usually such materials are freed from their moisture at the mine or factory, in order to save the unnecessary expenses of shipping water. Technically, this drying, evaporating, burning up, or roasting is most quickly performed in the so-called rotary dryers or kilns. This dryer, or kiln, consists of a slowly-rotating cylindrical tube or drum, which not seldom has a length of over 100 feet and a diameter up to 8 feet. The axis of rotation of these dryers is not always horizontal, often being more or less inclined. The shell usually rests on rollers, and the inside shell, according to requirements, either is provided with cascade bars (see Fig. 1), which lift and distribute the material over the entire space, or may be brick lined, or left bare.

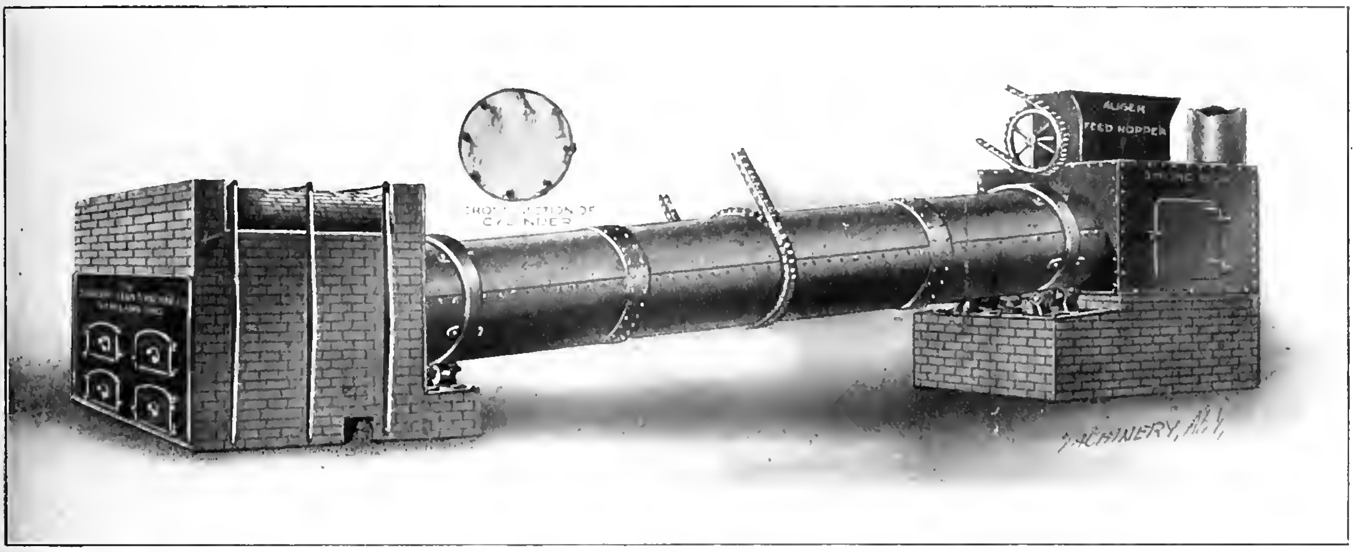


Fig. I. General Appearance of Drying Drum.

Large foundry tumblers are used for the purpose of smoothing and polishing the surfaces of various products, such as castings, tubes, etc., and similar tumbling barrels are also used in laundries. These drums or barrels, when not charging and discharging through the ends, are provided with suitable openings, located on the side of the drum, for the purpose of charging and removing the material. Finally, there are a great many revolving mining screens which have a close technical relation to the above drums, so far as construction is concerned. The object of this article is to discuss the principal points considered in calculating the strength and proportion of rotating cylinders.

In the following:

W = total weight of drum in pounds,

U = total weight of the uniformly distributed material,

L = length of the cylindrical drum, in feet,

C = cantilever arms, in feet,

M = moment; M_b = bending moment; M_t = twisting moment.

R = moment of resistance, usually called section modulus,

I = moment of inertia,

D = outside diameter, d = inside diameter of drum,

S = unit stress in material.

In general, a beam supported at two points, A and B, located at equal distances C from the end, Fig. 2, will have anywhere at the distance x the bending moment,

$$M_x = \frac{W + U}{2}\left(\frac{x^2}{L} - x + C\right) \qquad (1)$$

By moving the supports toward the ends, making $C = 0$, Fig. 3, the equation reduces itself to

$$M_x = \frac{W + U}{2}\left(\frac{x^2}{L} - x\right) \qquad (2)$$

A maximum bending moment is produced when $x = \frac{L}{2}$, therefore

$$M_b = -\frac{W + U}{8} L \qquad (2a)$$

Similarly by concentrating both supports A and B in the middle, $C = \frac{L}{2}$, (Fig. 4):

$$M_x = \frac{W + U}{2}\left(\frac{x^2}{L} - x + \frac{L}{2}\right) \qquad (3)$$

The maximum moment will again occur in the middle, *i. e.*, when $x = \frac{L}{2}$.

$$M_b = \frac{W + U}{8} L \qquad (3a)$$

Both maximum moments, Figs. 3 and 4, are equal, except that the moments are oppositely directed in rotation bout A or B. It is obvious now that there is a certain value for C in which the negative moment in the middle of the beam equals the positive moments at the supports A and B. As the bending moments between A and B change from a negative to a positive value, there will be two points O and O, Fig. 2, where the moments $M_x = 0$. In order to find this value for C, we simply make (Fig. 2) the moment in the middle equal the bending moments at the supports A or B; so that we have the condition:

$$-M_m = M_c \qquad (4)$$

or

$$-\frac{W + U}{2}\left(\frac{L}{4} - \frac{L}{2} + C\right) = \frac{W + U}{2}\left(\frac{C^2}{L} - C + C\right) \qquad (4a)$$

which equation, reduced, gives us the value for

$$C = (\sqrt{\tfrac{1}{2}} - \tfrac{1}{2})\, L = 0.207\, L \qquad (5)$$

The value substituted in equation (4a) gives for the maximum moment

$$-M_m = M_c = \frac{W + U}{47} L \qquad (6)$$

This formula indicates that a continuous beam of the length L, if supported symmetrically at the distance $C =$

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0.207 L from the ends, will possess the greatest carrying capacity. As regards the methods of supporting in the cases in Fig. 3 and Fig. 4, the continuous beam will carry about 6 times more weight. This, naturally, applies also to cylindrical drums supported on rollers.

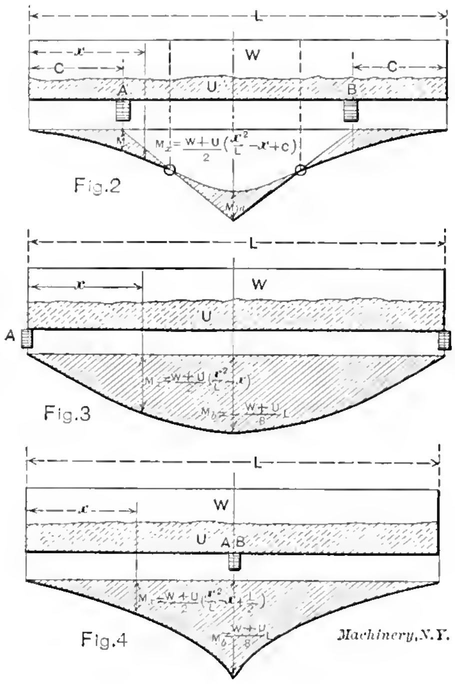
The moment of inertia of a circular ring section is

$$I = \frac{\pi}{64}(D^4 - d^4) \tag{7}$$

and the section modulus

$$R = \frac{\pi}{32}\,\frac{D^4 - d^4}{D} \tag{7a}$$

From formula (7a) by combining with the general equation



Figs. 2, 3 and 4. Bending Moments for Drum supported at Different Places.

(1) for the bending moment, we get for the maximum fiber stresses in bending:

$$S = \frac{16\,D\,(W + U)}{\pi\,(D^4 - d^4)}\left(\frac{x^2}{L} - x + C\right) \tag{8}$$

As these drums are built up of several single shells, it will be a good plan to distribute the joints in such a manner so that no joints come at the places of maximum bending, that is in the middle and at the supporting points. Then, at the joints where bolt and rivet holes weaken the material, the above fiber stress will have to be divided by the efficiency of the joint, which, according to best practice, seldom exceeds 85 per cent. Care should also be taken to provide a sufficient number of rivets, to take care of all occurring shearing stresses, such as we have in common built-up girders. Finally, stiffeners will have to be provided at intervals around the drum to keep it in shape. In barrels, which have to be provided with openings, the decrease in strength may, to a certain extent, be compensated for by reinforcements, such as bars, angles and beams (Fig. 5).

As the drum is rotating, the maximum fiber stress will alternately assume postive and negative values, similar to those we have in connecting-rods. On that account, the maximum fiber stress should be lower than the allowable stress for bridges or girders. Then, too, the drum is not only subjected to stresses by flexure alone; besides the shearing stresses already mentioned, there is also a torsional shearing stress due to the rotating power, which produces a twisting moment M_t in the drum. We may combine the bending and twisting moments to an ideal moment, by means of the Reuleaux formula—

$$M_o = \tfrac{3}{8} M_b + \tfrac{5}{8}\sqrt{M_b^2 + M_t^2} \tag{9}$$

From this the actual maximum fiber stress may be calculated by dividing formula (9) by the ideal section modulus R_o.

$$S_o = \frac{M_o}{R_o} \tag{10}$$

$R_o = R \times$ coefficient of strength of joint.

The torsional moment is easily figured from the frictional resistance of the supporting rollers and the turning moment of the material inside the drum.

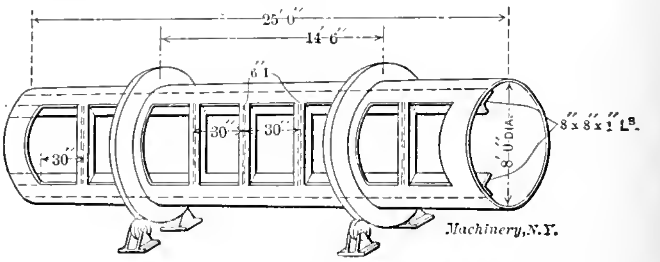


Fig. 5. Schematic View of Drum, showing Openings.

In order to illustrate this more clearly, we may proceed now with a specific example. Fig. 5 shows a drum used in a certain manufacturing operation, which is required, when it is filled, to carry a load $U = 200,000$ pounds of a material resembling sand, weighing, say, about 160 pounds per cubic foot. The natural slope of the materials is $\sim$ 45 degrees when calcined, and the weight is then 90 pounds. On account of the bolt or rivet holes for the supporting rings, we make M_c 10 per cent less than M_m, and derive then C, according to formula (4a) as follows:

$$-\,0.9\left(\frac{L}{4} - \frac{L}{2} + C\right) = \frac{C^2}{L};$$

$$C = \tfrac{1}{2}\,(\sqrt{1.71} - 0.9)\,L = 0.204\,L.$$

As the length $L = 25$ feet, we have $C = 5.1$ feet.

Therefore the most advantageous distance between the supporting rollers is $L - 2C = 25 - 10.2 = 14.8$ feet $\cong$ **14 feet 6 inches.**

This distance would produce the least bending moment if the load is distributed over the entire length of drum. While

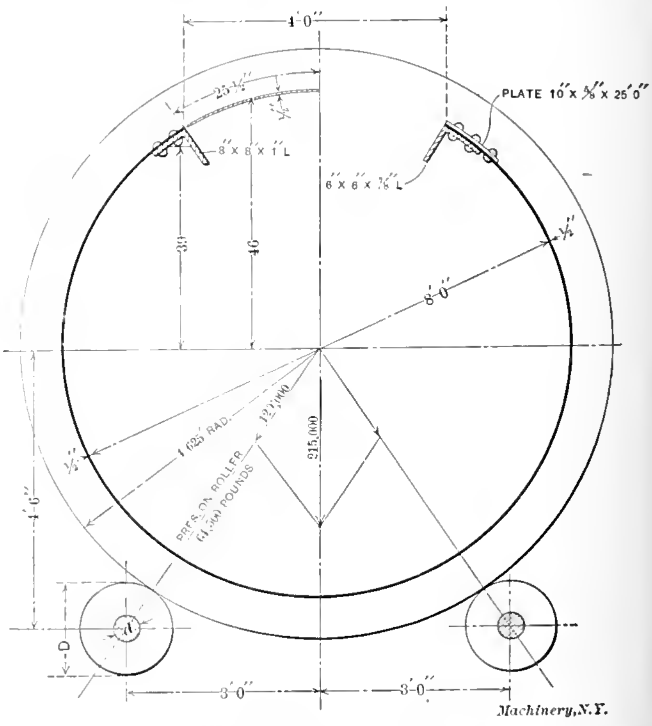


Fig. 6. Section through Drum.

in operation, however, such circumstances may probably occur that the load is mainly distributed between the supporting rollers, in which case it will throw a greater bending stress on the drum. Consequently, in the preliminary and final calculations for the required shell thickness, we will consider as the bending moment:

$$M_m = \frac{U\,(L - 2\,C)}{8} = \frac{200,000 \times 14.5}{8} = 362,500 \text{ foot pounds.}$$

To allow for sufficient stiffness, on account of the large diameter of the drum, the extreme fiber stress should be taken very low, say $S = 2{,}000$ pounds per square inch, giving the value for the moment of resistance

$$R = \frac{M_m}{S} = \frac{362{,}500}{2000} = 181.$$

[The moment of resistance is arrived at in the manner in common use with structural designers, lengths being expressed in feet, but stresses in pounds per square inch. In fact, the value for R then becomes merely a constant.—EDITOR.]

According to this value, we find in the accompanying table the nearest thickness of shell to be 5/16 inch. From the preliminary estimate we can now "guesstimate" that a thickness of ½ inch will be about right, when considering the additional torque, the efficiency of the rivet joints, and the abrasion inside the drum by the material, as well as the

SECTION MODULUS FOR VARIOUS THICKNESSES OF TUBES, DRUMS, STACKS AND STAND-PIPES.

For diameters in inches, length in feet, stresses in pounds per square inch, and moments in foot-pounds.

Inside Diam. in inches.	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	Inside Diam. in feet.	Weight per foot 1 inch Thick.
18	4.02	5.38	6.75	8.11	9.52	10.9	12.4	13.7	1′ 6″	202.9
20	4.96	6.63	8.32	9.99	11.7	13.4	15.3	16.9	1′ 8″	224.5
24	7.13	9.53	11.9	14.3	16.8	19.3	21.7	24.2	2′ 0″	267.0
28	9.69	13.0	16.2	19.5	22.8	26.1	29.5	32.8	2′ 4″	309.8
32	12.6	16.9	21.2	25.4	29.7	34.1	38.4	42.7	2′ 8″	352.5
36	16.0	21.4	26.8	32.1	37.6	43.0	48.5	53.9	3′ 0″	395.2
40	19.7	26.4	33.0	39.6	46.3	53.0	59.8	66.5	3′ 4″	438 0
44	23.9	31.9	39.9	47.9	56.1	64 1	72.2	80.4	3′ 8″	480.8
48	28.3	37.9	47.4	56.9	66.5	76.1	85.8	95.4	4′ 0″	523.5
52	33.4	44 5	56.7	66.8	78.1	89.4	101.0	112.0	4′ 4″	566.2
56	38.6	51.6	64.7	77.5	90.5	104.0	117.0	130.0	4′ 8″	609.0
60	44.6	59.3	74.0	89.0	104 0	119.0	134.0	149.0	5′ 0″	651.7
64	50.4	67.3	84.1	101.0	118.0	135.0	152.0	169.0	5′ 4″	694 4
68	56.8	75.9	94 9	114.0	133.0	152.0	172.0	191.0	5′ 8″	737 2
72	63.8	85.0	107.0	128.0	149.0	171 0	192.0	214.0	6′ 0″	779.8
78	74 8	100.0	125.0	150.0	175.0	200.0	226.0	251.0	6′ 6″	843.9
84	86.8	116.0	145.0	174.0	203.0	232.0	261.0	291.0	7′ 0″	908.0
90	100.0	133.0	166.0	200.0	233.0	267.0	300.0	334.0	7′ 6″	972.1
96	113.0	151.0	189.0	227.0	265.0	303.0	341.0	380.0	8′ 0″	1036 0
102	....	171.0	213.0	256.0	299.0	342.0	385.0	428.0	8′ 6″	1100.0
108	......	191 0	239 0	287.0	335.0	383.0	432.0	480.0	9′ 0″	1164.0
114	....	213.0	267.0	320.0	373.0	427.0	481.0	535.0	9′ 6″	1228.0
120	....	236.0	295.0	354.0	414.0	473.0	533.0	592.0	10′ 0″	1293.0
132	....	286 0	357.0	429.0	501.0	572.0	644.0	716.0	11′ 0″	1421.0
144	....	340.0	425.0	510.0	596.0	681.0	766.0	852.0	12′ 0″	1549.0
156	....	399.0	499.0	599.0	699.0	799.0	899.0	999 0	13′ 0″	1677.0
168	....	462.0	578 0	694.0	810.0	926.0	1043.0	1160.0	14′ 0″	1805.0
180	....	531 0	664.0	797.0	930.0	1064.0	1197.0	1331 0	15′ 0″	1934.0
192	....	604.0	755.0	906 0	1058.0	1209.0	1361.0	1513.0	16′ 0″	2062.0
204	....	682.0	853.0	1024.0	1194.0	1365.0	1536.0	1708.0	17′ 0″	2190.0
216	....	764 0	956.0	1147.0	1339 0	1530.0	1722.0	1914.0	18′ 0″	2318 0
228	....	852 0	1065 0	1278 0	1492.0	1705.0	1919.0	2133.0	19′ 0″	2446 0
240	....	943.0	1180 0	1416.0	1653.0	1889 0	2126.0	2362.0	20′ 0″	2574 0

For moments expressed in inch-pounds, multiply the corresponding value in table by 12.

considerable dead weight of the drum itself. This latter, according to the table amounts to $\frac{1036}{2} = 518$ pounds per running foot, not including the weight of joints and rivets, also necessary stiffening angles around the drum, etc. Assuming these to be 15 per cent of the weight, the total weight of drum amounts to about $W = 518 \times 1.15 \times 25 = 14892 =$ 15,000 pounds approximately.

If it is desired to find the amount of reinforcement which will exactly compensate for the cutting away of the plate for the openings of 4 feet width, it will be sufficiently accurate to make the momentum of plate section equal the momentum of reinforcing angle, so that (Fig. 6)

$$25\tfrac{1}{2} \times \tfrac{1}{2} \times 46 = A \times 39$$

From this follows the required area of reinforcement

$$A = \frac{586.5}{39} = 15 \text{ square inches.}$$

Selecting the commercial size $8 \times 8 \times 1$ inch angle, of 15.25 square inches area, this allows also for the rivet holes. Taking, for instance, a $6 \times 6 \times \frac{3}{4}$-inch angle of 9.71 square inch area, an additional strap $10 \times \frac{5}{8}$ inch thick will be required, as shown to the right in Fig. 6.

We are now ready to figure the maximum torque required to rotate the drum. Referring to Fig. 6, if the sum of the weight of contained material and of the drum equals 215,000 pounds, then the pressure on each of four rollers will be 64,500 pounds. If the coefficient of friction is assumed to be 0.08 (which would be about right for a proportion of d to D as one to four), we have $0.08 \times 64{,}500 = 5{,}160$, and if the radius of the drum at its contact line with the rollers is 4,625 feet, we have for the torque:

$$4 \times 5{,}160 \times 4.625 = 95{,}460 \text{ foot-pounds.}$$

The weight of the shell produces the bending moment

$$-M'_m = \frac{W}{2}\left(C - \frac{L}{4}\right) = \frac{15{,}000}{2}(5.1 - 6.25),$$

$$M'_m = 8625 \text{ foot-pounds.}$$

Obviously, the total maximum bending moment in the drum

$$M_b = M_m + M'_m = 362{,}500 + 8625 = 370{,}825 \text{ foot-pounds.}$$

Then the ideal bending moment, formula (9)

$$M_o = \tfrac{3}{8} \times 370{,}825 + \tfrac{5}{8}\sqrt{370{,}825^2 + 95{,}460^2} = 378{,}500 \text{ foot-pounds.}$$

Taking the strength of the rivet joint about 50 per cent of that of the full plate, it follows, from the table, the actual moment of resistance for a shell thickness of ½ inch:

$$R_o = \frac{303 \times 50}{100} = 151.5,$$

which finally gives us the corrected value for the maximum fiber stress, from bending and twisting,

$$S_o \frac{378{,}500}{151.5} = 2500 \text{ pounds per sq. in.}$$

There are varied opinions regarding the allowable stress as well as regarding the friction coefficients, and it is extremely important that the practical engineer should use good judgment and reliable data. Frequently, the material undergoes considerable changes before and after the process. The loss of strength through the higher temperature will have some influence on the thickness of the shell; and it will be almost impossible to give any more definite general rules to the designer for proportioning the drum and its parts than the outline of the process of calculation presented above.

By the continuous calcining process, Fig. 1, the torque will always remain approximately constant, while, as a rule, the intermittent working dryers, as here presented, will require variable power for turning the drum during an operation period. Not seldom the maximum torque is at a certain stage of the operation, and not at the beginning or end of the process.

[It will be noticed that in the above calculations reference has not been made to the influence on the twisting moment by the distribution of the material in the drum, which influence, of course, increases with speed of rotation, and depends on the number and location of cascade bars and the natural slope assumed by the material. The latter condition, of course, produces an eccentric loading, but for a given slope of material it is a comparatively easy matter to determine the center of gravity of the material, and thus figure the torque with reference to the central axis.—EDITOR.]

* * *

An investigation of man-hole explosions at Aberdeen, Scotland, discloses the fact, says the *Engineering Record*, that coal gas, leaking from street mains, may become odorless by filtering through a moderately thick layer of earth without losing its explosive effect.

FOUR 4000 H. P. GAS ENGINES.*

JAMES COOKE MILLS †

In the rebuilding of San Francisco from the very bed-rock, one might say, advantage has been taken of new discoveries, mechanical devices and inventions to provide the wheels of industry with the best power-producing machinery yet known to man. This spirit of substantial progress is no more evident than in the construction and installation of the most modern power plant in this country, for the California Gas and Electric Corporation, furnishing current for all the railways controlled by the United Railways.

The new electric plant has been in constant service for several months, auxiliary to the system which is fed by hydro-electric plants and two steam plants; and the success of the gas engines is so marked that it is the intention of the public service corporation to install more of the gas engine units until, in all probability, the output will amount to 50,000 H. P.

The plant now comprises four units, each of twin-tandem, double-acting gas engines, operating on crude oil water gas and rating at 4,000 B. H. P., with one-third overload capacity momentarily, or 4,600 B. H. P., on the usual overload rating of 15 per cent, at which rating the engines have frequently run for several days without inconvenience or interruption in the service. They are by far the largest and most powerful gas engines ever constructed, and the illustrations, Figs. 1 and 2, give some idea of the massive steel frames, huge cylinders, and the complicated valve sets and gears. Between the twin engines, and driven by the main shaft, is the Crocker-Wheeler 25-cycle alternating-current generator. One gas engine unit of the same size drives a 60-cycle A. C. generator.

The cylinders are cast in two parts, the joints being circumferential and placed half way between the ends, and coupled up by broad flanges. They are supported on pedestals and rigidly bolted to the tie piece between them carrying the guides for the piston rod, on top and bottom. The front end of the forward cylinder bolts direct to the frame block, and this, in turn, is bolted to the foundation by long bolts extending clear through the frame to the top. This design gives the full height and strength of the frame to insure against vibration. The frame block carries the cross-head with guides on top and bottom, and also the main shaft block for the two main journals, which are 30 inches diameter and 56 inches long. The fly-wheel is 23 feet in diameter and weighs 97,000 pounds for the 25-cycle units, and 135,000 pounds for the 60-cycle units. The main blocks weigh 93 tons each, and the total weight of the engine is 600 tons. The main shaft alone weighs 52 tons, and the cranks, pins, piston-rods and all working parts are of unusual size and strength. With four double-acting cylinders, each 42 inches diameter and of

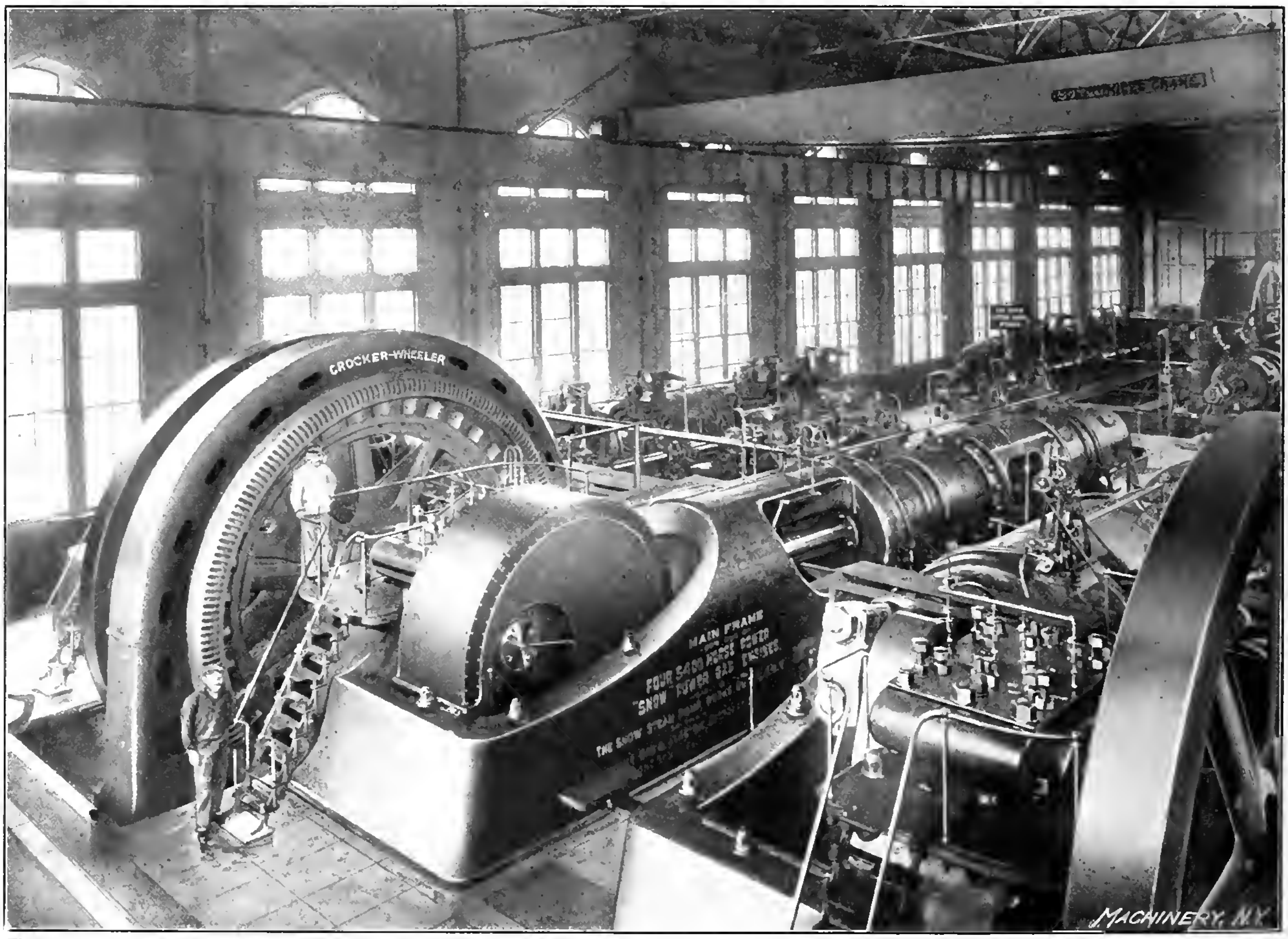


Fig. 1. Gas Engine Installation made by the Snow Steam Pump Works, Buffalo, N. Y., for the California Gas and Electric Corporation, San Francisco, Cal.

60-inch stroke, the engine is compactly built, and the space amounts to 74 by 35 feet—a space comparatively small for a gas engine of this type. The speeds of the engines are 88 and 90 revolutions a minute for the 25- and 60-cycle units respectively.

The tail-rod slides in guides, shown in the illustrations, and relieves the cylinder walls of wear. It adds a third support for the piston-rod, the cross-heads in front of the forward cylinder and between the cylinders in the tie piece providing the other two. The piston-rod is 15 inches diameter, the crank-pin is 19 inches diameter and of the same length. The wrist-pin is slightly smaller, being 17 inches diameter and 18 inches long. These figures give an idea of the massive construction employed throughout.

The valves are all located on the same side of the cylinders, the intake valves being above and the exhaust valves below. They are operated from a common lay-shaft geared to the main shaft. Their action is positive, being operated by vertical rods, rocker-arms, and cams. The inlet valve, mixing chamber, and cut-offs are designed so that gasoline can be injected to the surfaces which require cleaning, and any deposit is removed without touching the parts.

All cylinder working parts—cylinders, pistons, and piston

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: Gas vs. Steam, December, 1901; The Vogt Gas Engine, February, 1904; Formulas and Constants for Gas Engine Design, February, 1906; Gas Engine Economy, May, 1905; A Naval Gas Engine, July, 1906; Alcohol as a Fuel for Gas Engines, August, 1906; Gas Turbine, March, 1907.

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rods are thoroughly water-jacketed, each part being supplied with a separate water pipe, so that the amount of water may be regulated. In this way the cylinder may carry a high temperature, the cylinder jackets a medium temperature, and the rods and metallic packing a low temperature.

Lubrication is effected by means of an individual oil-pump with four leads to each cylinder. The oil is taken in on the inhalation stroke, spread on the compression stroke, and made ready for the working stroke which follows next after in the order of the cycle. Positive feed lubrication for the journals is provided by pipes leading from a multiple feed oiler.

The crude oil water gas supplied to these engines is generated by the Lowe system. It is a notable fact that the engines can be started and synchronized to 88 revolutions a minute, with hydro-electric and steam plants, in from 55 seconds to two minutes from the moment of receiving the signal. This includes turning on the compressed air for the starting, the gas, oil, electric current for the igniters, and coming up to full service speed.

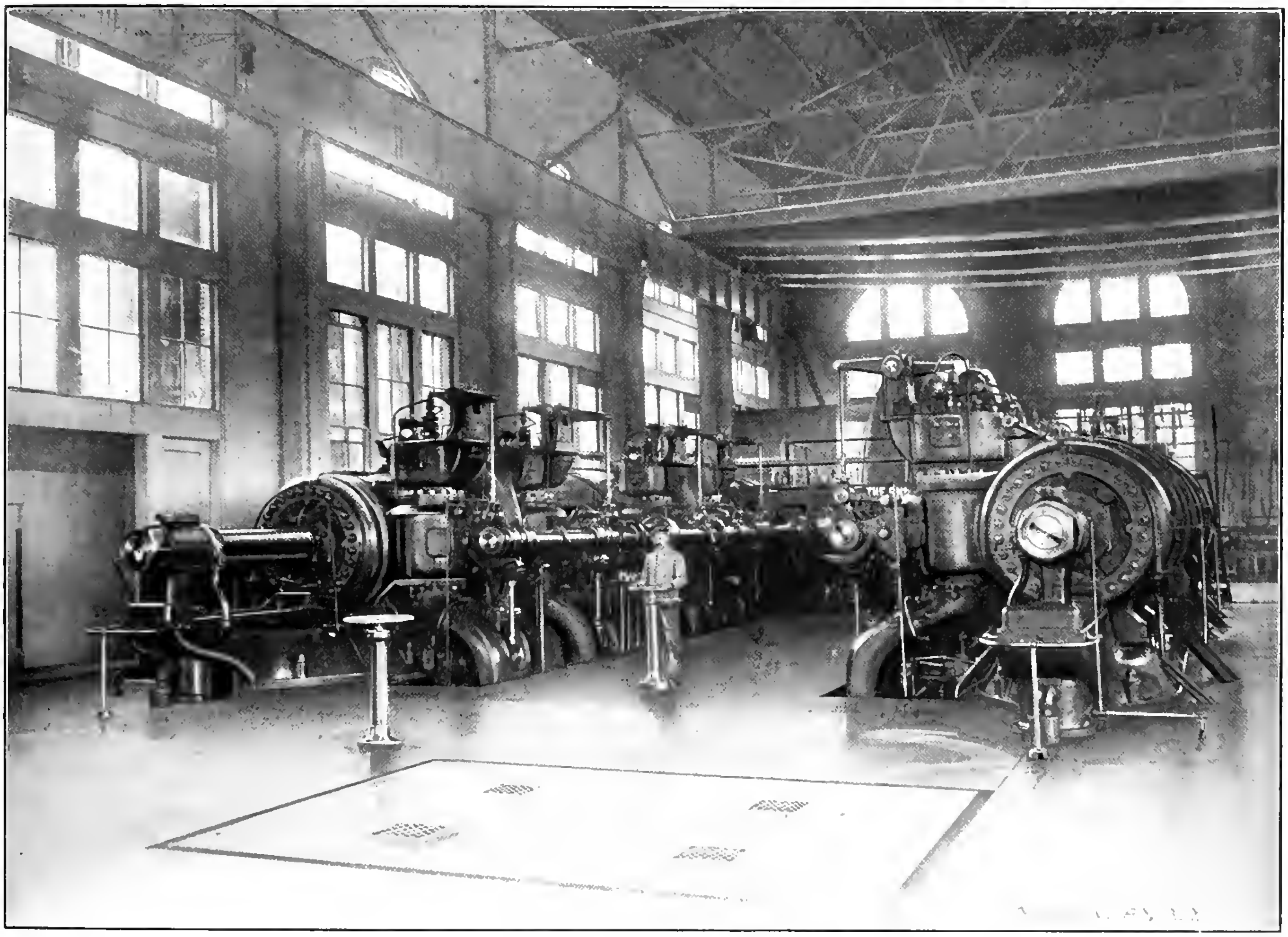


Fig. 2. View of a 4000 B. H. P. Gas Engine Unit from Floor Level. Note Tail-rod Supports and General Massiveness of the Construction.

* * *

VANADIUM AND AUTO CYLINDERS.

One of the most serious features of deterioration in cars is the loss of compression through the wearing of the cylinders. Foreign engine castings always have been superior to any American products in this respect, but few have understood why. Light has been thrown on the subject recently by some experiments made by the American Locomotive Automobile Company. It was found that the inside of the cylinder castings obtained here will take a polish from the piston action quite readily, but that very soon after the inside polish has reached its best, it begins to check and crack away, leaving roughness. To this is due the loss of compression. Some imported Berliet cylinders, tried under the same conditions, took higher polish and held it, the compression showing no loss after long service. The fact that the Berliet castings have a considerable percentage of vanadium is believed to partly explain the difference. *Graphite.*

THE VARIATION OF THE STRENGTH OF GEAR TEETH WITH THE VELOCITY.*

RALPH E. FLANDERS †

The generally accepted formula for calculating the strength of gear teeth is that proposed by Mr. Wilfred Lewis, first published in the Proceedings of the Engineers' Club of Philadelphia, January, 1893.

The merit of this formula lies in the great number of variables taken into account as compared with other rules in more or less common use, and in the fact that these variables are rationally considered. The effect of each of them can be calculated with some assurance, with the single exception of the influence of the velocity on the safe stress. In the fourteen years since the formula was first proposed, the original values for the stress as affected by the velocity have been largely used. Many designers, however, have felt that these values are rather unsatisfactory, although most of them will agree that they err rather on the side of safety than otherwise. By referring to Mr. Lewis' original paper it will be seen that these values were not given as being definitely determined, but merely as agreeing well with successful cases met with in his own practice. It has recently been proposed, by some individuals interested in the matter, to undertake a series of tests for determining this as yet undetermined factor. This article is written with the purpose of calling attention to this matter, with the hope of bringing out suggestions as to the conduct of such tests; the writer also desires to indicate some considerations which he believes should be taken into account in making the experiments.

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: The Pitch and Strength of Gear Teeth, March, 1895; The Strength of Gear Teeth, October, 1895; Proportion of Gear Teeth, September, 1896; Strength of Gear Teeth, September, 1896; Strength of Gear Teeth, February, 1897; Diagrams for Relative Strength of Gear Teeth, July, 1897; Formulas for the Strength of Gear Teeth, October and November, 1898; Gearing 2, Calculations for Strength and Power Transmitted, March, 1902; The Strength of Gear Teeth, engineering edition, October, 1906; Strength of Gears, engineering edition, December 1906. See also MACHINERY'S data sheets, July, 1903; October 1903; February, 1905; October, 1906; December, 1906.

† Associate Editor of MACHINERY.

Variation in Strength is Due to Impact.

A variation in the strength of the teeth of a gear, due to a variation in the velocity, can be due, of course, to but one thing—impact. To illustrate this idea, and to show the cause of the impact, we will study the action of gearing under three different conditions. First, when made of an imaginary material which does not deflect under any strain below the breaking point. Second, with gears of commercial material, such as steel, with teeth of perfect form. Third, gears of commercial material with teeth of commercial accuracy.

1. *Gears of an imaginary undeflectable material.*—In Fig. 1 is a diagram in which the horizontal distances give velocity in feet per minute, and vertical distances give stresses in pounds per square inch, starting in this case at 4,000, which is assumed to be the maximum fiber stress in the gear we are considering, due to the load at the pitch line, which is supposed to be constant at all speeds. If the teeth of this gear are perfectly formed and well fitted together, so that there is no back lash, if the power is delivered to them

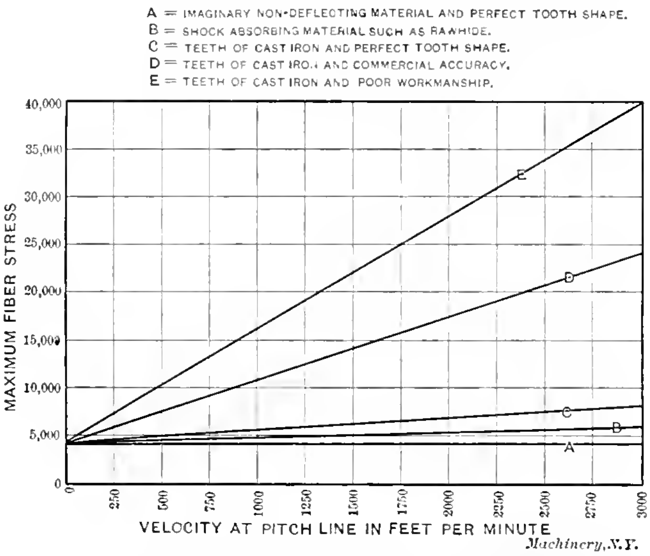


Fig. 1. Hypothetical Diagram showing the Relation of the Velocity to the Fiber Stress.

steadily and smoothly, and the mechanism they drive runs without shock, any disturbance of the even movement will be impossible, and impact will be entirely absent. In the diagram in Fig. 1, then, there will be no rise of maximum fiber stresses with the velocity, so that the horizontal line *A* will show the conditions for this imaginary case.

2. *With commercial material and theoretically accurate workmanship.* The conditions in this case are shown in Fig. 2, with all the phenomena greatly exaggerated. The full lines show the conditions under load, while the dotted outlines show the conditions when the load is removed from the driven gear. The teeth A_1, B_1 and A_2, B_2, carrying the load, are deflected by it, as shown. Tooth *B*, just about to come into contact with tooth *A*, is on that account shifted from its normal position; it should be located as shown by the dotted lines. If it were in this position, it would come in contact with tooth *A* under mathematically perfect conditions, and there would be no shock of engagement. As it is, the two come suddenly into action as shown at *E*, under different conditions than those contemplated by the design, thus the contact takes place in the form of a slight blow, after which the teeth are deflected more and more, until they have taken up their share of the load, as shown later at A_1 and B_1. If the gears are moving very slowly, the deflection takes place very slowly, and the problem is practically a static one. If the gears are running at a high velocity, the problem becomes essentially a dynamic one, and the stresses induced are greater than with the slow speed.

The increase in stress with the increase in speed for this second case could probably be represented by a line something like *C*, of Fig. 1. The location of this line is purely hypothetical. All we can say about it is that the increase in stress as the speed is increased would be comparatively small, and probably regular. The line has been drawn straight for convenience; we do not know what the real shape is.

3. *With commercial materials and commercial accuracy.* This is, of course, the practical case to consider. A line to show the relation of the velocity to the maximum fiber stress for a given gear, would very probably look something like *D* in Fig. 1. This is, in fact, approximately the line which embodies the conclusions of the Lewis tables for a static stress of 4,000 pounds. It is considerably higher than line *C*, because impact due to irregular tooth outlines is added to the impact due to the deflection. In all probability the latter is comparatively unimportant as compared to that due to irregularity of outline in gears of only ordinary workmanship.

Deflection Due to Impact is Slight, but Stresses are Great.

It may be objected that the deflections produced either by the gears coming into mesh out of step, as in case No. 2, or with the added aggravation of poor workmanship, as in case No. 3, are so minute that they could scarcely be considered as a serious factor in the problem. It is true that these deflections are minute—undetectable even, by ordinary means; but this admission does not destroy the argument for laying to this distortion the increase of the stress with the speed. If great loads produce slight deflections, slight deflections likewise produce great stresses, so that the slight bending brought about by the teeth coming into contact at *E* in Fig. 2, under slightly imperfect conditions, may produce great effects proportionately in the fiber stress, and the effects are magnified by the irregularities due to poor workmanship. When we stop to figure out what a load per inch of face is required to deflect a 2-inch circular pitch gear, say 0.003 inch, it is evident that an irregularity in outline of this amount would scarcely be negligible at high speeds, if our hypothesis is correct.

The phenomena of impact are complicated to a high degree. The maximum stresses produced depend on the rapidity of transmission of a wave of stress or deflection, produced in the material by the impact. If this wave is propagated slowly, the stresses are nigh; if rapidly, the stresses are low. The factors entering into the problem are the elasticity of the material, and the mass and shape of the part affected. In very simple cases the problem has been investigated mathematically, but our problem with the gear teeth is so complicated that we must of necessity at once apply to the engineer's court of last resort—experiment.

Practical Considerations Affecting the Conduct of the Proposed Tests.

It is now evident that other variables besides the strength of the material and the velocity at the pitch line enter into the fixing of the line on the diagram of Fig. 1. In addition, the following points will have to be considered.

1. *Accuracy of tooth outlines.* From what has just been said, it is evident that the variation of the stress with the velocity will be affected by the accuracy of the workmanship involved in forming the tooth of the gear. Investigating the conditions in the case of a second pair of gears, similar to those from which line *D* was determined, but of a considerably poorer grade of workmanship, we should expect to find results giving a line something like *E* on the same diagram, giving much higher values for the stresses resulting from the load. It is evident, then, in considering lines *C*, *D* and *E* that workmanship is a variable which should be considered in the experiments, and that a series of tests should be run with two sets of gears of varying workmanship, one of high and the other of only ordinary grade, to make sure that this consideration is really of importance.

2. *Design of wheel and mechanism.*—Another factor which may affect the increase of the stress with the speed is the design of the rim and spokes of the wheel. It is conceivable that a gear with a very heavy rim and rigid spokes will absorb the shocks due to high velocity less easily than a gear with a light rim and flexible spokes or arms. The whole structure of the machine in which the gearing is carried, so far as its rigidity and massiveness is concerned, should, in fact, affect this matter. The further away from the point of tooth contact the members of the structure are, however, the less effect will they have, so perhaps even the influence of the arms and rim can be neglected. The same consideration affects the design of the mechanism to be used in the tests. It is conceivable that a mechanism involving long shafts and other flexible members

might give, for a given set of gears, a line lower down on the diagram of Fig. 1 than would be the case if the construction were very heavy and rigid. The supporting mechanism must not in any case, of course, deflect in such a way as to prevent the teeth from having a full bearing on each other.

3. *The nature of the materials used.* Referring to what has previously been said as to the factors governing impact, it will be seen that the nature of the material used would affect the shape of the curve. It is probable, for instance, that two sets of gears, one made of cast iron and the other of a bronze alloy of the same tensile strength, would show lines of very different shape, owing to the difference in the modulus of elasticity and the specific weight of these two substances. From this it will be seen that we cannot be sure that the results found to be applicable to cast iron or steel could also be applicable to either a pair of bronze gears or to the case of a bronze gear meshing with a mate of steel or iron. That the nature of the material would have a vital effect on the shape of the curve is still more probable, when we consider the practice followed in the use of such substances as rawhide. This material is particularly fitted to sustain impact and absorb without undue stress the deflection caused by it. Owing to this characteristic, we might expect that the line for a gear of this substance would be practically horizontal, as shown at *B* in the diagram, approaching *A*, though governed by entirely different conditions from those producing *A*. So far as can be learned, this supposition agrees with the practice of the manufacturers of rawhide gears.

It may be found that the points mentioned have so much influence on the question at issue that it would be very difficult to lay down a law governing the variation of stress with velocity, and that the most that can be done is to determine the variation in cases of commercial workmanship and rigid design, using the relation thus established in an empirical formula, with the knowledge that poorer conditions may bring the fiber stresses much higher, while good workmanship and careful design may, on the other hand, bring them much lower. Qu· e possibly the factors now in use may be found to nearly fill commercial requirements, in which case we must conclude that the criticisms of their being too high have been founded on experience with cases combining the favorable conditions just mentioned.

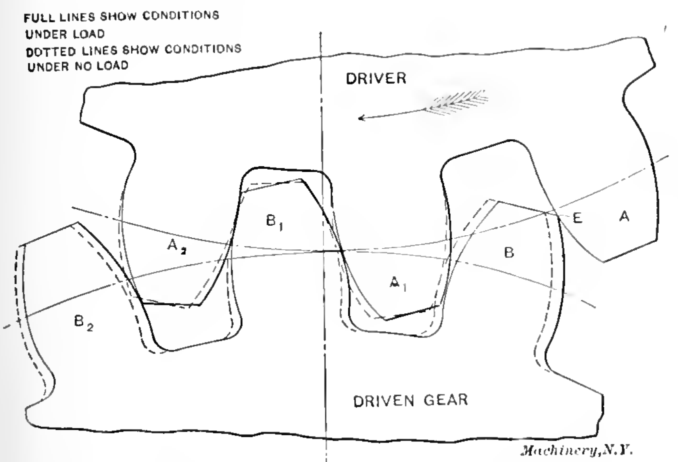


Fig. 2. The Action of Gear Teeth under Load, Greatly Exaggerated.

Practical Considerations Affecting Design.

The fact that the variation of the strength with the velocity is due to impact, suggests also a number of points relating to design. Most of these are already well known, and are standard practice, the conclusions being so obvious that simple common sense has suggested them without theoretical analysis being necessary.

1. *Value of accuracy.* It is evident that this theory of impact puts a premium on accuracy in workmanship for gears that are to run at high speed under a heavy load. It is probable that the strength of a given pair of gears may be cut in two if the tooth outlines are not carefully determined, and if the cutter is not set centrally. This suggests the desirability of a greater sub-division of the standard cutter series for work of this kind. Of course, the gears can always be made heavy enough for the required service, but the extra cost of accurate cutters and careful cutting will be repaid in cases where light weight and compact design are at a premium. In such cases the use of cutters specially designed for each gear is recommended.

2. *Resilience of design and materials.* In high-speed gearing it is evident that the shock due to the impact should be absorbed as quickly and as fully as possible. This suggests the use at abnormally high speeds of rawhide, wood, etc., for one of the members of the pair of gears. The introduction of spring couplings or similar devices may also be desirable, especially where the other parts of the mechanism are liable to transmit shock to the gearing.

3. *Easing off the points of the tooth.* As was suggested to the writer a short time ago by Mr. Fellows, of the Fellows Gear Shaper Co., this matter of impact affects gear tooth design in another way. There has always been a sort of superstition that the points of the tooth should be eased off to make the action smoother. This is done, of course, in standard involute gears, though for another reason, that of avoiding interference with the flanks of the pinions. It can now be seen that there is a solid basis for this practice in all cases where gears are to run at such speeds that severe impact is liable to take place. Referring to Fig. 2, teeth *A* and *B* are taking up the load very suddenly, owing to the fact that they are out of step, due to the deflection of the other teeth momentarily carrying the load. Easing away the points of *A* and *B* would mitigate this sudden reception of the load, allowing the inevitable deflection to take place more slowly, with a consequent gain in the strength of the gear at high speeds. It would have a similar effect in minimizing impact due to inaccuracy of outline.

This modification of the outline of the tooth should be very slight, and extend but a short distance, so that, when the load is entirely transferred, the "doctored" portion of the curve will be passed, and the true involute or cycloidal portion begun.

* * *

The question of aerial navigation is coming so much to the front that, while it is as yet only in its first experimental stage, any engineering review would be incomplete without a reference to what has been done in this territory of human achievement. Various European governments have already experimented with steerable airships for military purposes, and our own government has made an appropriation for the same purpose. A German steerable airship, according to a recent statement in the *Berliner Tageblatt*, was constructed in perfect secrecy, and has performed, with satisfactory results, a first four-hour trial run. The airship navigated at a height of about one mile with a speed of from 28 to 31 miles an hour, and showed a remarkable stability. The platform under the supporting balloon, which latter is of the spindle shape, affords accommodation for six persons and can be armed by automatic guns. Remarkable feats have also been accomplished by ordinary balloons. The results obtained from the international contest at St. Louis are well-known, but even more interesting feats have been accomplished on the other side of the ocean. The *Daily Graphic* of London financed a balloon expedition which recently left London with the hope of securing the world's record for long distance balloon traveling, which consists of a travel of 1,193 miles, from Paris to Russia. The *Daily Graphic* balloon did not accomplish this object, but its passage over the sea is of interest as being the longest over-sea balloon voyage undertaken. The balloon crossed the North Sea, then moved across Northern Denmark and over the Cattegat, until the descent was finally made in Sweden after a distance of about 1,000 miles entirely over the sea had been covered. The balloon, it is stated, was the largest that has ever been manufactured, having a capacity of 108,000 cubic feet. The car was so constructed that if it dropped into the sea, it would be capable of keeping afloat.

* * *

'Tis a shifting belt that has no crowned pulley.

A belt-shifter that sticks, and the man who does not as he is told shall be "cussed."

DECEMBER MEETING OF THE A. S. M. E.

The New York meeting of the American Society of Mechanical Engineers, held in December of each year, was a notable event this year, inasmuch as it was the first general meeting of the society held in the new Engineering Societies Building. This magnificent structure was dedicated last April 16 and 17 (see the May, 1907, issue), but the spring meeting of the A. S. M. E. always being held outside of New York City had prevented many of the members seeing the new building until the regular December meeting. That its spacious assembly rooms, splendid auditorium, fine library and many other carefully planned features were generally appreciated, there can be no doubt. Many were the expressions of pleasure in regard to the new society house and the manner in which the meetings were carried on.

Following is a list of papers presented and their authors:

The Mechanical Engineers and the Function of the Engineering Society (presidential address)..Prof. F. R. Hutton
The Rational Utilization of Low-Grade Fuels in Gas Producers ....F. E. Junge
Duty Test on Gas Power Plant..................J. R. Bibbins
Control of Internal Combustion in Gas Engines, Prof. C. E. Lucke
Evolution of the Internal Combustion Engine....S. A. Reeve
Industrial Education..........................W. B. Russell
The Foundry Department and the Department of Engineering Design..............................W. A. Bole
Molding Sand..............................A. E. Outerbridge
Power Service in the Foundry...............A. D. Williams
Foundry for Bench Work......W. J. Keep and Emmet Dwyer
A Volumetric Study of Cast Iron................H. M. Lane
Specifications for Iron, Coke, and Method of Testing Output ....Dr. R. Moldenke
Foundry Cupola and Iron Mixtures..............W. J. Keep
Foundry Blower Practice........................W. B. Snow
Patterns for Repetition Work....................E. H. Berry
Some Limitations of Molding Machines........E. H. Mumford
The Specific Heat of Superheated Steam...Prof. C. C. Thomas
Engine Design Adapted for the Use of Superheated Steam.................................Max E. R. Toltz
Power Transmission by Friction Driving..Prof. W. F. M. Goss
Cylinder Port Velocities..................Prof. J. H. Wallace

The fact that both the main auditorium and smaller assembly rooms were available for the meetings of the society permitted the papers to be discussed simultaneously. The papers were read in the main auditorium and the discussions of some, which were very lengthy, continued during the following sessions in the smaller assembly rooms, thus permitting full discussion by all who wished to take part.

On Wednesday afternoon between 300 and 400 of the members and guests crossed the North River on the Lackawanna ferry to the Lackawanna Railroad terminal station, and there met Mr. Chas. M. Jacobs, chief engineer of the Hudson Companies, who escorted the party on a tour of inspection through the tunnel. The route followed the North River shore from the Lackawanna Railroad terminal to 15th St., Jersey City, where the tunnel first built crosses the river. The party emerged from the tunnel at Morton and Hudson Sts., New York. The tunnel trip was a novel and interesting experience to the engineers and their friends, and nearly all thought it well worth the fatigue incident to the rough walking. It is expected that trains will be running in a few weeks.

The symposiums on foundry work and power development included the bulk of the papers presented, the papers by Mr. Russell: Industrial Education, and by Prof. Goss: Power Transmission by Friction Driving, being the exceptions. Mr. Russell's paper provoked considerable discussion, which is an indication of the interest in this present vital subject.

This meeting was the first in recent years in which all functions incident to the meeting, except excursions, were held in the Society house, including the reception and ball. This latter event for several years heretofore has been held at Sherry's.

There was a large registration of members and guests, the total number of members registered being 699; and of guests, 613.

The following officers were elected: President, M. L. Holman; vice-presidents, L. P. Breckenridge, Arthur West, Fred J. Miller; managers, Wm. L. Abbott, Henry G. Stott, Alexander C. Humphreys; treasurer, Wm. H. Wiley.

M. L. HOLMAN, PRESIDENT A. S. M. E.

Minard LaFever Holman, the newly elected president of the American Society of Mechanical Engineers, was born in Maine in 1852. His father was Col. Holman of the United States supervising architect's department. Col. Holman moved his family from Maine to St. Louis in 1860, and the subject of this sketch has lived in that city ever since. He graduated from Washington University of St. Louis in 1874 with the degree of Civil Engineer, and the University has since conferred on him the honorary degree of Master of Arts. For some time after his graduation Mr. Holman was connected with the supervising architect's department. He left that position to connect himself with the St. Louis Water Department under the late Thomas J. Whitman. After serving several years as principal assistant engineer under Mr. Whitman,

M. L. Holman.

he was appointed Water Commissioner of St. Louis in 1887. This office he held for three terms of four years each, making twelve years in all. Under his efficient supervision the St. Louis water works was almost entirely rebuilt, and experiments were inaugurated which resulted in a satisfactory clarification of the Mississippi River water, making it available for general city use.

After leaving the water department, Mr. Holman was for over four years the general superintendent of the Missouri Edison Electric Co., and for the last four years he has devoted his entire time to consulting work, having formed a partnership for this purpose with Mr. John A. Laird, member of the American Society of Mechanical Engineers, under the firm name of Holman & Laird. Mr. Holman has made a specialty of water works and power plants and has served on some important commissions, notably the one for designing new water works for Omaha. He was chairman of that committee, and he is now a member of the committee for appraising the property of the Denver Water Co., representing the city of Denver on the commission. Besides being a member of the A. S. M. E., Mr. Holman is a member of the American Society of Civil Engineers, American Institute of Electrical Engineers, St. Louis Engineers' Club, St. Louis Academy of Science, and is an honorary member of the American Water Works Association.

* * *

A contributor to the *Practical Engineer* states that it is possible to harden copper on its surface. This is accomplished by heating the copper, which is filed up clean before the process, to a bright red heat throughout its mass, and then plunging it into a pot of pure melted tin. The copper should remain in the tin until its heat is the same as that of the melted tin. The tin should be well covered with ground charcoal to prevent oxidation to any great extent. Proceeding in this way, the surface of the copper will be even harder than that of unhardened tool steel, and the hardness will penetrate to some depth. The tin alloys with the surface of the copper to cause hardness.

GEAR-CUTTING MACHINERY.—1.

METHODS OF CUTTING GEAR TEETH.

RALPH E. FLANDERS.*

There is no form of machine tool which has called for more ingenuity in design than the gear-cutting machine. The methods by which gears may be cut are so numerous, the requirements are so varied, the possible application of ingenious geometrical principles through the mechanism used are so nearly limitless, that a wonderful variety in design and construction has been evolved, affording a field of study which is unparalleled in its interest to the machine designer.

The earliest form of gear-cutting machinery to attain anything like its present state of development was the automatic spur gear machine using a milled cutter to shape the tooth. Later, came a period in which various forms of bevel gear cutting machinery were evolved, the demand being stimulated by the necessities of the chainless bicycle business. More recently, the requirements of the automobile have resulted in another period of inventive activity, which has resulted in the development of new machines and processes for gears of all kinds, though the bulk of the attention has been given to the spur and bevel forms.

In the following pages we have attempted to cover the whole field of gear cutting, representing, so far as possible,

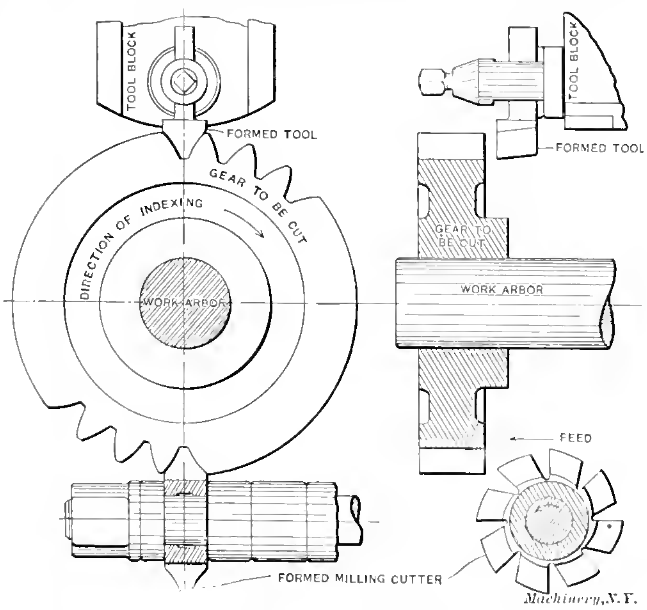


Fig. 1. The Formed Tool Principle of Action as exemplified by the Shaper Tool and the Milling Cutter.

every machine and process which has come into commercial use, including at the same time some which have been built and used successfully, but which have not been, for one reason or another, placed on the market. Some of these machines are old, some of them new, some of them simple, some of them complicated. Some of them are used for the finest kind of work, such as is required in watch and instrument gearing, while one of them will cut teeth in a gear up to 10 feet in diameter. The reader will see, as we proceed, that all these widely varying tools may be brought into a definite classification which links them all into one large family—the old and new, simple and complicated, large and small—by characteristics which are common to the different groups.

The Classification of Gear-cutting Machinery.

Gear-cutting machinery may be classified, first, according to its *product*. There are four main divisions in this classification, separating from each other the machines designed for cutting spur, spiral, bevel and worm gearing, respectively. The cutting of internal gears and racks is analogous to the cutting of spur gears, and is included with it. Twisted or herringbone gears having parallel axes are in general cut in the same way as spiral gears, though, as gears, they belong to a different class. Some machines are so designed as to be capable of cutting more than one form of gear, but it is only done by making certain adjustments or using certain attachments which, for the time being, convert them into machines of other types. The best example of a machine which covers all the divisions of this classification is the universal miller, which may be arranged to cut the teeth in any one of the four forms mentioned.

The second classification of gear-cutting machinery depends on the *principle of action* involved. The five methods we will consider are—the formed tool, templet, odontographic, describing-generating, and molding-generating methods. This classi-

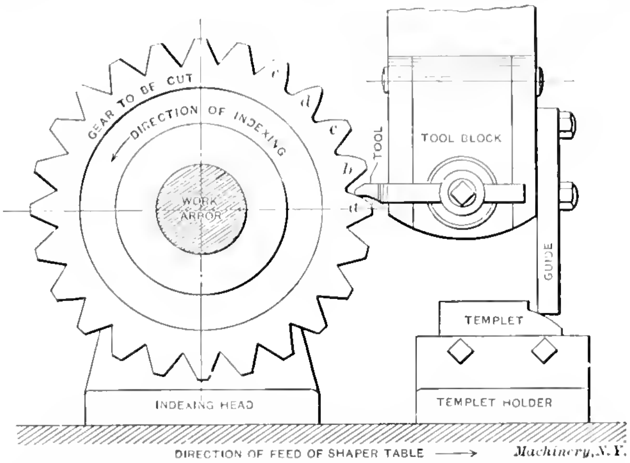


Fig. 2. The Templet Principle, as arranged to be applied to the Shaper.

fication relates particularly to the way in which the tool is held and guided with reference to the work, to produce the desired form for the tooth surfaces.

The third method of classification relates to the *nature of the operation*. The four operations we will consider are—forming the tooth by impression, by planing or shaping, by milling, and by grinding or abrasion.

In studying the various combinations possible in these three different classifications, it will be simplest to first consider the matter of cutting the teeth of spur gearing, investigating the principle of action involved, and the nature of the operation performed, in the different methods. From that we will be able to proceed to the application of these principles and operations to the other forms of gearing, like the spur, bevel and worm.

Five Principles of Action.

The Formed Tool Principle: This, the simplest and most obvious way of forming a gear tooth, is illustrated in Fig. 1. The gear to be cut is held firmly on a work arbor which, in

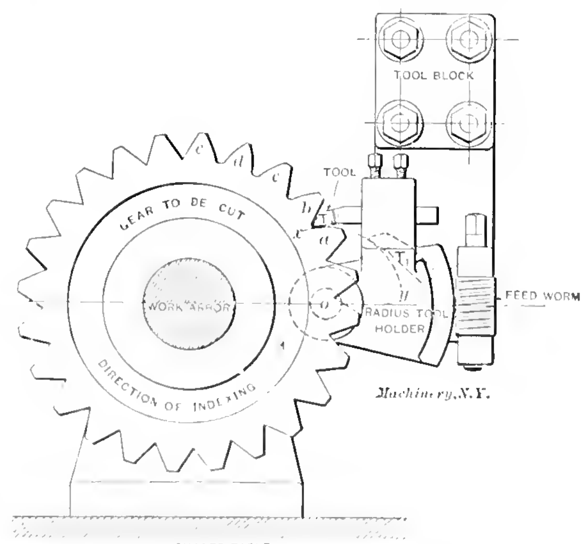


Fig. 3. The Odontographic Principle, which approximately outlines the Tooth Form by Mechanical Means.

turn, is firmly supported in the machine, in such a way that it can be *indexed* (or rotated through an angular distance corresponding to one tooth) from time to time as occasion requires. In the upper part of the cut is shown a planer or shaper toolpost, carrying a formed tool having outlines accurately corresponding to the shape of a space between two of the teeth it is desired to form. It is evident that this formed tool,

* Associate Editor of MACHINERY.

when mounted in the tool-post of the planer or shaper, may bo fed down into the work to the proper depth, in which case, being set centrally, it will reproduce its outline in the work. The work may then be indexed, and the operation repeated to form another tooth space. With the work indexed in the direction shown in the cut, four tooth spaces, or three complete teeth have been formed. A formed milling cutter may be used instead of the planer or shaper tool. This is shown

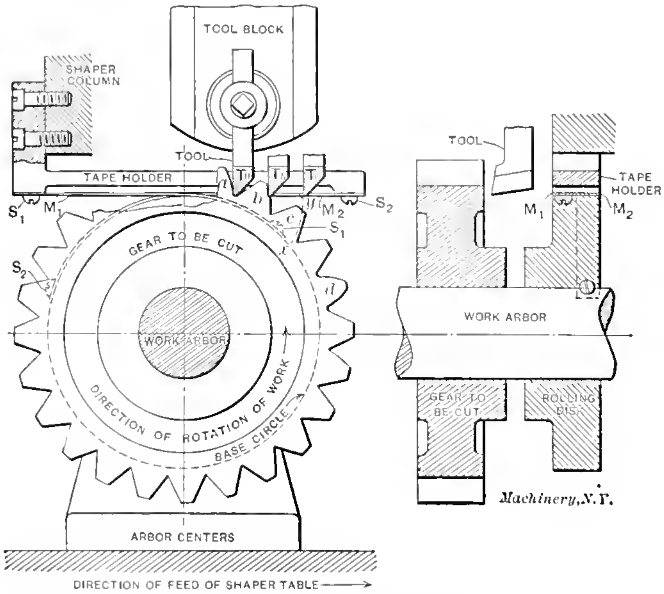


Fig. 4. The Describing-Generating Process, by which the Point of the Tool is constrained to follow the Desired Outline.

at work on the under side of the blank. It reproduces its outline in the work in the same way as does the planer tool, being rotated in the direction indicated, and fed through the work at the same time.

The Templet Principle: This method of cutting gears is shown in Fig. 2. As in the previous case, the work is held on the table of the shaper. A templet holder is also mounted on the shaper table, carrying a templet, having a surface formed to the exact outline desired for the finished tooth. The tool block is disconnected from the feed screw, and weighted

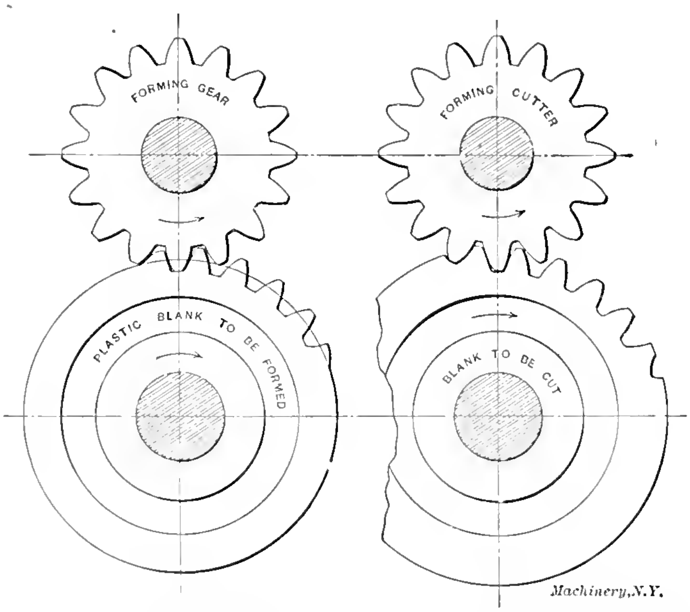
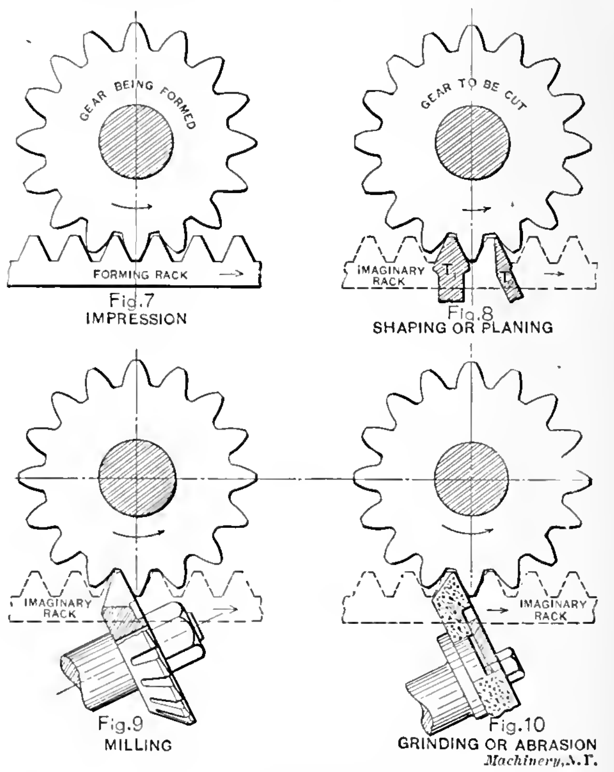


Fig. 5. The Molding-Generating Principle applied to Rolling the Proper Form in a Plastic Blank.

Fig. 6. The Same Principle employing a Cutter having a Shaping Action, cutting Teeth in a Solid Blank.

so that it falls of its own accord. To its side is clamped the guide shown, which bears on the templet. As the table of the shaper is fed to the right, it will be seen that the curved surface of the templet will raise the guide, the tool block and the tool, in such a fashion that the desired outline will be reproduced on the gear tooth. The upper surfaces of teeth *a*, *b*, *c* and *d* have been formed in turn in this way, the work being indexed for this purpose as in the previous case. With the primitive arrangement shown, it will be necessary to reverse the work in the arbor to form the other side of the teeth. Teeth *d* and *e* had their faces finished in this way, tooth *d* being thus completely formed. It will be seen that obtaining accurate teeth by this method requires—first, an accurate templet; second, accurate setting of the templet and tool in proper relation to each other; and third, a bearing surface on the guide of exactly the same shape as the cutting edge of the tool. As shown, the gear to be cut has had the tooth spaces roughed out to shape, so that the finishing operation removes a comparatively small amount of metal.

The Odontographic Principle: In shaping teeth by the odontographic principle, the tool is guided in some way by suitable mechanism, to closely approximate the desired tooth outline by means of circular arcs, or other easily obtained curves. A simple example is shown in Fig. 3. The gear to be cut is held and indexed as in the two previous cases. The blank has had the teeth roughed out as in the previous case. The gear to be cut has involute teeth. With teeth of this form, in most cases a circular arc may he found which will more or less closely approximate the true outline. Such a circular arc is shown at $x\,y$, with its center at o. The radius tool holder shown has its center at o to agree with that of arc $x\,y$. The



Figs. 7, 8, 9 and 10. The Four Methods of Operation, as applied to the Molding-Generating Principle of Action.

cutting point of the tool used is located on arc $x\,y$. It will be seen from this, that when the radius tool is fed from position T_1 to T_2 by the feed worm, its point will follow the desired arc and cut the desired outline for the tooth. By this means, the upper surface of tooth *a* is formed. The same surfaces of teeth *b*, *c* and *d* have previously been cut, as well as the opposite faces of *d* and *e*, tooth *d* being completed. To cut the opposite faces, the work may be reversed on the arbor.

The Describing-Generating Principle: This principle is shown in Fig. 4, applied to the shaping of involute teeth. The cutting of involute teeth only has been hitherto shown in these examples, owing to the fact that in other cases, as in this, it lends itself most readily to the purposes of illustration. The involute, as is well known, is the curve formed by a point in a cord which is being unwrapped from the periphery of a circle. In the cut, the dotted line $x\,y$ shows an involute generated in this fashion from the *base circle* shown. This base circle is formed by the periphery of the rolling disk, which is firmly connected with the gear to be cut through the work arbor on which both are mounted. Unlike the previous cases considered, the work arbor in this case is free to revolve on centers without being restrained by an indexing mechanism; as in previous cases, the blank has had the teeth

roughed out. The tool used is a shaper, as before. To some fixed part of the machine is clamped the tape holder shown. This has fastened to it two thin flexible metallic tapes, M_1 and M_2 the former stretched between screw S_1 on the tape holder and the corresponding screw on the rolling disk, while the latter is similarly stretched between screws S_2 and S_3. By this means, it will be seen that when the shaper table is fed in the direction indicated, the unwinding of M_1 and the winding of M_2 will positively roll the disk and the work with it. If now, a tool be placed in the tool block of the shaper, having a cutting point set at the same height as the middle thickness of the steel tapes, and if the table be fed as shown, the mechanism will constrain the tool point to cut an involute on the side of the tooth of the gear blank. When the tooth is at c, the tool will be at T_c; when the tooth is at b, the tool, at T_b, will have cut down about half the length of the face, as shown; when the tooth is at a, its outline will have been completed on that side by the tool, at T_a. The way in which the involute is generated will be easily understood, when it is seen that the cutting point of the tool always coincides with a given point y in tape M_2, so that the same involute as is generated by this point in the unwinding tape is reproduced by the tool point. The device is incomplete, as shown, in that no provision is made for indexing. In this case the gear to be cut and the rolling disk have to be indexed with relation to each other, so as to present the different teeth properly for the tool to act upon them. At d is shown a completed tooth.

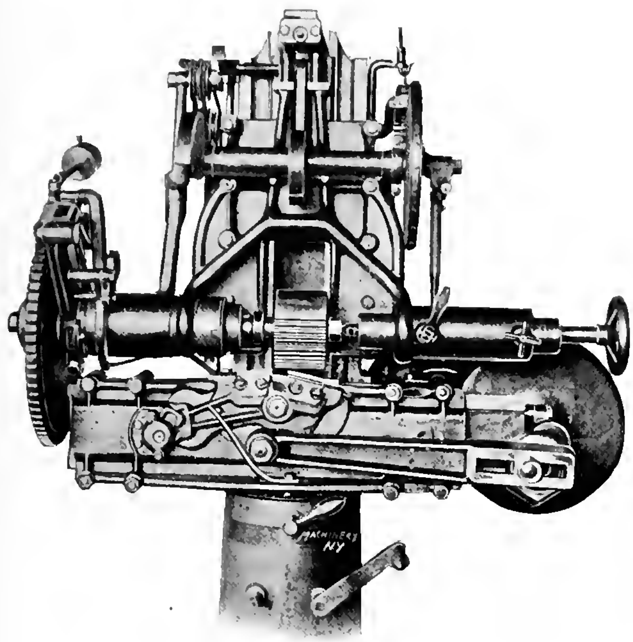


Fig. 11. The Pederson Formed Tool Gear Shaping Machine.

The Molding-Generating Principle: This method of making gears depends on the fact that in a set of interchangeable gearing a gear formed correctly to run with one of the series will run with all of the series. The molding process consists in using a completed gear tooth or gear, of proper shape, to from the others. Two examples of this are shown in Figs. 5 and 6. The first case supposes a forming gear, as shown, of correct shape. The blank to be formed is made of some plastic material like wax or clay. The blank and the forming gear are mounted on arbors at the proper distance apart, and rotated together at the proper speed ratio. The teeth of the forming gear, pressing into the plastic blank, will form spaces and press out teeth of the correct shape to mesh with itself, or with any other gear of the same interchangeable series.

In Fig. 6 the blank is of metal or other non-plastic material, and the forming gear is replaced with a forming cutter, having sharp edges of exactly the same outline. The blank, which in this case is of the full outside diameter of the gear into which it is to be made, is rotated with the cutter, as in Fig. 5. The cutter is reciprocated in the direction of its axis so as to take a series of cuts, to form the tooth spaces as the rotation takes place. The principle is identical with that shown in Fig. 5. Of course, the cutter has to be fed directly in to the proper depth to start with, before the rotating commences.

Four Methods of Operation.

In classifying gear-cutting methods by the operations involved, we will take for the purpose of illustration the molding-generating method as applied to the spur gear. Later on we will see how the same operations are applied to the cutting of other forms of gears, by other methods. In the four cases shown in Figs. 7 to 10, the molding-generating is done by a rack working in a gear, not by one gear working in another, as in Figs. 5 and 6.

By Impression: Fig. 5 is an example of this kind, the teeth in the plastic blank being formed by the impression made by them on the forming gear. In Fig. 7 the same thing is shown, except that the forming member is a rack which has shaped the periphery of the gear with which it meshes into correct teeth, as shown.

By Shaping or Planing: In Fig. 8 but one tooth space of the gear is formed at a time, and instead of using a rack to do the forming, a tool T_1 may be used having an outline the shape of a rack tooth. This is fed along horizontally, and the gear to be cut is rotated in unison with it, the same way as in Fig. 7. If tool T_1 is given a cutting movement in a shaper, the spaces formed will be of exactly the right shape and identical with those formed in the previous case. Each of the spaces will have to be formed in the same way one after another, the work being indexed with reference to the imaginary rack, to bring the tool into the proper position for each of them. Instead of forming both sides of a space at one operation, as with tool T_1, a single side tool T_2 may be used, corresponding with one side only of the rack. In this case one side only of each tooth is finished, so the tool or the work has to be reversed, after which the other sides are completed.

By Milling: Instead of using a planer or shaper tool to match the side of the imaginary rack tooth, a milling cutter may be used, as shown in Fig. 9. In this case the gear is rotated, and the milling cutter advanced to agree with the advance of the imaginary rack. The cutting face of the cutter must of course be formed on a plane surface, as shown. This arrangement presents some difficulties when the gear to be cut has a wide face, since the circular cutter will cut deeper into the tooth space at the center than it will toward the edges. This deepening of the tooth space at the center does not affect the acting tooth surface, and so is harmless (except possibly in the case of the generation of pinions having a small number of teeth, and involute outlines of low pressure angle, in which case the trouble due to interference is aggravated). The larger the diameter of the cutter as compared with the face of the gear, the less is the trouble on this score.

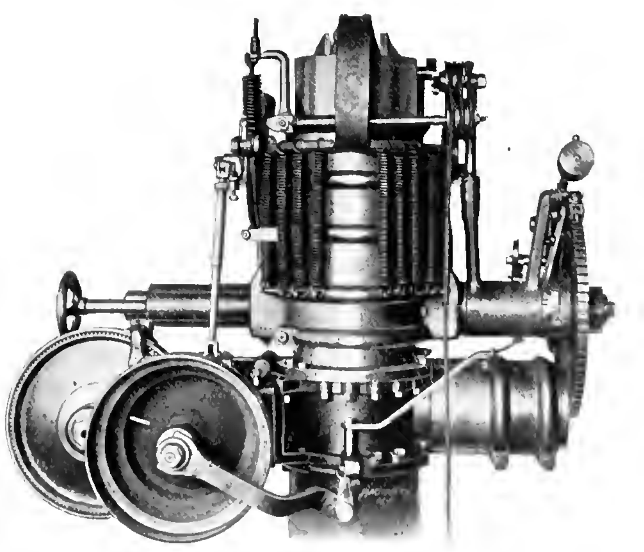


Fig. 12. Rear View of the Pederson Machine.

By Grinding or Abrasion: In Fig. 10, the milling cutter of Fig. 9 has been replaced by an emery wheel of similar shape, having a plane face perpendicular to the axis of the wheel

spindle. The action on the work is identical with that in the previous case, subject only to the limitations of the grinding process, such as the rapid wearing away of the material of the wheel, involving the necessity for constantly truing it up. Besides this, only a small amount of stock can be removed in a given time, as compared with the execution possible with a milling cutter. The process has the advantage that it can be used in hardened work.

As intimated, each of these various operations can be applied to different kinds of gears, acting according to different principles, though many of the possible combinations are impracticable. This preliminary discussion of methods, however, will serve to systematize the study of the various machines illustrated and described in the following pages, and will render an understanding of their construction more easily intelligible.

MACHINES FOR FORMING THE TEETH OF SPUR GEARS.

As described in the previous section, spur gear teeth may be formed in any one of five ways—by the formed tool method, the templet method, the odontographic method, the describing-generating method, or the molding-generating method. The extent to which these various schemes have been applied in practical use varies greatly. The formed tool method is at once the most obvious and the most used of them all. The templet principle has been applied to a limited extent, principally for gears of very large size. So far as the writer is aware, no practical application of the odontographic principle has been made in the cutting of spur gears. The only machine that has come to his notice involving the describing-generating process, was one invented by Mr. Ambrose Swasey, and in use a number of years ago in the shops of the Pratt & Whitney Co. This was not used, however, for making gear teeth, but for making gear tooth cutters—before the days of the formed cutter, which it was not adapted to making. The molding-generating process in various forms has received a wide application, second only to the formed tool method.

The operations available for the formed tool method are—impression, shaping or planing, milling, and grinding or abrasion. Of these, the impression process is obviously unsuited for practical work. The shaping or planing, and the milling (particularly the latter) have a wide range of application.

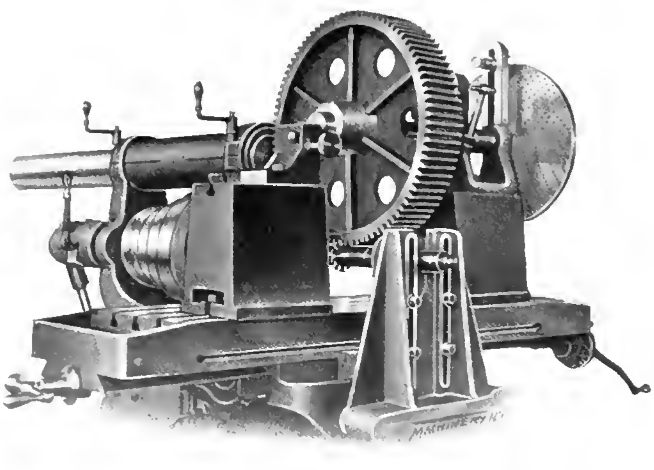


Fig. 13. Attachment for cutting Gears of Large Diameter on Cincinnati Milling Machines.

In the case of the operation of grinding or abrasion, but a single machine has ever been built embodying the formed tool principle, so far as the writer is aware.

Machines using Formed Shaper or Planer Tools.

The primitive application of the formed tool method is that in which a gear blank is mounted on index centers on the planer or shaper table, and has its teeth cut by a tool having an outline corresponding to the desired tooth space. In this operation the tool is fed by hand to the proper depth and withdrawn. The work is then indexed for a second cut, the tool is fed down again, and the operation is repeated until the gear is finished. This is shown diagrammatically in the upper part of Fig. 1. It is the simplest method of cutting a gear which has to be made immediately, and for which formed milling cutters are not available. It also has its application in the case of gears of unusual size. Under these circumstances, however, the machine used is generally a slotter instead of a planer or shaper. A formed tool is fastened in the tool-post of the machine, while the work is clamped to the revolving table. The indexing is done by such means as may be provided, usually a worm and worm gear or a master wheel.* The Gleason and Newton templet machines (described in the next installment) also may be, and doubtless often are, used in the same way.

Figs. 11 and 12 show a machine using the formed tool with the shaper method of action. The machine is an interesting one in its details, and it would require considerable space to

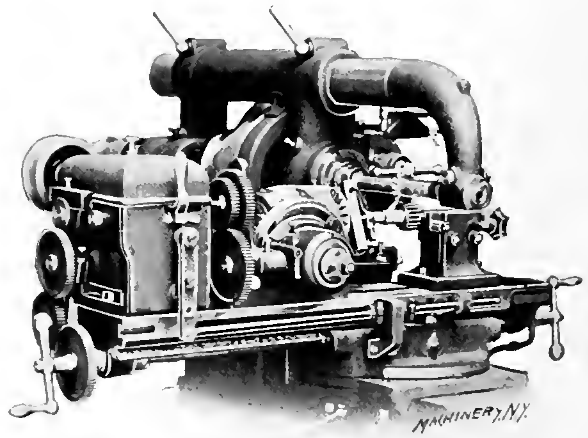


Fig. 14. Attachment made by Ludwig, Loewe & Co. for converting the Milling Machine into an Automatic Gear Cutter.

go into full particulars, so only a general description of it will be given. The mechanism is mounted on a circular column. The work arbor is carried by a slide, vertically adjustable to suit the diameter of the work, the adjustment being obtained by the crank handle shown at the front of the column. The feed and indexing movements for the work are controlled by cams on the shaft shown at the upper side of the work slide, this cam shaft being operated by an adjustable ratchet mechanism from the driving gear. One of these cams, by suitable lever connections, feeds the blank slowly down toward the cutters until the proper depth has been reached, when it allows the springs shown at the rear of the column to quickly return it, whereupon the cam at the left of the shaft operates the mechanism by which the work is indexed. The feeding cam then comes into action again—and so on until the work is completed. The depth of the feed given the work slide by the cam movement is varied by altering the position of the contact block by which the cam lever transmits the feeding movement to the slide. This is changed by the horizontal square-head screw seen at the extreme top of the column. The indexing is effected by a notched dial plate, operated by pawls and locking levers moved by the cam previously mentioned. The number of notches moved at each indexing can be regulated by a guard covering more or less of the teeth included in the stroke of the indexing pawl. Provision is made for stopping the action of the machine automatically when the required number of teeth have been cut.

The cutter slide is driven by a back-geared crank movement, adjustable for length of stroke and for various numbers of strokes per minute. Two tools are used, one cutting on the forward, the other on the return stroke. These tools, as may be seen from Fig. 11, are mounted in a rocking holder, which is tipped to bring first one and then the other into action as the end of each stroke is reached. This tipping is effected by the rocking and locking cam at the left end of the cutter slide in Fig. 11. This rocking and locking cam is connected with a slot cam near the right-hand end of the slide, this latter being operated by a pin near the crank end of the connecting-rod. As the connecting-rod passes the center, going in either direction, it operates the slot cam, which, through its connection with the rocking and locking cam, brings the desired

* See "Generating a Large Index Plate," by A. L. DeLeeuw, August, 1905.

one of the two blades into action. The one of these blades which has the heaviest of the cutting to do is of a simple U-shape, forming the bottoms and fillets of the tooth spaces. The other one, which has a lighter cut, forms the curved faces of the teeth.

Among the advantages claimed for this machine are extreme rigidity of action, exceeding that of the ordinary automatic gear cutter, and very low first cost. The cost of the cutters is also very moderate, being about one-fifth of that for formed milling cutters of the same pitch. These cutter blades are planed to shape, and may be ground on the face without change of contour. By means of special cutters straddling the teeth of the gear, provision is made for cutting pinions of few teeth and considerable under-cut. We are informed that the British rights have been acquired by Vickers Sons and Maxim, who are preparing to manufacture it on a large scale.*

Standard Machine Tools and Attachments Using Formed Milling Cutters.

More gears are cut by formed milling cutters than in any other way. It is distinctly a commercially successful process. The cutting tools are comparatively inexpensive, and retain

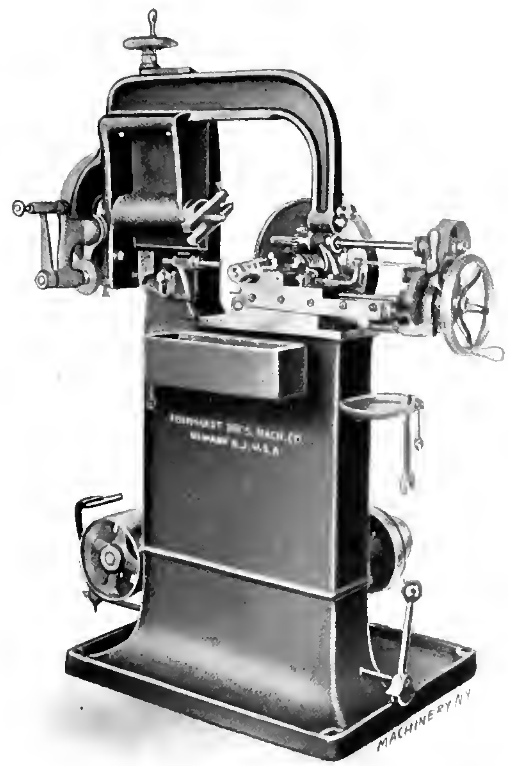


Fig 15. Eberhardt Bros. Semi-automatic Gear Cutter for Small Work.

their shape until they are entirely ground away, which is only after the accomplishment of a surprising amount of work.

The simplest way to use a formed cutter is in the milling machine. In a milling machine provided with an indexing head, no attachments are required for gears of moderate size and small pitch, and many thousands of them are cut with this simple equipment. For gears of larger diameter, though still of a pitch small enough so as to be within the range of the pulling power of the spindle, the worm-wheel of the dividing head becomes too small to satisfactorily and accurately index the wheel. For such work, many of the milling machine makers provide indexing attachments suitable for work of greater diameter than is possible otherwise. In Fig. 13 is shown an outfit of this kind built by the Cincinnati Milling Machine Co., Cincinnati, Ohio. The head- and foot-stock are mounted on elevating blocks which make it possible for them to swing work of a larger diameter. When working on large diameters, the table is raised and the cut taken on the under side of the work. This brings the thrust due to the cut down nearer to the bearing surfaces which have to resist it, and gives a steadier cutting action than would be the case if the work were lowered far enough to have the cutter act on the top of the blank. The indexing is done simply and directly by a plate with rows of holes, of numbers corresponding to the number of teeth it is desired to cut. This plate is of much greater diameter than the index worm of the regular spiral head, and so gives more accurate results.

An attachment of a different kind for cutting gears in the milling machine is shown in Fig. 14. Here we have an ar-

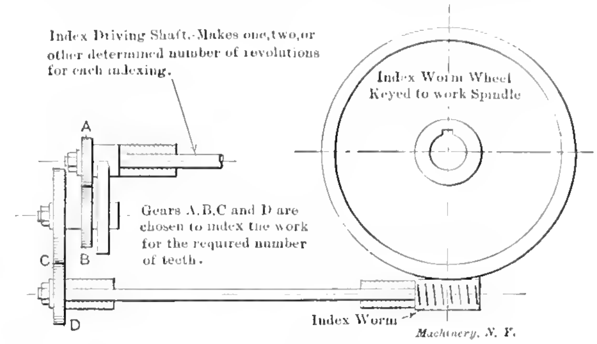


Fig. 16. Diagram showing the arrangement of the Standard Indexing Mechanism.

rangement which is bolted on the milling machine table and connected with the dividing head. This attachment is driven from the counter-shaft by a special belt connection which serves to operate the feed and indexing of the work, the usual feed connections being disconnected. The device renders the milling machine automatic in all its actions. The table with the work on it is fed forward slowly until the cutter has passed through the work and formed the tooth space. The table and work are then rapidly returned, when the work is indexed and again fed forward as before. These processes are repeated until the gear is finished. The milling machine is thus made in effect an automatic gear cutter, capable of cutting bevel gears and clutches, as well as spur gears. This device is made by Ludwig, Loewe & Co., Berlin, Germany.*

Semi-automatic Machines Using Formed Milling Cutters.

Leaving the special use of the standard milling machine in this work, and coming to milling machines specially adapted to cutting gear teeth, we are met by a bewildering variety of designs of varying degrees of ingenuity and interest. We will first consider the simpler forms of these specialized milling machines, or "gear-cutting machines," as we may better call them.

In the simpler forms, the development from the milling machine consists principally in embodying the dividing mechanism as a part of the machine, instead of making it an at-

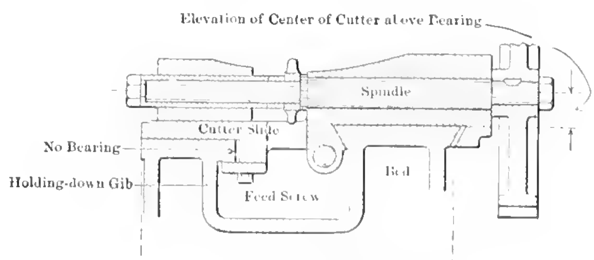


Fig. 17. Cross-section through Cutter Slide of Typical Gear Cutter, Illustrating Certain Principles relating to Accuracy and Cutting Power.

tachment. The feed may be operated by hand, or it may be connected by belt or gearing with the spindle, so as to be driven positively. In the latter case, an automatic stop is provided for throwing the feed out when the cut is completed. In the automatic form of machine the indexing mechanism, as well, is operated by power, as is also the quick return of the feed; and the movements are made dependent on each other

* Information concerning the American rights for this machine, may be obtained from Mr. H. A. Elliott, with Alfred H. Schutte, corner of Cedar and West Streets, New York.

* See article entitled "Automatic Indexing and Feed Attachment for the Milling Machine" in the June, 1907, issue of MACHINERY.

in such a way that the machine of itself feeds the cutter through the work, returns it when the cut has been completed, indexes the work, and repeats the cycle until the job is finished.

An example of the semi-automatic form of the machine, made by Eberhardt Bros. Machine Co., Newark, N. J., is shown in Fig. 15. The mechanism is quite simple and may be readily understood from the cut. The spindle is carried on a slide which may be adjusted at an angle for cutting bevel gears, though it is shown in the cut down in a horizontal position as required for cutting spur gears. An automatic feed is provided for the spindle slide, connected with the cutter spindle by spiral gears and change gears, which may be set to give the desired rate. An automatic stop is provided for throwing out the power feed when the required length of cut has been taken. The slide then has to be run back by hand and the work indexed by hand, when the automatic feed is again thrown out. The work spindle is carried on a slide gibbed to the face of the column of the machine. This slide carries the indexing mechanism also, and an over-hanging arm for supporting the outer end of the work arbor. The indexing mechanism is of the same type as that illustrated in Fig. 16 and described later. Such tools are adapted to manufacturing in small quantities where unskilled labor is employed. The machines are inexpensive, and the operating skill required is of a comparatively low order.

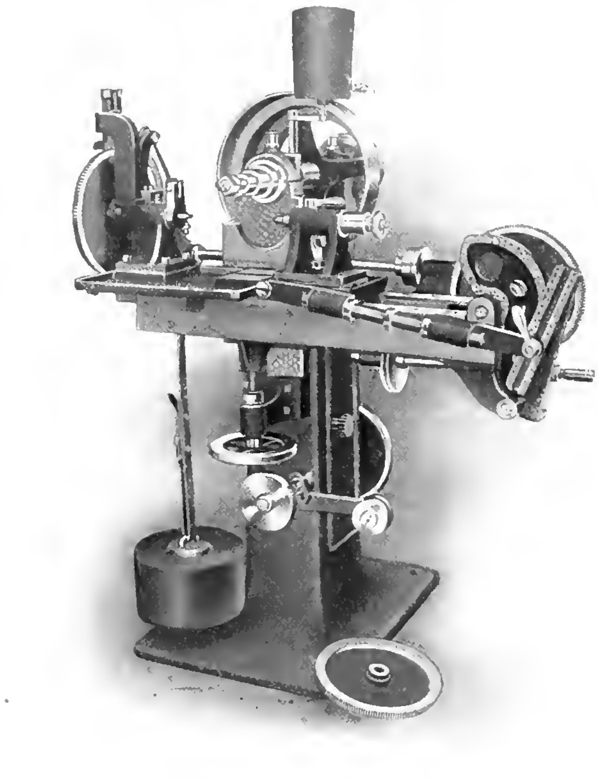


Fig. 18. The Dwight Slate Cam Actuated Automatic Gear Cutter.

Machines of similarly simple action, but for larger work, have been built from time to time by builders of special machinery as required by their customers.* These machines may be handled by comparatively inexpensive labor, are furnished at a low first cost, and are very substantial in construction.

Automatic Machines using Formed Milling Cutters—General Principles of Design.

The fact that we illustrate twenty-five automatic cutting gear machines of this type, built by twenty-two makers, is good evidence of its commercial position. Much thought and experience has gone into the development of the automatic gear cutter. In selecting a machine of this kind, important requirements to be looked out for are—accuracy of indexing, power and durability of the feed and cutter-driving mechanisms, rigidity of construction, convenience of handling, and range of usefulness.

* See, for instance, the description of Newton machine, in article, "American Gear Cutting Machinery," in the June, 1898, issue of MACHINERY.

In the matter of accurate indexing (which is of prime importance, especially for gears which are to run at high speeds), the important considerations are the accuracy of the index worm-wheel and the mechanical construction of the indexing mechanism. With the exception of the machines shown in Figs. 18 and 19 (also 41, 42, 43 and 44, shown in the next installment), which are for comparatively small work with small numbers of teeth, the principle of the indexing mechanism is the same for all of these machines.

The work spindle has mounted on it (see Fig. 16) a worm-wheel driven by an indexing worm. This worm is connected by change gears A, B, C and D with a shaft which is arranged (usually) to make one complete revolution, when the proper time for indexing arrives. The change gears are so set in connection with the invariable movement of the index shaft, as to give the exact movement required to rotate the blank to the point where it is desired to cut the next tooth. In some machines, provision is made for giving two or four complete revolutions to the driving shafts when the number of teeth to be indexed is small. It is important that the mechanism by which this shaft is set in motion and stopped shall be very carefully designed, so that the stopping will always take place at exactly the same point in the rotation, thus permitting no over-running or under-running of the worm.

In the construction of the worm-wheel, there are two plans followed. Some makers, notably the Brown & Sharpe Mfg. Co., prefer to make each worm-wheel an accurate copy of a master wheel which they know to be of unimpeachable accuracy. Other builders prefer to make each index wheel by itself, and generate each one to a high degree of perfection by methods well understood and commonly employed in such work, generally involving making the rim in halves.

In the matter of obtaining power and durability for the drive, a variety of opinions will be found expressed in the various designs. Some of them have the spindles driven by spur gearing (or bevel gearing in some cases) while other makers prefer spiral or worm gear drives. There is much conflict of opinion as to the advantages of these various forms. In some cases the builder is restricted in his choice by structural features which limit him to one form only. In any event, the drive should be smooth and powerful.

The capacity of gear-cutting machines for taking heavy chips may be easily allowed to fall below the limit of the driving power available at the spindle, if the frame of the machine and the design of gibbing of the various slides are such as to make the machine lacking in rigidity. The various requirements for doing work rapidly and accurately may be understood from the rough sketch of a section through the spindle and cutter slide of a gear cutting machine shown in Fig. 17. This sketch does not represent any particular machine, but shows some features which are common to a number of makes; unnecessary details have been omitted. One of the requirements is that the strain of the cutting action shall be brought as close to the bearing surface as possible. This applies in the case of both the work spindle and the cutter spindle. It will be noted in Fig. 17 that the elevation of the center of the cutter above the bearing is very small,

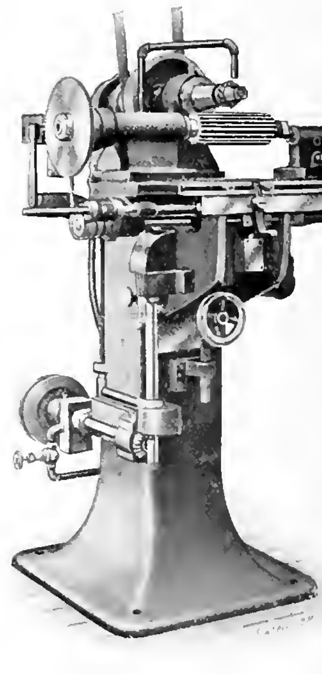


Fig. 19. The Sloan & Chace Automatic Gear Cutter for Small and Medium Work.

so that the irregular thrust of the cutting action when working at full capacity has little effect in disturbing the rigidity of the machine. Bearing surfaces of great area are also advisable to give firmness to the structure. It will be noted that the bearing surface extends the full width of the bed of the machine in the sketch. With this wide bearing surface, however, provision should be made for guiding the slide for alignment, with much narrower surfaces, to prevent a cramping or "bureau-drawer" action, as it has been called. The guiding in this case is done entirely by the comparatively narrow dove-tail slide at the left. There is no side bearing at the

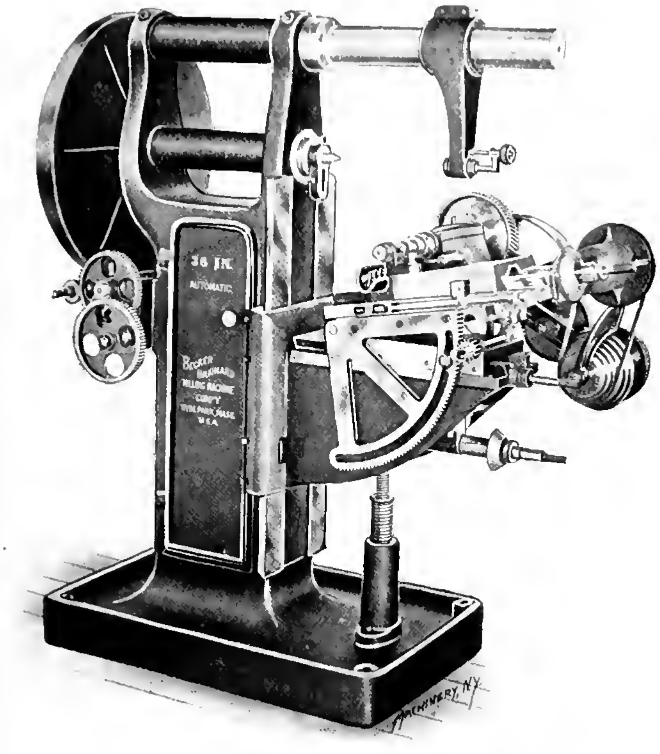


Fig. 20. The Becker-Brainard Automatic Gear Cutting Machine.

right, a clearance space being left at the right hand edge of that slide as indicated. A strap is provided here, however, for holding the slide down onto its bearing, thus preventing any lifting tendency which may develop at this point. It will be noted that the feed screw is placed quite close to the cutting point. This provision also tends toward smoothness and ease of action, since the power is then directly applied instead of being applied in a way to cramp the slide on its bearings. The rigidity and smoothness which these provisions insure are of great importance in permitting the use of very heavy cuts and lengthening the life of the cutter.

In regard to these matters, and the matter of convenience of operation as well, much can be surmised by the mechanic from a careful inspection of the engravings we show herewith. Instead of making invidious comparisons in these particulars, it has been thought best to let the reader draw such conclusions as he can from the information given. The descriptions of the various automatic gear-cutters will be found to contain explanations of their construction, and to refer to such particular points as may be peculiar to each case. To make comparisons easy, machines of similar type have been placed together in regular order. Of course such of the good qualities in a machine tool as depend on accurate workmanship and the design of details not visible from the exterior, will have to be judged by other means than a mere inspection of half-tones. In the matter of accurate workmanship, particularly, the reputation of the builder will go a long way with the intending purchaser.

Miscellaneous Forms of the Automatic Spur Gear Cutter.

As has been stated, the automatic gear cutter is a specialized form of the milling machine. There are no machines in our list that show this more plainly than the two shown in Figs. 18 and 19. The first of these is built by the Dwight Slate Machine Co., of Hartford, Conn. The machine at once shows itself to be a modified milling machine, with the usual screw feed replaced by a cam mechanism which gives a slow forward movement and a quick return. This is altered to give the proper length of feed, by means of the slotted link shown. The orthodox dividing head with worm and worm-wheel, has been replaced by a dividing plate on the head-stock spindle, with notches to correspond with the number of teeth it is desired to cut. An automatic trip is provided which throws out the feed at the completion of the last tooth. The various adjustments for different diameters of gears and lengths of cut will be readily understood from an inspection of the figure. This machine is one of a series of three of varying sizes, one of which is adapted to the cutting of bevel gears as well as spur gears.

In the machine shown in Fig. 19, built by Sloan & Chace Manufacturing Co., Ltd., Newark, N. J., the feed is effected by a screw, as in the ordinary milling machine, instead of by cams as in the previous case. The motion for the indexing and quick return is taken from the counter-shaft by the pulley shown near the base of the machine at the left. This gives a constant speed at the highest practicable rate whatever the spindle speed may be. The cutting feed is obtained from a connection with the spindle through a feed box, giving three changes. The indexing is ingeniously effected by the first half-turn of the feed screw, and is done positively without requiring the use of springs. A dial plate is used as in the previous case. The spindle head is adjustable in and out on the top of the column for centering the cutter. This machine shows the influence of the watch machinery makers' ideas, applied to a machine of rather larger capacity than usual with such construction. It is intended to show the watch makers' ideas of accuracy as well.

Another machine that shows the hereditary influence of the miller is shown in Fig. 20. In this case, however, the relative positions of the work spindle and the cutter spindle have been reversed from that occupied in the milling machine, or in the tools shown in the two preceding cuts. The work spindle passes through the uprights of the column, and carries a worm dividing gear at the rear end, while the cutter slide is located on the knee. In the position shown, with the intermediate quadrant elevated, the cut is being taken on an angle as would be required in cutting bevel gears, for which this machine is also adapted. For cutting spur gears, the slide is horizontal. Change gears for dividing are seen at the rear of the column beneath the casing for the indexing wheel. The indexing is done by a friction mechanism which is released at the proper time, coming up against a positive stop when one revolution has been made. The spindle driving

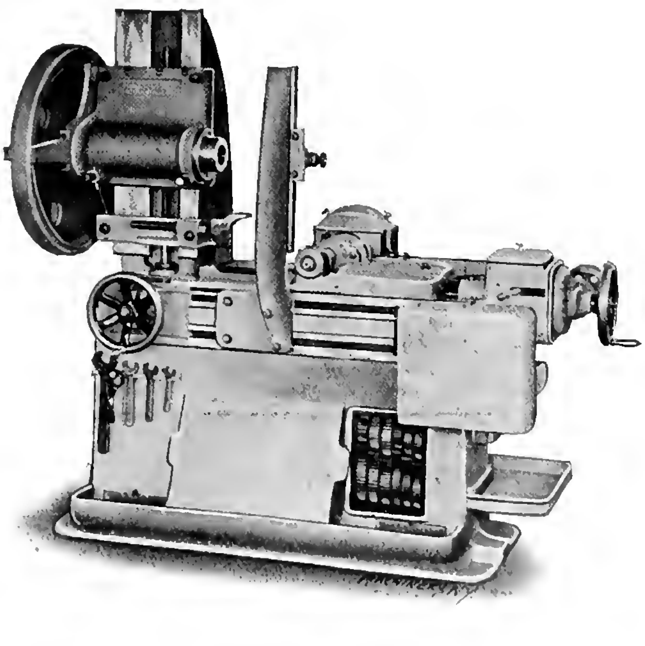


Fig. 21. An Example from the Brown & Sharpe Line of Automatic Gear Cutters.

* Described in "New Machinery and Tools" section of MACHINERY, January, 1907.

and feed mechanisms are carried entirely by the knee. It will be noted that the gear driving the cutter spindle has helical teeth. Where a cutter spindle is to be driven by spur gears, this is a construction often followed, particularly in Europe, to give a smoother and more even motion than would be obtained by teeth cut straight across in the ordinary fashion. An incidental convenience of this machine is a trough just beneath the cutter spindle, enclosing a slowly-moving spiral conveyer. The chips fall from the cutter into the trough, and are pushed by the conveyer out over the edge of the knee into the pan base, away from the mechanism of the machine. This machine is built by the Becker-Brainard Milling Machine Co., Hyde Park, Mass.

The Orthodox Automatic Spur Gear Cutter.

The automatic gear cutters of the conventional type, for small and medium-sized work, have the work and cutter spindles both horizontal, and arranged in the same relation to each other as in the Becker-Brainard machine. Instead, however, of adjusting the machine for the diameter of work by the raising or lowering of the knee carrying the cutter spindle, the work arbor is raised or lowered, being carried for that purpose in a head vertically adjustable on a column at the end of the bed of the machine. The cutter slide on these machines, when arranged for cutting spur gears only, is gibbed directly to the top surface of the bed.

One of the best known examples of this orthodox type of automatic gear-cutting machine is that built by the Brown & Sharpe Mfg. Co., Providence, R. I. A front view of one of their smaller sizes, the No. 3, is shown in Fig. 21. The spindle of this machine is driven by worm gearing, though with the parts reversed from the order they would naturally take, since the worm-wheel is the driver, and the worm, which is much larger in diameter than the wheel, is the driven member.* This arrangement gives the smoothness of drive of worm gearing, an enlarged bearing area, and the advantage of being able to shift the whole spindle with its driving gear endwise in adjusting the cutter centrally with the work, instead of requiring that the driving gear remain fixed in position, driving the spindle by sliding keys, as in the ordinary

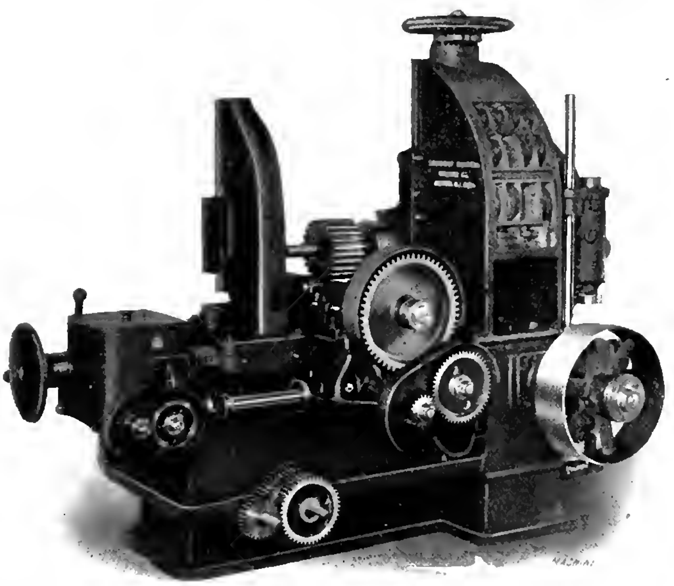


Fig 22. A Machine made by Eberhardt Bros., with Special Shortened Column; of Rugged Design for cutting Coarse Pitch Pinions.

construction. The plan generally followed by this company with all its machinery, of building the various parts of the mechanism on the unit system and assembling them as units in the machines, gives an air of neatness in design to the tool, which will be readily appreciated from the cut. A feature common with most automatic gear cutters, the outboard support for the work arbor, will be noticed clamped to guiding surfaces on the front of the bed. The index wheel is solid, and is made an accurate copy of a precision master wheel, as previously explained.

* Described in article entitled "The Figuring of Gear Drawings," by L. D. Burlingame, in engineering edition of MACHINERY, August, 1906.

The spur gear cutter shown in Fig. 22 is built by Eberhardt Bros. Machine Co., of Newark, N. J. The machine shown was designed primarily for cutting pinions of large pitch. For this reason the machine is ruggedly built and has a comparatively short column, limiting the diameter range for which it is adapted. The whole mechanism is driven from a pulley running at constant speed, the various changes of spindle speed and feed being obtained by change gears. It is like most other machines of its class, also, in the fact that the interior of the base of the machine serves as a collecting chamber for chips and a reservoir for the oil which is drawn from them.

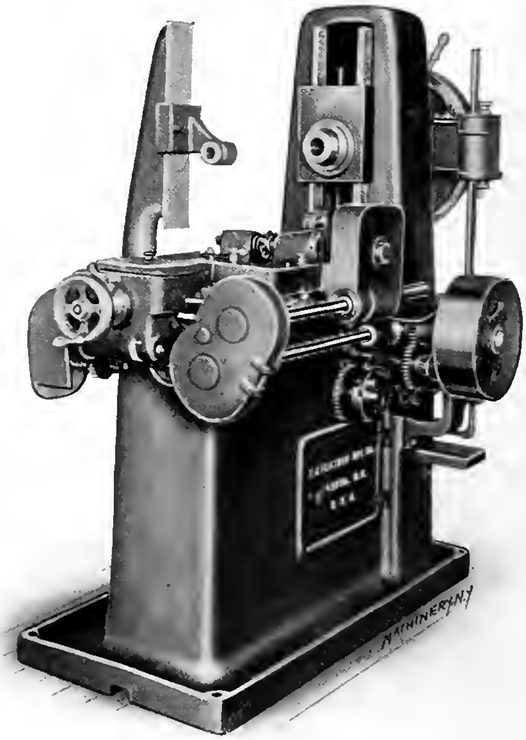


Fig. 23. The Flather Automatic Gear Cutter.

From here it is returned to the cutter by an oil pump. It will be seen that the cutter spindle driving gear in this case is a spur gear. The change gearing for altering the speed is placed next to it in the order of transmission, so that the splined shaft which leads the motion to the cutter shaft runs constantly at high velocity, whatever the speed of the cutter may be. Smaller machines of somewhat similar type are also built by this firm, some of them adjustable for cutting bevel gears as well as spur gears. The machine shown in Fig. 22 is, of course, ordinarily supplied with a higher column, than is here shown, which provides for work of greater diameter.*

An automatic gear cutter built by the E. J. Flather Mfg. Co. is shown in Fig. 23.† One of the most noticeable features of this machine as compared with those previously considered is the construction of the column which supports the work carrying head. This is made double, and the work carrying head passes through it instead of being clamped to ways on its face. The handle shown projecting at an angle in front of the index wheel casing at the back of the column, is used for clamping the work head solidly to its seat on both the front and back sides of the column, when the adjustment for depth of cut has been made. The spindle of this machine is worm-driven. The indexing mechanism is of the positively operated type, with a friction device to prevent rebound. As in previous cases, all changes of feed and speed are made by change gears, the machine being driven by a constant speed pulley.

* * *

A French formula for fireproofing wood and cloth calls for a mixture of $4\frac{1}{2}$ ounces of sulphate of ammonia, one-half ounce of borate of soda, one-sixth ounce of boric acid, all diluted in $2\frac{1}{4}$ pounds of water.

* See "New Machinery and Tools" section of MACHINERY, November, 1906, and June, 1907.
† See "New Tools of the Month" section of MACHINERY, July, 1904.

GIGANTIC METAL-WORKING PLANER.

The accompanying illustrations show the largest and heaviest metal-working planer ever built in America, and as far as we know, it exceeds also in size any tool of this class of European production. This planer was recently shipped from the Bement-Miles Works, Philadelphia, of the Niles-Bement-Pond Co., to the Mackintosh Hemphill Co., of Pittsburg. The best idea of the size of this planer is gained from the photograph reproduced on this page, which shows the planer erected in the shop, just prior to shipment, with 89 men distributed over it. If it is preferred to arrive at an idea of the size of this planer from figures, it may be mentioned that the total weight of this gigantic machine is 845,000 pounds (422½ tons), and that five motors, with a total power aggregating 207½ horse-power, are required for its operation. An idea of the difficulties attending the shipment of a machine of this size, as well as of the dimensions of the machine itself, may also be gained from the single fact that a special flat car with a central opening in the deck was required for the uprights alone, these being so large that their dimensions exceeded the clearance limits of tunnels and bridges, if loaded directly on the car deck in the usual position. The total weight of the two uprights is about 110,000 pounds.

General Dimensions.

The machine normally is a 14-foot planer of the ordinary type, as far as general principles of design is concerned, but in addition to the common features of planers, it is provided with some other features, which will be described later, and which are not found on general standard machines. The distance between the uprights is 14 feet 1 inches; the maximum distance from the table to the bottom of the cross-rail, 12 feet 2 inches; maximum stroke of table, 30 feet; total width of bed, 13 feet; length of bed, 60 feet. The table ways are each 15 inches wide. The tool slides are 7 feet 8 inches long, having a 4-foot vertical traverse. The cross-rail is long enough to admit full traverse of either head between the uprights. The face of each upright is 2 feet 6 inches in width, and the vertical height of the cross slide, including the top rib bracing, is 5 feet. Figs. 2 to 9 inclusive, which show the details of the planer, convey also some idea of the great size of the component parts.

Power Equipment.

As mentioned, the machine is provided with five motors. The main driving motor is of 100 horse-power, the lifting motor for the cross-rail is of 20 horse-power, and the traverse motor for the heads on the cross-rail, for fast traverse, is of 7½ horse-power. One motor of 50 horse-power normal capacity is provided for the independent slotter bars placed in each head, which are driven by rack and pinion. This motor also operates the heads for cross planing, the machine being adapted not only to ordinary planing, but to slotting and cross planing work as well, thus enabling the planer to be of service on the top, ends and sides of the work at one setting. The driving clutches are operated pneumatically, and an air compressor is provided, with a 30 horse-power motor, the planer being fitted with its own air compressor and independent motor. The planer is thus independent of the air supply of the shop, although the shop supply may be used, if it is desirable. Another feature of notable interest is a complete switchboard, which is furnished for controlling all the motors.

Provisions for Cross-planing and Slotting Work.

As has been mentioned, each head is fitted with a slotter bar independently driven by a rack, giving practically constant cutting speeds and a quick return. The maximum stroke

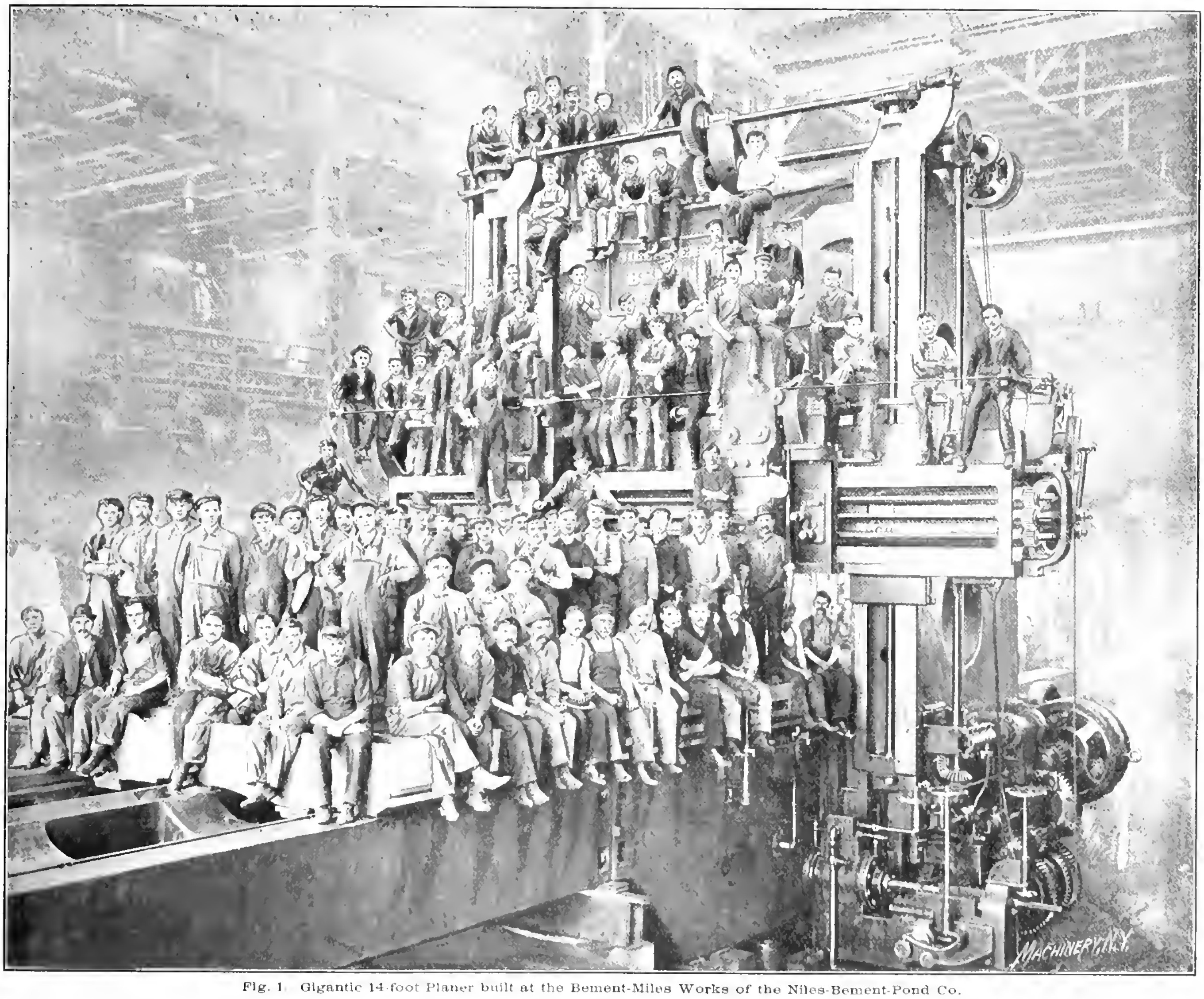


Fig. 1. Gigantic 14-foot Planer built at the Bement-Miles Works of the Niles-Bement-Pond Co.

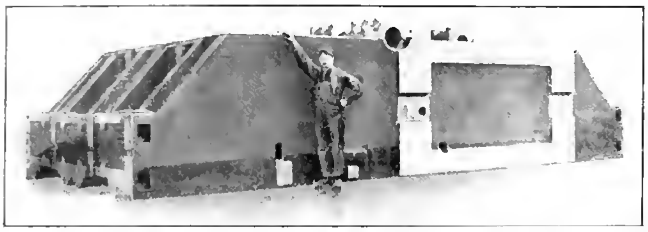


Fig. 2. Section of the Planer Bed, Inverted.

Fig. 3. Tie-beam, a Comparative View showing the Tie-beam's Unusual Proportions.

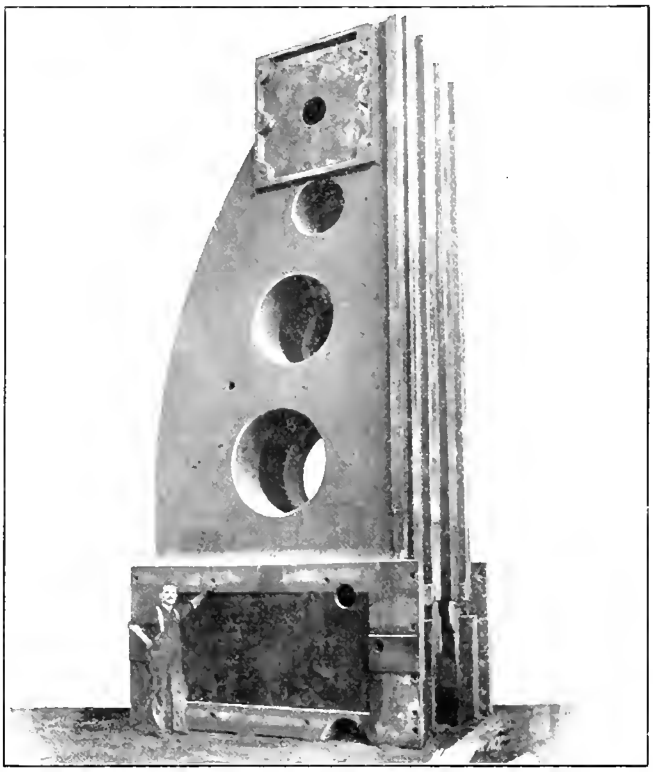


Fig. 4. The Uprights before Assembling.

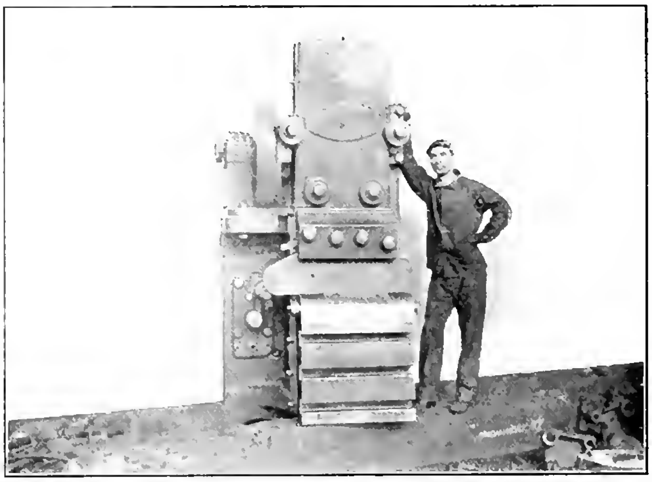


Fig. 5. View showing the Size of the Planer Head.

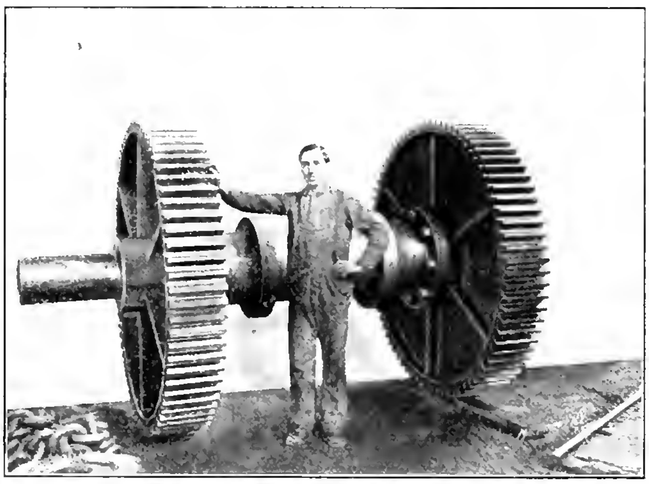


Fig. 6 Bull-wheels.

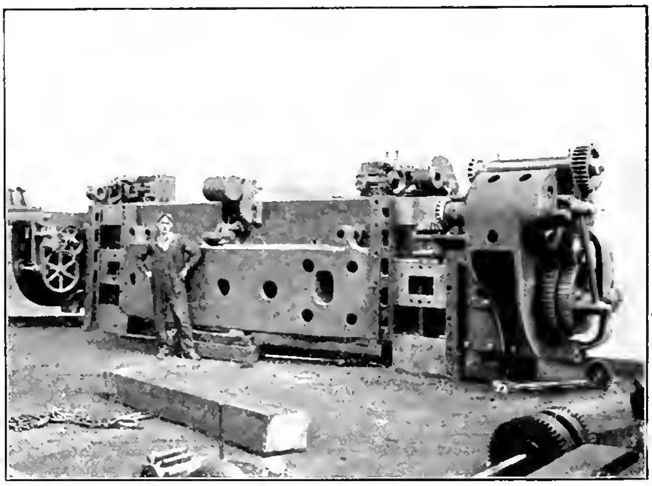


Fig. 7. Cross-rail.

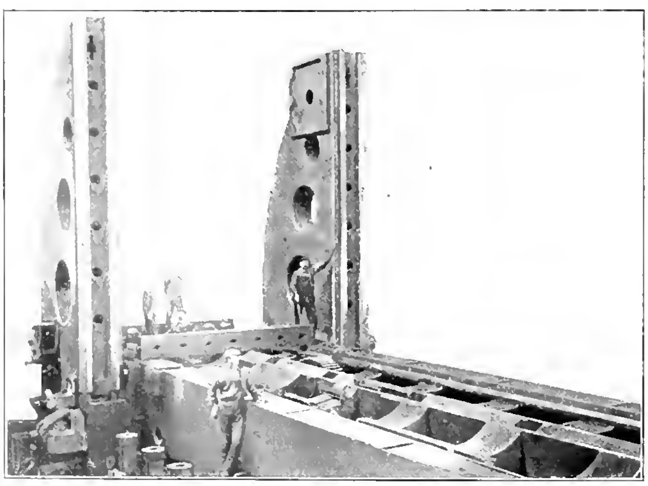


Fig 8 The Uprights Assembled.

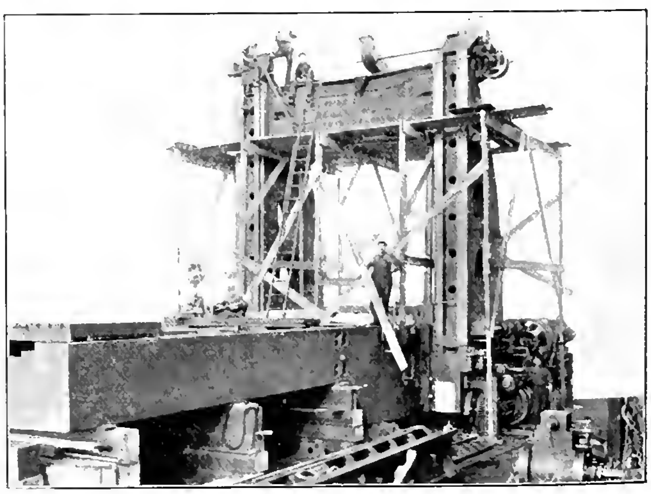


Fig. 9. Erecting the Tie-beam.

of the slotter bar is 8 feet. The cross planing movements of the heads, also referred to above, can be varied as to speed within certain limits, and are also provided with a quick return motion. The movements for slotting and transverse planing make it necessary to throw out the rack driving mechanism of the table. When the machine is used for slot-

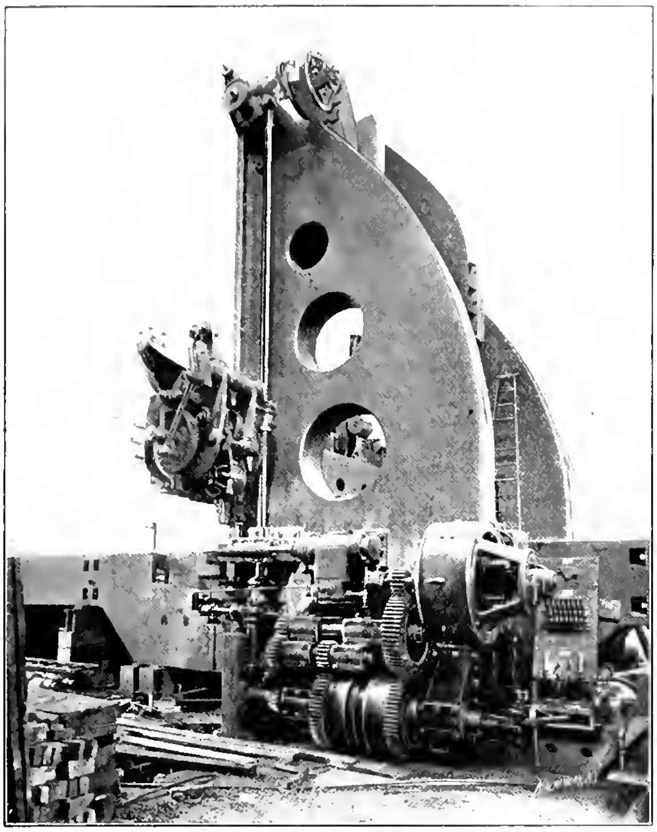


Fig. 10. View showing the 100-horse-power Motor for the Main Drive.

ting or transverse planing, the table is connected to a separate feed motion entirely distinct from the rack feed motion. The throwing out of the driving mechanism is accomplished by simply putting the pneumatic driving clutches into the idle position.

Speeds and Feeds.

The cutting and return speeds are variable through the motor, which has a variation of 1 to 1¼. Changes in speed may also be effected through a range of change gears. The regular cutting speeds are from 14 feet to 25 feet, and the

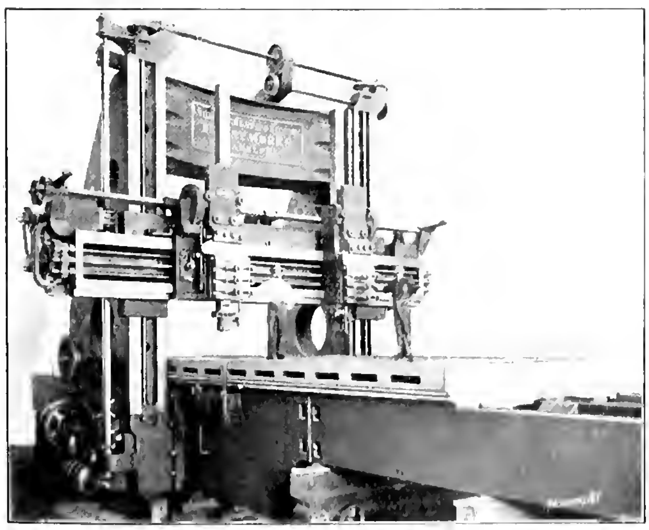


Fig. 11. View of the Slotter Drive.

return speeds are from 52½ to 65½ feet per minute. The slotter bars have a cutting speed of from 18½ to 30 feet, and a return speed of from 57 to 71 feet. Finally, the cutting speed for cross planing is from 11½ to 19 feet, and the return speeds from 35 feet to 13½ feet. The cross traverse feed of the heads is 50 inches per minute. The vertical speed for raising and lowering the cross rail is 26 inches per minute.

The Main Drive.

In Figs. 1 and 10 the main drive from the 100-horse-power motor is clearly shown. The drive is through gearing from the motor to the pneumatic reversing clutches at the base of the right-hand upright. These pneumatic clutches are completely encased, and are made, according to the Niles-Bement-

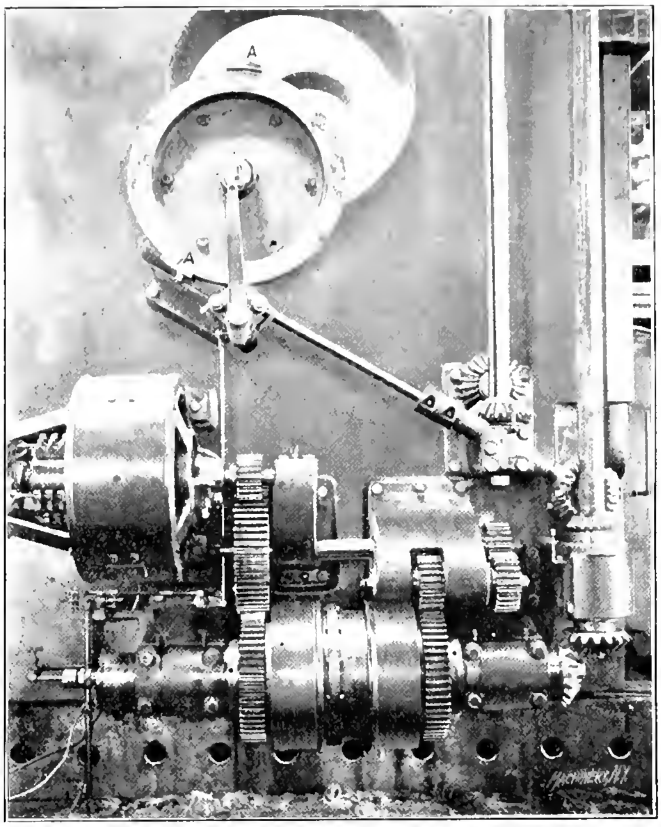


Fig 12. Detailed View of the Slotter Drive.

Pond type, with a large number of friction disks, through which arrangement a large friction area is obtained within a comparatively small space. The stopping, starting, and reversing of the table is controlled through a small valve easily moved by hand. The remaining portions of the drive, from this point on, are practically in every respect the same as those found on other planers, excepting, of course, that the drive distinguishes itself through its enormous proportions. All parts of the drive are made of steel, and the two bull pinions are forged directly on the shaft. They are cut so

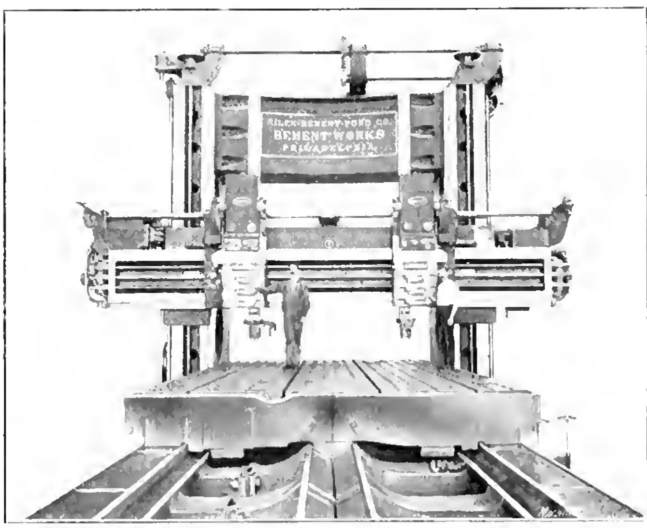


Fig. 13. Front View showing the Three Ways which support the Table

that the teeth of the one are half a pitch ahead of the teeth in the other. This arrangement tends to produce smoothness of action.

The Pneumatic Feed.

The feed of the cross-heads is operated pneumatically. On the side of the upright, just above the gearing, Fig. 10, there is a cylinder with a piston rod extending to the left. In this

piston rod rack teeth are cut which mesh with a pinion near the lower end of the vertical feed shaft. Near the extreme end of this shaft is placed a bevel gear meshing with another bevel gear on a horizontal shaft, which latter transmits motion to the vertical feed shaft on the left-hand upright on the other side of the planer. The movement for these feed shafts is constant at all times, and the variations in amount and direction of the feeds of the heads are obtained by adjusting the connecting-rods in the slotted cranks on the ends of the cross-rail. In order that definite cross and vertical feeds may be obtained, these cranks are graduated. An angular feed can be obtained and given to the tool by using at the same time the slotted cranks for both vertical and cross feeds. This provision is also necessary on account of the fact that the heads are not designed to swivel. At each end of the stroke of the planer table the valve controlling the air

scale. The general arrangement of this drive is the same as for the main drive on the opposite side, up to and including the pneumatic clutches. For the slotter drive the power is then transmitted through bevel gears to a vertical square shaft, from which the power in turn is transmitted to a horizontal square shaft running on the top of the cross-slide, as plainly shown in Fig. 11. A pinion on this shaft drives a large gear enclosed in the gear cover shown at the side of each head. On the same shaft as this large gear is a pinion which meshes with the rack teeth on the back of the slotter bar. The pinion on the square shaft slides back and forth on the shaft, and can be thrown out of mesh when desired, so that either one or both bars may be used. The disk or wheel shown directly above the motor on the left-hand upright controls the length of the stroke of the bar. This disk is driven from the vertical square shaft, and adjustable stops

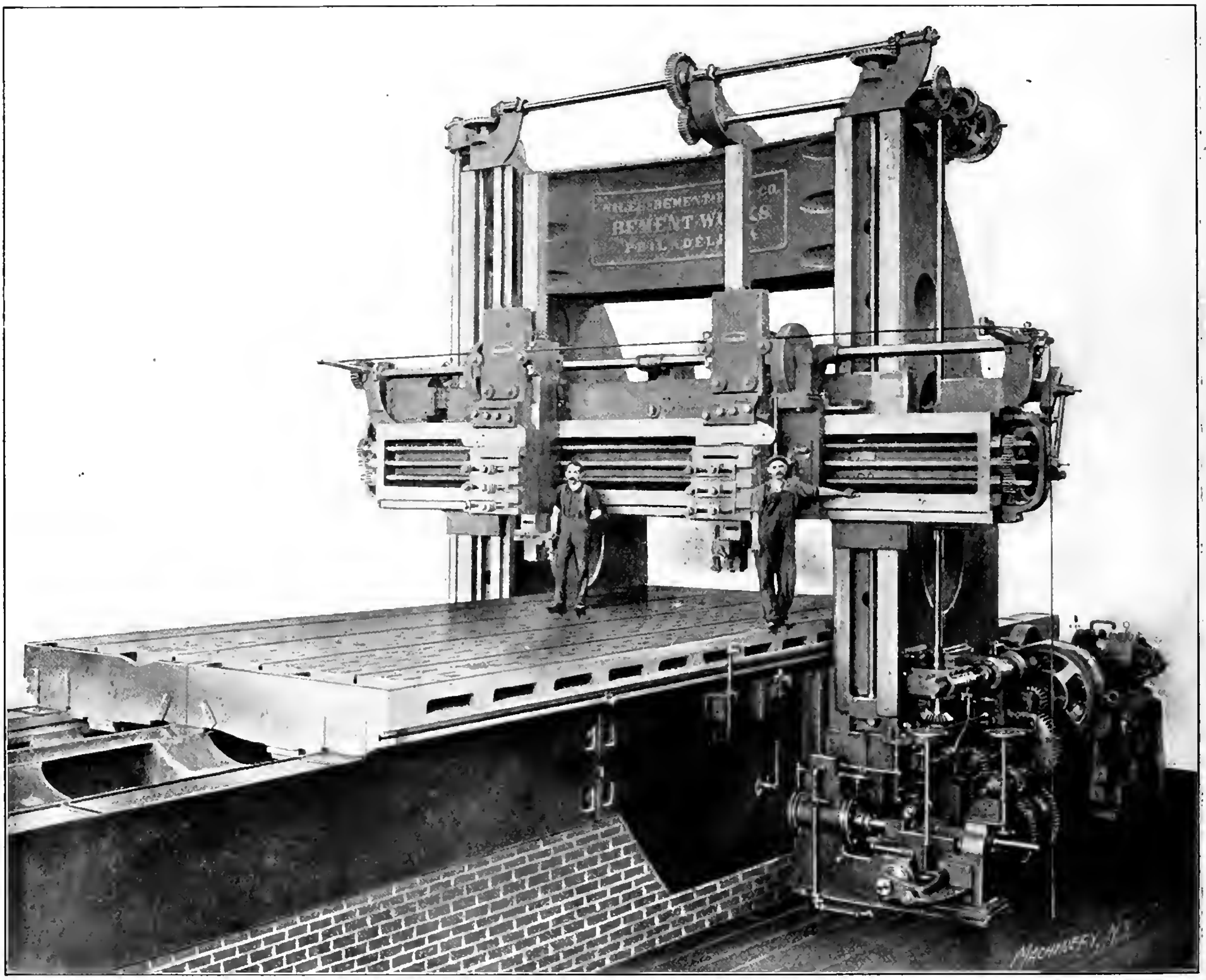


Fig. 14. General View of the Planer showing the Slotting Attachment and the Feed Mechanism.

for the feed cylinder is tripped automatically. The feed is thrown out by the closing of a valve on the main air supply pipe to the cylinder.

The table feed, which is used when slotting or planing transversely, was not put in place when the photograph from which Fig. 10 was reproduced, was taken, but it is shown in Fig. 14 directly in front of and at the base of the upright. The operation of this feed is practically the same as the operation of the feed for the cross-head, previously described, excepting that the amount of feed is obtained by varying the stroke of the piston in the cylinder, an adjustable stop being used for this purpose. This adjustment is made by the right-hand hand-wheel shown in Fig. 14, the left-hand hand-wheel serving the purpose of connecting and disconnecting this feed mechanism to and from the main driving shaft.

Slotter Drive.

In Fig. 11 is shown the slotter drive on the left-hand side of the planer, and in Fig. 12 this drive is shown in a larger

on the outside of its rim can be set at any desired point. These stops effect the reversal in the same way as the dogs on the side of the planer table effect the reversal of the table motion. Near the lower end of the vertical square shaft is seen a bevel gear on the end of a horizontal shaft through which motion is transmitted through the bed and to the other side of the planer, where the shaft is connected to the mechanism operating the valve of the feed cylinder on the opposite side, so that the feeds are available when using the slotter bar as well as when using the main drive for the planer.

Hand Control of Slotter.

In Fig. 14 a vertical shaft will be noticed (at the usual place for the reversing lever) the upper end of which is provided with two sockets, in one of which there is a handle. The upper of these sockets is connected to a shaft which runs down to the bottom lever or crank. This handle is for the hand control of the slotter. The method of connection can

be easily followed, starting from the handle shown in Fig. 14, going through the bed to the corresponding arrangement in Fig. 11, and then following the curved connecting-rod running in back of the upright and out through the upright to the slotter reversing mechanism at the reversing disk previously referred to.

The lower socket in this vertical shaft controls the movement of the table when the planer is used for ordinary planing. The mechanism is then connected by a lever and rods to the reversing dogs on both sides of the planer. It will be noticed that only one handle is furnished for each side of the machine. This prevents mistakes arising from throwing the wrong lever.

The Planer Bed.

It is evident that the bed for a planer of such dimensions as this could not very well be made in one piece, or, at least, an attempt to do so would have been impracticable. To produce and handle such a piece of work in the shop would not only have been attended with the greatest difficulties, if at all possible, but it would also have been a very difficult piece to ship. The bed is therefore made in seven parts, each end section being made in two parts, and the central section being made in three parts. The total weight of the bed is about 275,000 pounds.

The Table.

The table of the planer is made in two sections, the table being divided longitudinally in the center. The weight of the two sections together is about 140,000 pounds. The holes in the table for clamping bolts, etc., run entirely through an upper plate, but below this plate there is a second plate, without openings, extending the full width of the table. In the pocket formed between two plates of the table, all chips will collect. These can then easily be removed through the side openings of the table, clearly shown in Figs. 11 and 14. The table slides on the bed on two flat ways at the sides of the table, and in one V-way at the center, as is shown in Fig. 13.

At the end of the table, as shown in several of the cuts, but perhaps most plainly in Fig. 13, there are finished pads, two over the V-way and to two over each of the flat ways. These pads are intended to carry tool-heads when it is wanted to true up the ways, when worn out of alignment. The method of performing this work is rather interesting and, as far as we know, distinctly new. The table is raised about ¼ inch above the ways, and is supported in this position on sliding blocks which fit the narrow inner auxiliary ways, shown in Fig. 13, which are used for this purpose only. The heads carrying the tools for truing up the regular ways are now fastened to the end of the table, the machine is started up, and the ways are trued up from the center to one end. The heads are then placed on the opposite end of the table, and the remaining portions of the ways are finished. Then the sliding surfaces of the table itself are planed up by placing the same truing heads in pockets provided in the ways in the bed, near the center of the machine. The accuracy of the finished work depends, of course, entirely upon the accuracy of the auxiliary ways, and these are therefore finished on the completed planer with great care.

Fast Traverse and Cross rail Operating Mechanism.

A motor for the fast traverse of the heads is shown at the end of the cross-slide in Fig. 10. The reversing is accomplished through friction clutches, and, in order to prevent the throwing in of the fast traverse and the feed mechanism at the same time, a special safety device is provided. The motor for operating the cross-rail is placed at the top of the right-hand upright, as shown in Figs. 1 and 10. This motor is connected at all times to the elevating screws, and is started, stopped, and reversed from the switchboard. The elevating screws for the cross-rail are firmly held at the top and bottom, and the cross-rail nuts are placed in square pockets against shoulders. It is expected that this will take care, satisfactorily, of the thrust of the slotter bars when in operation, but provisions have been made so that the cross rail can be firmly clamped to the uprights in case any trouble from loosening should be experienced.

FORMULAS FOR CIRCULAR FORMING TOOLS.

When laying out circular forming tools, such as shown in Fig. 1, the cutting edge, as is well known, must be located a certain amount below the horizontal center line of the tool, in order to provide for sufficient clearance for the cut. On account of this, the actual differences of diameters in the piece of work to be formed cannot be directly copied in the forming tool. The distance A in the piece to be formed must

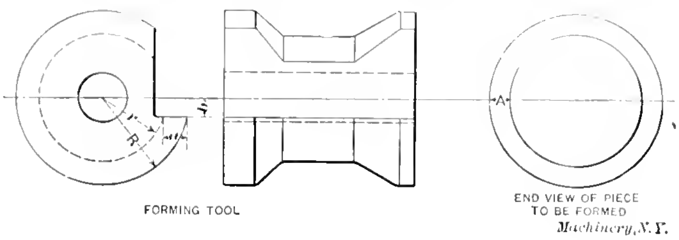


Fig. 1.

equal the distance a on the forming tool, but as this latter distance is measured in a plane a certain distance b below the horizontal plane through the center of the forming tool, it is evident that the differences of diameters in the tool and the piece to be formed are not the same. A general formula may, however, be deduced by use of elementary geometry by means of which various diameters of the forming tool may be determined if the largest (or smallest) diameter of the tool is known, the amount that the cutting edge is below the center, and, of course, the diameters of the piece to be formed.

If R = the largest radius of the tool,

a = difference in radii of steps, and

b = amount cutting edge is below center,

then, if r be the radius looked for,

$$r = \sqrt{(\sqrt{R^2 - b^2} - a)^2 + b^2}$$

If the smaller radius r is given and the larger radius R sought, the formula takes the form:

$$R = \sqrt{(\sqrt{r^2 - b^2} + a)^2 + b^2}$$

Suppose, for an example, that a tool is to be made to form the piece in Fig. 2. Assume that the largest diameter of the tool is to be 3 inches, and that the cutting edge is to be ¼ inch below the center of the tool. Then the diameter next smaller to 3 inches is found from the formulas given by inserting the given values: $R = 1\frac{1}{2}$ inch, $b = \frac{1}{4}$ inch, and $a = \frac{1}{4}$ inch (half the difference between 4 and $3\frac{1}{2}$ inches; see Fig. 2).

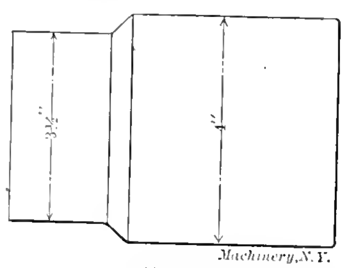


Fig. 2.

Then

$$r = \sqrt{(\sqrt{(1\tfrac{1}{2})^2 - (\tfrac{1}{4})^2} - \tfrac{1}{4})^2 + (\tfrac{1}{4})^2} = \sqrt{(\sqrt{\tfrac{35}{16}} - \tfrac{1}{4})^2 + \tfrac{1}{16}} = \frac{5.017}{4}$$

$= 1.254$ inch.

While the formula looks complicated, by means of a table of squares the calculations are easily simplified and can be carried out in three or four minutes. The value r being 1.254 inch, the diameter to make the smaller step of the forming tool will be 2.508 inches, instead of $2\frac{1}{2}$ inches exact, as would have been the case if the cutting edge had been on the center line.

* * *

The usual plan followed in making punches and dies is to harden the die, leaving the punch soft. The punch is generally finished to exact shape and size by shearing it into the die. An alternative practice which is advocated by some die-makers for such work as armature laminations, is to make the punch hard and the die soft, it being argued that the wear of the soft part, which then is the die, does not tend to raise a burr on the punchings. When the punch is left soft it leaves a burr on the work as it wears, which is very objectionable in the case of armature laminations. If the die is made soft it is not necessary to frequently peen the punch and shear it into the die to overcome the burring referred to.

THE ELASTIC LIMIT AND THE TESTING OF MATERIALS.

H. GANSSLEN.*

The following article is intended to explain in a popular way a subject on which manufacturers, mechanics, and others interested purely in what is called the practical side of the machinery business, judging from my experience, are greatly in need of some definite information. It is not meant to contain any information for specialists on testing materials, although even the specialist may find some valuable data in it, as the diagrams and the figures given are the results of actual tests made by the writer when in charge of the testing department of the E. W. Bliss Co., of Brooklyn, N. Y., and also while assistant to Prof. Bach, the well-known German authority on testing and strength of materials.

The term "elastic limit" has lately become quite popular around the factories and in the sales offices, but I have met very few people who have a clear idea of what the term really means, and of what practical use its application is. I cannot help but cite a case illustrating this lack of familiarity with the subject, even among people who ought to know. A few years ago I made some commercial tests of a special high-grade steel in the presence of the representatives of the two contracting parties and of the maker of the testing machine. The latter was asked by a venerable looking official: "What is elastic limit, anyhow?" After he got half through with what promised to be a fairly good definition of the term, the old gentleman interrupted him with: "You may be all right, but I don't know what you are talking about." There was a complete silence, and I doubt whether anyone present at that time knows any more about that mysterious thing, elastic limit, to-day than they knew then.

Method of Testing Materials.

By means of the following diagrams, the writer will try to illustrate what happens to a round test bar of steel under a load *P*, this load starting at zero and increasing by the bars

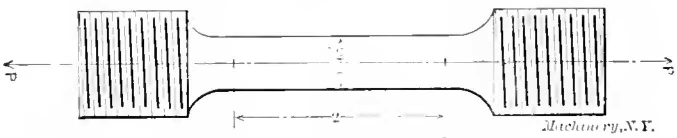


Fig. 1. Piece to be tested.

being stretched with a uniform speed of the machine, say 3/16 inch per minute, until the bar breaks. Fig. 1 shows the shape and dimensions of a bar which is, incidentally, the same as prescribed by the United States Government for certain purposes. The threads on both ends fit the two chucks on a testing machine, the upper one of which is stationary and a part of the machine frame, while the lower one is part of a cross-head moved by gears and screws which exert a tension on the test bar. Besides these parts, the machine consists of a system of levers, similar to the ones on scales, enabling the operator to see the load at any time. The diameter, 0.505 inch, of the test bar gives the latter a sectional area of 1/5 square inch, over which the total load is assumed to be equally distributed. The load on any test bar is, for the sake of comparison, usually expressed in pounds per square inch of its area, and is then called a unit-load. The resistance of the material is, of course, the same as the external force or load. A unit load of 1,000 pounds (external) causes a unit-stress of 1,000 pounds (internal), which holds the equilibrium. A thousand pound load on our test bar, for instance, would, therefore, cause $5 \times 1,000 = 5,000$ pounds unit-stress. After putting a load of 1,000 pounds on the bar, the length under observation, which was originally 2 inches, will then undoubtedly be greater, say 2.0003 inches. The quantity 0.0003 inch is called the elongation at the load of 1,000 pounds. This elongation for 1-inch length would be $0.0003 \div 2 = 0.00015$ inch, and this we call unit-elongation. It is generally assumed that all parts of the 2 inches of the bar under observation take an equal share in this elongation, or, in other words, the elongation is supposed to be equally distributed over the entire length. Elongations are measured with very fine instruments, extensometers, which are working either on optical or mechanical principles. It is a fundamental law that every stress should be accompanied by a deformation, however small it may be, and whatever material we may test, whether steel, iron, copper, brass, stone, concrete, wood, glass, etc., this holds true, but the amount of the deformation of these materials differs very much under the same stresses.

Fig. 2 shows a diagram giving the unit-stresses and the respective unit-elongations of a piece of high-grade steel of

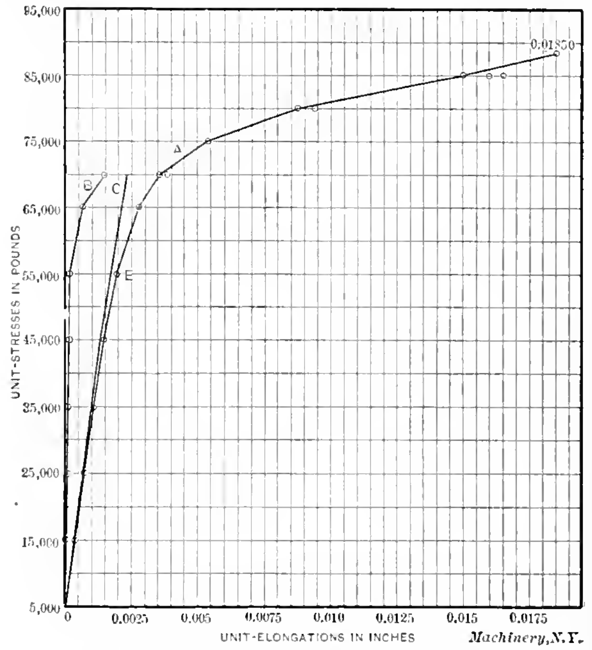


Fig. 2. Diagram of First Part of Test.

the dimensions given in Fig. 1, which I tested some time ago. Curve *A* gives the *total unit-elongation*, as per the accompanying table, *B* the *permanent sets*, and *C* is the curve of the *elastic unit-elongations*, which was arrived at by deducting *B* from *A*. The table gives also the actual record of the test, the load, as indicated on the beam of the testing machine and the corresponding extensometer readings. As seen from the table, a small initial unit-load of 5,000 pounds per square inch was put on the bar, to have all the parts of the testing machine and extensometer in tension. After gradually increasing the unit load to 45,000 pounds, there was a total unit-elongation of 0.00145 inch. At this point the load was reduced to the initial one, and there was noticeable a slight permanent set of 0.00015 inch. The difference of 0.00145 and 0.00015, equaling 0.00130 inch, is called the elastic unit-elongation, as it disappears completely after taking the

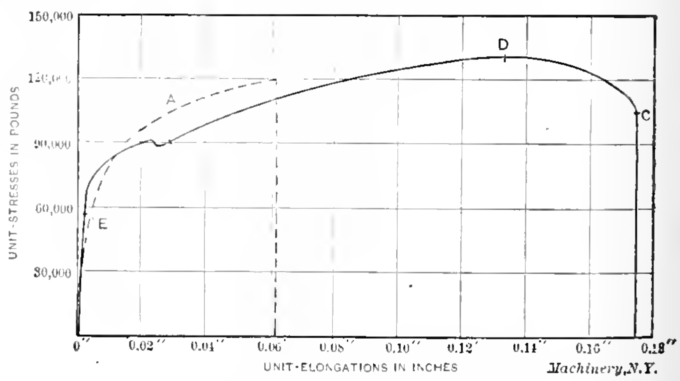


Fig. 3. Diagram of Complete Test.

load off. The permanent set at that point and up as far as 55,000 pounds unit-stress (point *E*, Fig. 2), is so small as to be almost negligible. It is due to some extent to the natural error in reading the instrument. Above point *E* the curves of the total and permanent elongations deviate from the hitherto straight line, *i. e.*, the permanent set of the material becomes now more marked. The stress 55,000 pounds is therefore called the *elastic limit* of this particular material, as any higher stress leaves a set in the material after releasing it, or, in other words, stretches the material beyond its elasticity. This test was continued up to a stress of

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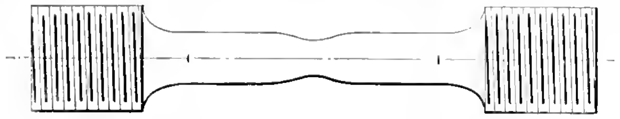
70,000 pounds, and then the bar was unloaded down to the initial 5,000 pounds per square inch; the permanent set at that point was found to be 0.0029 inch. Above 70,000 pounds stress the total elongations only were measured, as the elastic elongations are of no further practical value, the material being stretched beyond the range which is of importance for commercial engineering purposes. In Fig. 3 are, however, given the diagrams up to the point of fracture, from which we are still very far away. The material beyond point E goes into a "flowing" state, as small increases in the load produce now much larger elongations than was the case below E. Furthermore, the bar stretches without



Machinery,N.Y.

Fig. 4. Test Bar after having reached the Ultimate Limit of Strength.

increasing the load, as shown by the figures in the table, and also in Fig. 2, at 80,000 and 85,000 pounds stress. Time now becomes a factor. The different elongations given for each of the two loads were recorded within small fractions of a minute. At 88,500 pounds stress per square inch the extensometer was removed, as it had reached the limit of its capacity, and because the elongations could now be measured near enough for the purpose with a pair of dividers. A stress of 93,000 pounds brings us to the most remarkable point of the whole test. The material, without any outward signs visible to the naked eye, seems to utterly collapse; it stretches from

RECORD OF TEST ON STEEL BAR.

Load in pounds.	Stresses, Pounds per square inch.	Elongations, inch.	Unit Elongations, inch.
1,000	5,000	0	0
3,000	15,000	0.0007	0.00035
5,000	25,000	0.0014	0.00070
7,000	35,000	0.0021	0.00105
9,000	45,000	0.0029	0.00145
1,000	5,000	0.0003	0.00015
9,000	45,000	0.0029	0.00145
11,000	55,000	0.0038	0.00190
13,000	65,000	0.0056	0.00280
14,000	70,000	0.0072	0.00360
1,000	5,000	0.0029	0.00145
14,000	70,000	0.0075	0.00375
15,000	75,000	0.0108	0.00540
16,000	80,000	0.0173	0.00865
16,000	80,000	0.0186	0.00930
17,000	85,000	0.0300	0.01500
17,000	85,000	0.0320	0.01600
17,000	85,000	0.0330	0.01650
17,000	85,000	0.0370	0.01850

0.023 inch to 0.032 inch per inch length, and the load which the bar was able to stand in the meantime dropped down to 90,000 pounds, until it reached 93,000 pounds again at 0.032 inch elongation. The stresses 93,000 and 90,000 pounds per square inch are called the *upper* and *lower yield-points*, respectively. In practical life they are frequently, but wrongly, called elastic limit. After this stage the material revives again, and the load can be materially increased, the elongations becoming greater and greater for the same increments in load. The maximum load this particular test bar stood was 131,500 pounds per square inch. This is called the *ultimate strength* of this material. After this point was

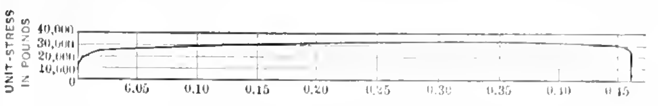


Fig. 5. Diagram of Test on Copper.

passed, the test bar was getting thinner at one point, it contracted more and more, and the load which the material stood became smaller and smaller, as the descending part of the curve, Fig. 3, shows, until the bar broke at point C. Fig. 4 shows the test bar after point D, Fig. 3, was passed, *i. e.*, after the local contraction became plainly visible. The elongation in 2-inch length, measured after the fracture, was 0.354-inch, or $\frac{0.354}{2} \times 100 = 17.7$ per cent. The smallest diameter at the place of contraction measured after the fracture was 0.380 inch, which gives a reduction of area, or contraction, of 43.4 per cent.

By planimetering the area of the diagram, Fig. 3, it is possible to find the work in foot-pounds necessary to tear the material apart. This is sometimes called *resilience*. The amount of work necessary to stretch the bar up to its elastic limit is called the *elastic resilience*, and it can be reclaimed. It is not intended here to further consider this subject, except to show by curve A, in Fig. 3, how little work it took to break a similar piece of steel heat treated in a different way. The test piece has almost the same tensile strength (120,000 pounds per square inch) but only 6.3 per cent elongation and 14.4 per cent contraction. One shock will lead to its fracture, where it would require several shocks of the same kind to break the material described above. The ultimate strength of a material alone is, therefore, no criterion as to its fitness for any particular purpose. It will be noticed from the diagram that there is no yield-point perceptible in this material.

It may be in place here to also explain in a few words a term which is often used—coefficient of elasticity. At 55,000 pounds stress (Fig. 2) there is an elastic unit elongation of 0.0018 inch. The coefficient of elasticity is, therefore $\frac{0.0018}{55,000} = \frac{1}{30,500,000}$. The modulus of elasticity is the value 30,500,000. The coefficient of elasticity is nothing else than the elastic unit-elongation per one pound stress. It is a measure of the

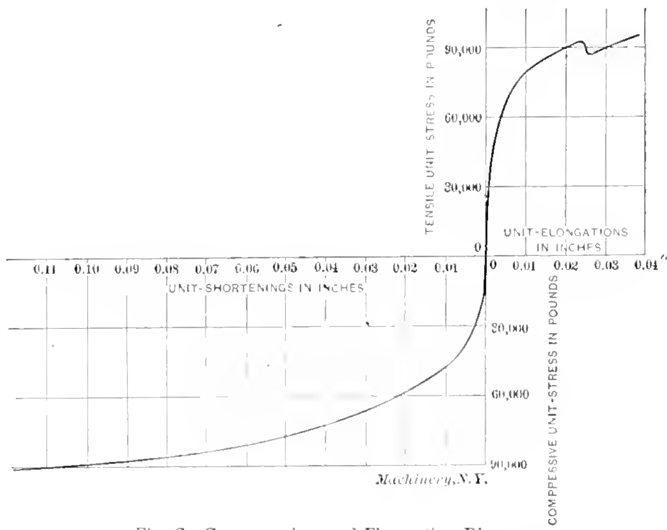


Fig. 6. Compression and Elongation Diagram.

elasticity of various materials. Leather, for instance, is very elastic, wood is less so, and steel still less elastic, their coefficients of elasticity being respectively about

$$\frac{1}{18,000},\ \frac{1}{1,300,000},\ \text{and}\ \frac{1}{30,000,000},$$

the largest coefficient referring to the most elastic material, and *vice versa*. The *degree of elasticity* is something different from the measure of elasticity. It refers to the elastic elongation in proportion to the total one of the same material at the same load; the steel in Fig. 2 at 55,000 pounds stress, for instance, would show this ratio to be $\frac{0.0018}{0.0019} = 0.95$. The nearer this ratio comes to 1 the more perfect the elasticity is, or, in other words, any material showing no set at a certain load, after same is removed, is called perfectly elastic at that load.

Concluding Remarks.

As to the practical application of the term elastic limit, the buyer of materials, especially of steel with a specified elastic limit, should realize that it is very necessary to state what he means by elastic limit, it having become rather customary to use the term wrongly in place of yield-point. It is possible to obtain steel for about 3½ cents per pound, which will, if properly treated, have a yield-point of probably 90,000 pounds per square inch, besides having quite an appreciable elongation, say, 15 per cent. The buyer might, how-

ever, be very disappointed if he would try to treat it so as to obtain an actual elastic limit of 90,000 pounds per square inch, the term this time being used in its correct meaning as given in the above definition, which is generally accepted by engineers. Another factor which makes the word elastic limit a rather uncertain and vague term, is the speed at which the test bar is being stretched during the test. For the test piece shown in Fig. 1, the United States Government in certain specifications requires a speed of the testing machine, that is, an elongation of the test bar, of from ½ inch to 3 inches per minute. Aside from the large margin it leaves the operator of the machine, even the smallest of specified speeds appears much too large for such a short test bar, especially where high-grade steel is used, inasmuch as the load comes on very suddenly, almost like a shock. Under such conditions it takes a very skilled operator to determine the yield-point with any degree of accuracy. The yield-point, as well as the ultimate strength, is greater under such high speed than under slower ones. This difference has been found to amount to as much as 15 per cent. (See C. Bach, Elasticität und Festigkeit, 1898, page 129.) Government inspectors are very strict, as they ought to be, with regard to the margin below and above the elastic limit required. It seems to be an urgent necessity to introduce proper rules regarding the speed of tests, and to the writer it appears that a certain maximum increment of stress per minute for each class of material would be a better way of putting it than the one mentioned above, as this would eliminate the proportions of different test bars.

Fig. 5 shows a diagram of a test of copper under tension, having no yield-point at all; the same applies to the particular steel shown in curve *A*, Fig. 3. Not all materials possess a yield-point. As a criterion as to what stress we should then allow on any part of a machine or structure, we will have to use the curve of the total elongations and permanent sets. For special purposes, as for instance, embossing press work, we are only interested in the curve of the permanent sets of the material to be embossed. Without going further into this subject at this time, there is shown, in Fig. 6, a curve of the permanent sets of a Bessemer steel cylinder under compression (Transactions of A. S. M. E., 1906) as compared with the steel in Figs. 2 and 3 under tension. Whereas, the yield-point of the tension curve is plainly marked, it hardly is marked at all in the compression curve. There we might consider it as being at from 50,000 to 60,000 pounds per square inch, and the material's range of usefulness for embossing lies above these points, below which its applicability for ordinary engineering purposes has already ceased.

* * *

It is less than a decade ago since the first turbine was sold in the American market, but there are to-day about 700 in use throughout the country, aggregating a total capacity of approximately 1,000,000 kilowatts or about 1,350,000 horse-power. This great demand for a new prime mover is, of course, easily explained by the advantages the turbine has over the reciprocating steam engine. An interesting test was conducted recently by the engineers of the New York Edison Company at the Waterside Station near 30th Street, which developed facts hitherto unattained by any steam prime mover in this country. The unit under test was a Westinghouse turbine of 10,000 horse-power capacity. It had been sold under a steam consumption guarantee of 15.9 pounds of steam per kilowatt hour, but the test recorded the phenomenally low steam consumption of a shade less than 14.9 pounds per kilowatt hour. (See MACHINERY, November, 1907, engineering edition.) Apart from the fact that this result gained a bonus for the Westinghouse turbine of over $25,000, it is of interest to all users of steam engines as an illustration of the lowest record for steam consumption which has ever been recorded by a stationary steam engine. This steam consumption figures less than 1½ pound of coal per kilowatt hour. It should be mentioned that the steam supply was superheated, which fact, of course, materially reduces the steam consumption without a corresponding reduction in consumption of heat units.

NEW SHOP OF THE MUELLER MACHINE TOOL COMPANY.

Improvements and new buildings have been the order of the day with most machine tool firms during the last two or three years, and we have from time to time recorded some new shop constructions in our columns. In this issue we show two half-tones of the interior appearance, and a number of line cuts of the plan and elevations, of the new shop of The Mueller Machine Tool Co., Cincinnati, Ohio. This shop has been completed during the year just past, and the machinery and equipment has just been installed. The general arrangement of this shop, as well as some of its commendable constructional features, may prove both of interest and of suggestive value to persons who either directly or indirectly may be connected with the planning of new shops or additions to present plants.

The feature which is most strikingly apparent when one examines the two half-tones showing the interior of the shop is the excellent light afforded by the numerous and large windows as well as by the skylights above. To persons acquainted with shop photography, a good idea of the excellence of the light is afforded by the statement that the photographs from which the half-tones shown were reproduced were taken with a 5 seconds exposure, F-16 stop, at 12:15 P. M. The main shop is a one-story building, but the rear portion of the shop is provided with a basement which, in fact, adds another story for half the length of the shop. This basement has the same advantages of good light from the outside as the main floor, on account of the difference of the ground level at the front and rear of the shop, the slope at the rear end amounting to about 12 feet. In this basement all the unfinished stock and other raw materials are stored. The floor is made of concrete, and wide doors are provided from the yard so that a wagon may drive right into the basement for unloading, a traveling crane being provided for facilitating this work. In the basement is also installed a Stewart combination hot blast furnace, and the forging shop is located here. All hardening, case-hardening, etc., also takes place in this portion of the shop.

The floor level of the main shop is three feet above the street level, which makes it very convenient for loading and unloading machines to and from trucks, the wagons or drays being backed into the building at the drive-way shown in the lower part of the plan view, Fig. 3. The opening into the street from this drive-way is provided with steel rolling shutters which can, without much trouble, be closed, and thus, during cold weather, as soon as the team has been backed into the drive-way, the shutters may be closed during the loading and unloading, thereby retaining the heat in the shop. All machine tools are installed on the rear portion of this floor, one side and the middle of the building being almost entirely given up to the machine tools themselves, while the erection and bench work is done on the other side of the building. In the front of the building are the offices, drawing-room and the shop washroom, which latter is provided with individual lockers for the men. A special stock-room for finished material is located behind the drawing-room, or rather, between the drawing-room and the shop. The main entrance to the building opens into a vestibule from which one may enter either the office to the right or the shop directly in front. At the rear of the building the freight elevator is installed for carrying material between the basement and the main floor. The platform of this elevator is 6 feet by 9 feet, and it has a carrying capacity of 5 tons. The stairs leading down to the basement are located immediately beside the elevator. Near the elevator, also at the rear of the building, is shown a steel chute through which all the chips from the machine operations are dropped. The chute leads to a concrete bin outside of the building, in which the chips are stored until disposed of. The building is steam heated, the steam being generated by an "American" low-pressure boiler. All the benches along the wall are three inches from the brick wall, in order to permit the pipes to be carried near the wall and keep the direct radiation of the heat away from the men working at the benches.

Of the general specifications for the shop the following data

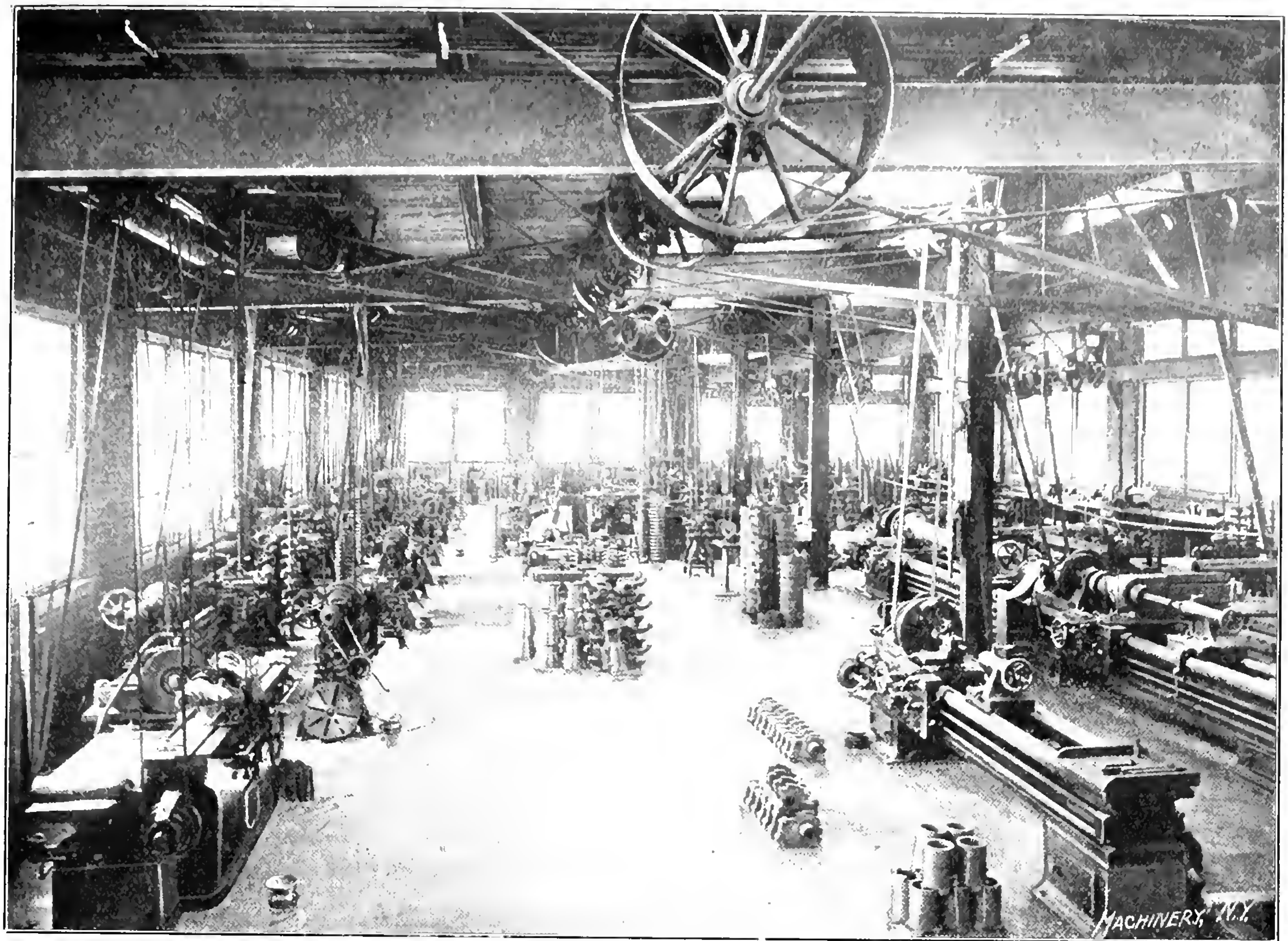


Fig. 1. View of the Machine Tool Department of The Mueller Machine Tool Company.

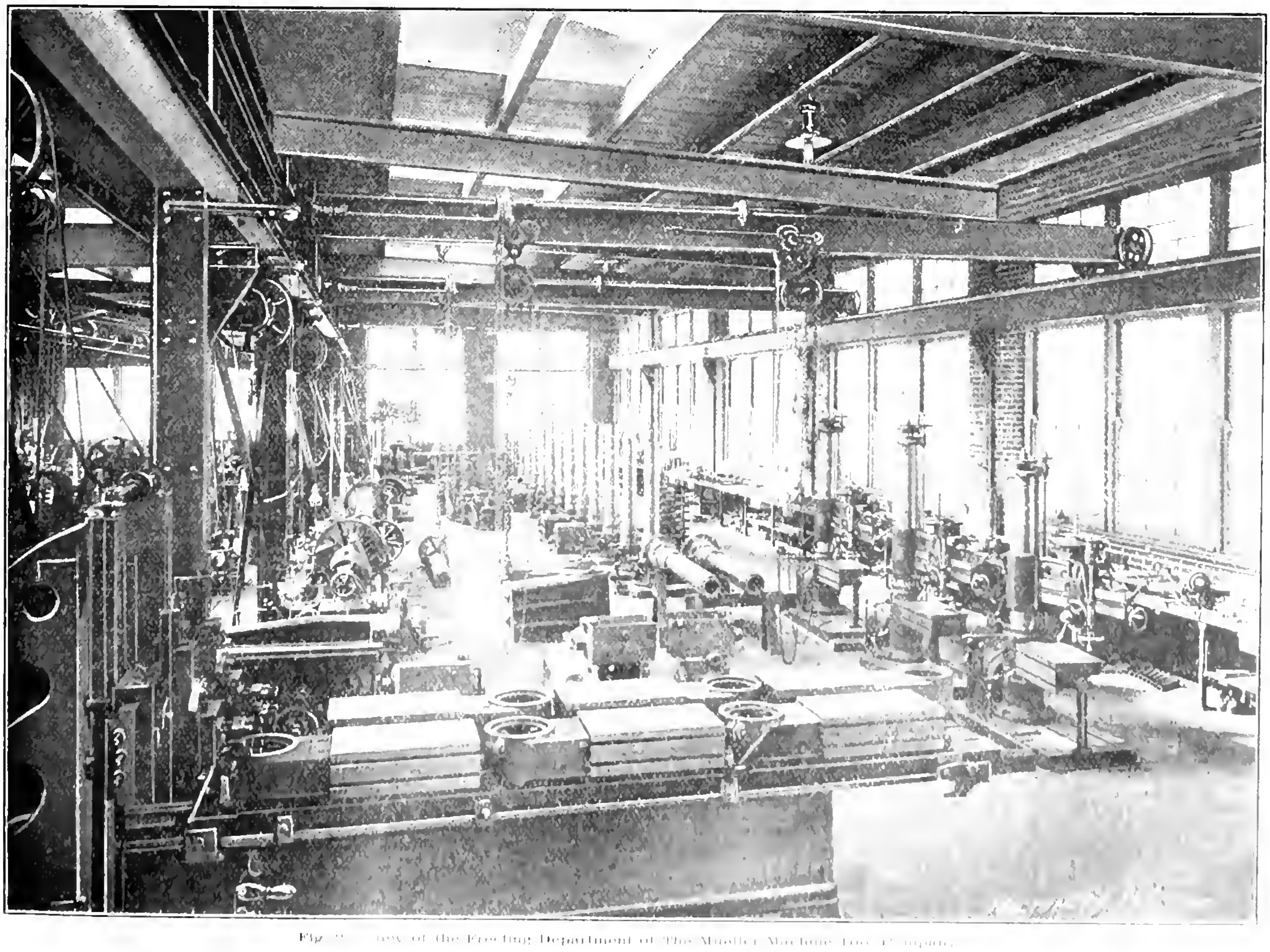


Fig. 2. View of the Erecting Department of The Mueller Machine Tool Company.

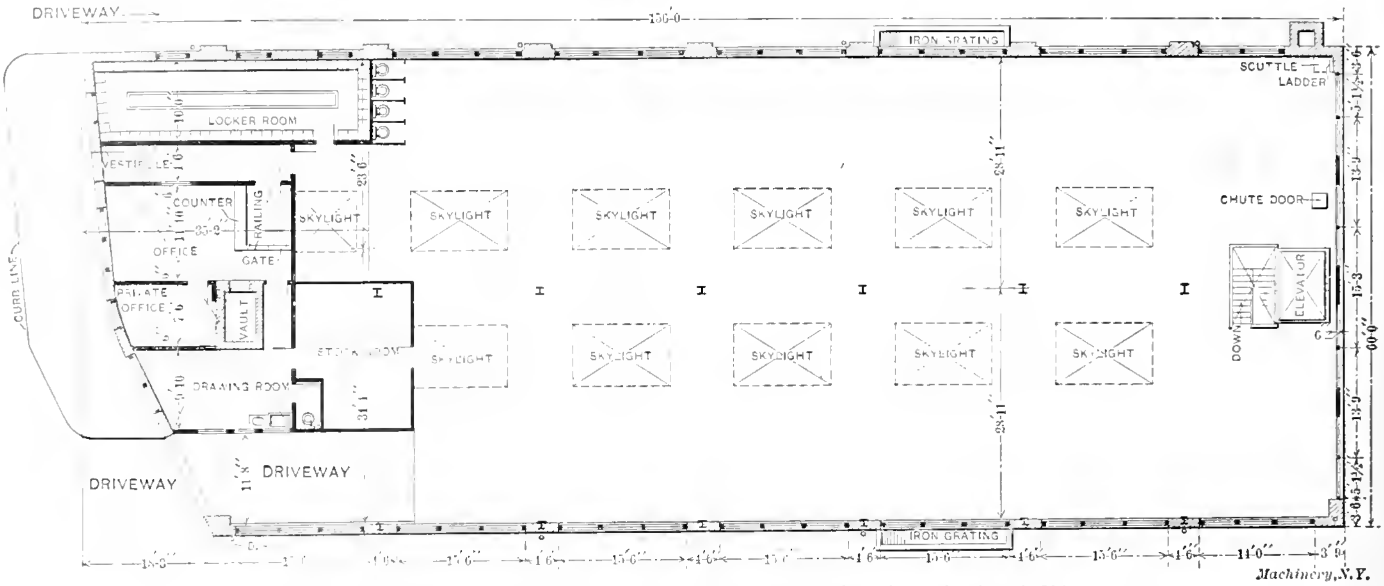


Fig. 3. Plan of the First Floor of The Mueller Machine Tool Co.'s Shop, Cincinnati, Ohio.

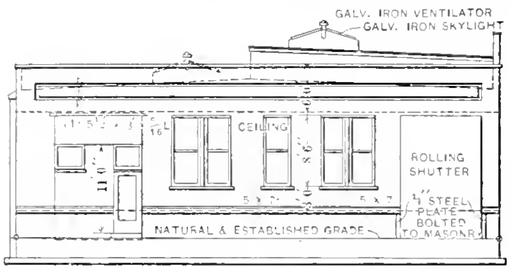


Fig. 4. Front Elevation.

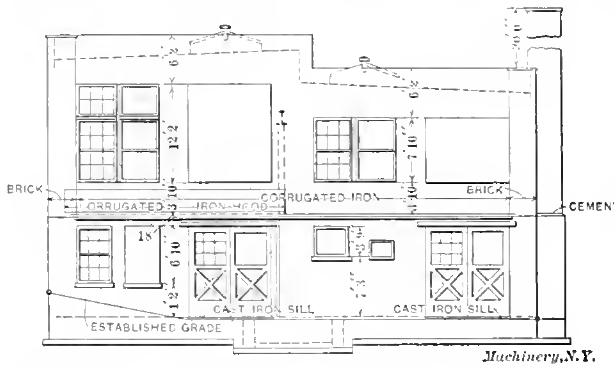


Fig. 5. Rear Elevation.

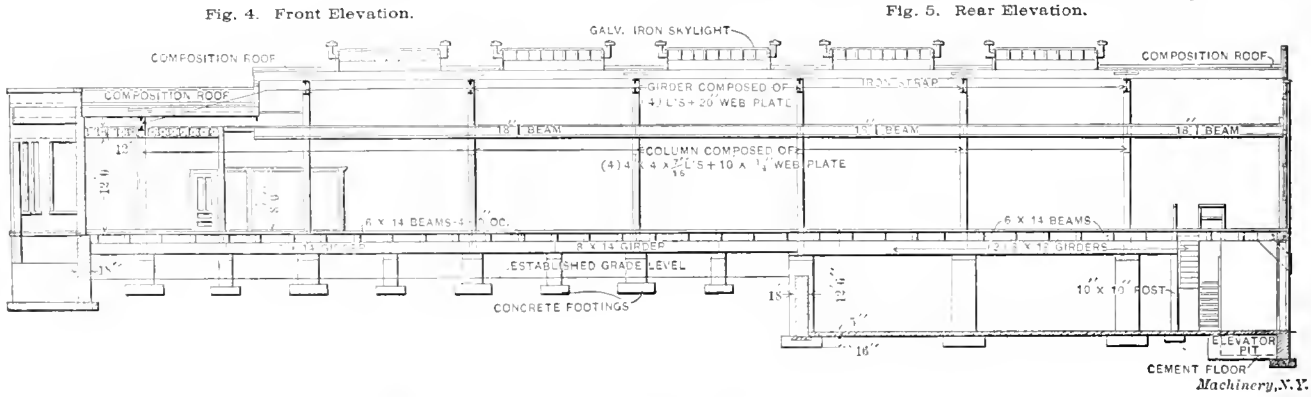


Fig. 6. Longitudinal Section.

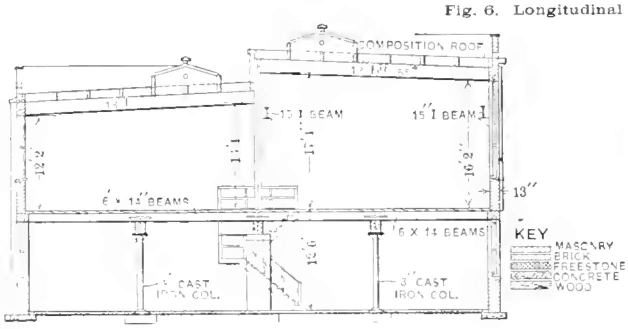


Fig 7. Cross-section through the Shop.

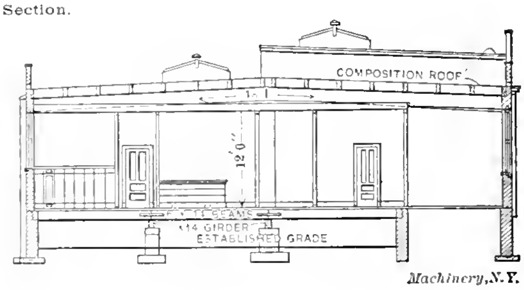


Fig. 8. Cross-section through the Office Partitions.

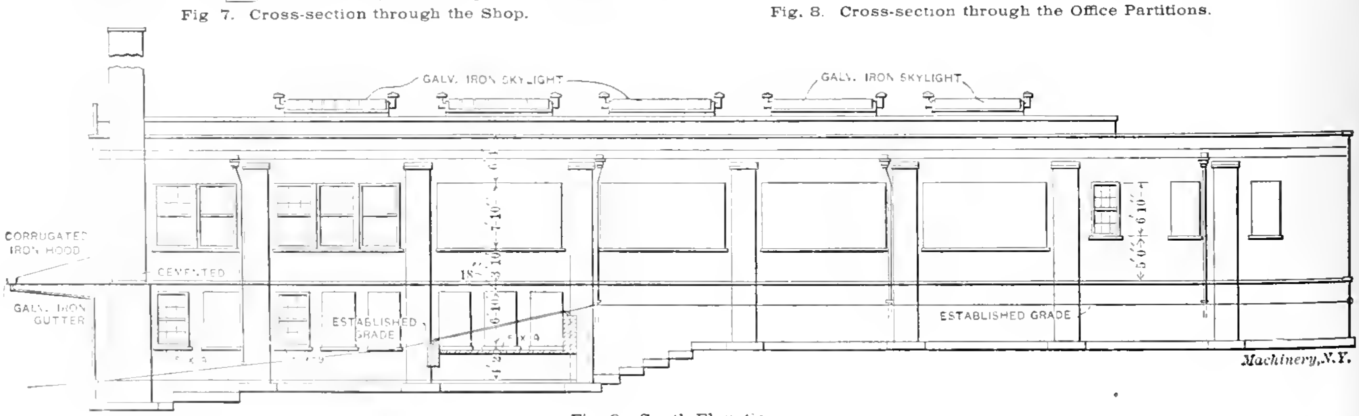


Fig. 9. South Elevation.

may be of interest and of suggestive value. The floor on the upper or main story in the shop is laid diagonally with 2¼-inch tongued-and-grooved pine lumber, and has a top layer, laid diagonally at an opposite angle, of ⅞-inch tongued-and-grooved maple lumber. The steel columns through the center of the building are placed 20 feet apart, and carry 18-inch I-beams which in turn support the roof. The erecting side of the building has a clear height of 16 feet, it being possible to thus obtain a 12-foot lift with the cranes installed, each of which has a capacity of 4 tons. Besides the traveling cranes, there is at the rear wall of the building a 15-foot jib crane, intended to be used by the vise hands when handling parts of machines for assembling, such as heads, arms, tables, etc. The side of the shop, which is exclusively given up to the installation of machine tools, is 12 feet high, this height being the most convenient for the installation of counter-shaft and belting. The skylights, previously mentioned, are ten in number, each measuring 6 feet by 10 feet, projected area. By means of these skylights the middle of the shop is fully as well lighted as are the sides near the windows, and the light over the whole shop is diffused in the most satisfactory manner. The windows all come up close to the ceiling, and those on the north and south sides have transoms for ventilating purposes. Ventilators are also placed one at each end of each skylight.

The line-shaft is motor driven, a Bullock motor and a Renold silent chain constituting the drive. The motor, as will be seen from Fig. 1, is attached to the ceiling, as usual in this kind of installation. The line-shaft is provided with two Dodge clutches, so that sections of the line-shaft can be thrown out if required. All the line-shaft hangers, as well as the counter-shaft hangers, are supported by angle plates bolted directly to the I-beams, thus doing away with all wooden hanger planks. All large machine tools are placed on concrete foundations, while the smaller ones are simply bolted to the floor.

The general construction and equipment of the shop shows care and forethought, everything having been arranged so as to be advantageous for economical manufacturing as well as convenient for the men, and the shop constitutes a good example of moderate sized shop construction adapted to machine tool manufacture.

* * *

HOW A LARGE CASTING WAS PLANED ON A SMALL PLANER.

The photograph for the half-tone cut, Fig. 1, was sent to MACHINERY by Mr. L. T. Wilmarth, of the Wilmarth & Morman Co., Grand Rapids, Mich., to illustrate how a machine frame casting weighing about 1,200 pounds, and of very awkward shape, was planed on a 24 x 24 x 6-foot Woodward & Powell planer. While the method is not new it is of general interest to small shops which frequently are called upon to perform work that is beyond the ordinary capacity of their machine tools.

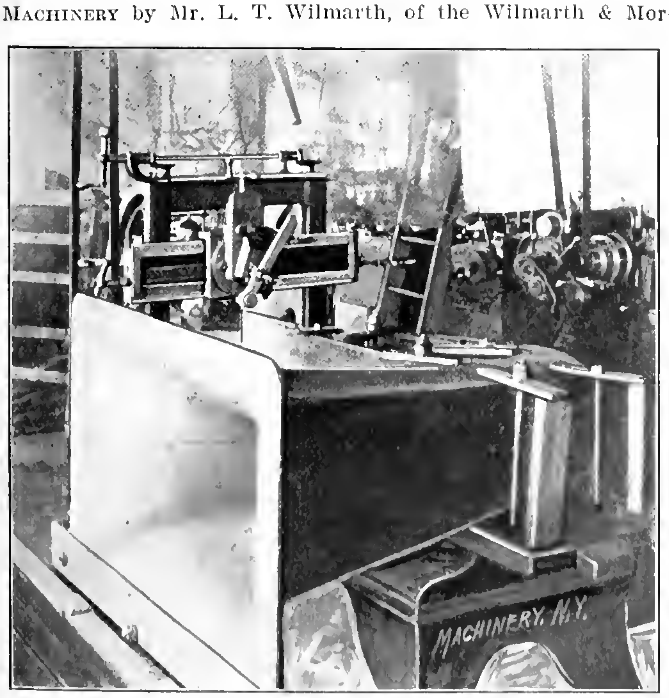


Fig. 1. Method of Planing a Large Casting on a Small Planer.

The surfaces to be planed were the two opposing faces of the jaws indicated by *A* and *B* in Fig. 2, being the upper and lower sides of the projecting arms at the outer ends. The upper surface was 7½ inches long by 14 inches wide, and the lower surface was 9¼ inches long by 14 inches wide. The lengthwise dimensions are in a direction parallel to the direction of the arms. The casting was about 63½ inches long, measured from the end of the lower jaw to the perpendicular through the back edge of the base; the width was 30 inches measured on the base; and the height was approximately 58 inches.

Obviously the casting could not be planed on a 24 x 24-inch planer without allowing the base to over-hang the table. The over-hang was about 3 feet and it was carried on a frame-work partly shown in Fig. 1. Its construction, however, was simple, consisting of three wooden blocks, 12 x 12 x 24 inches, laid on the floor at right angles to the planer bed, on which was placed a 9 x 12-inch x 12-foot timber lengthwise with the planer. This timber was strongly braced sideways to hold it in place, the braces being spiked to the timber and to the floor. A flat iron runway or track was screwed on top of the long timber and upon this track were placed two 2-inch rolls. On account of the unevenness and irregularity of the base, it was necessary to provide a straight-edge bearing for the casting which could be made parallel with the planer ways. This was made with two pieces of flat iron ½ x 4 inches x 4 feet long bolted or clamped to the lower edge of the base.

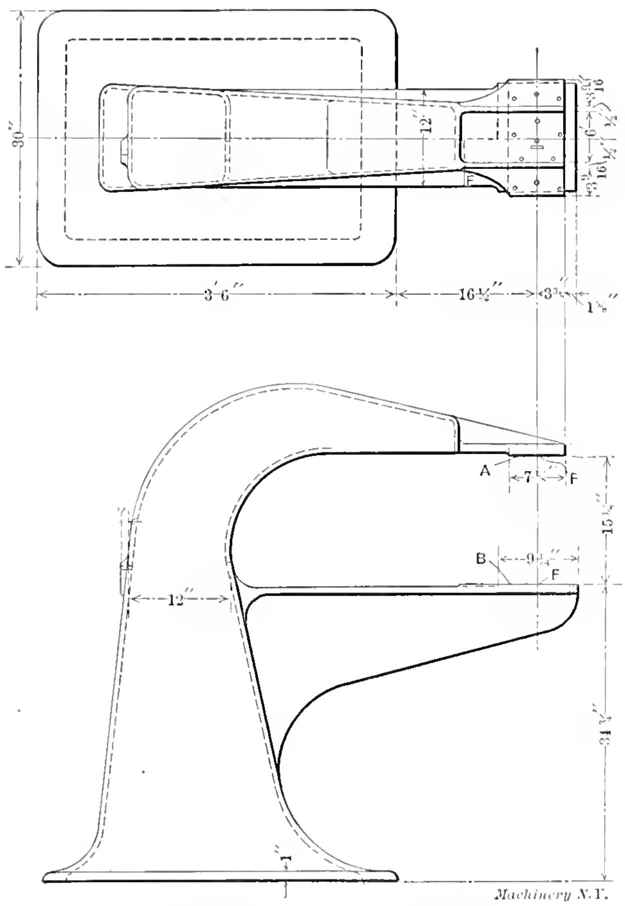


Fig. 2. Elevation and Plan of the Casting.

The time required for getting the outfit together and assembled, and the planing of the first casting was 28 hours; the time required for the second casting was 18 hours, but before the job of 20 castings was completed, the time was reduced to about 12 hours each.

* * *

At the end of 1906 the electric railways in the United States aggregated 36,212 miles. The equipment included 66,206 electric motor cars. Canada had at the same time 1,073 miles of electric railway.

MILLING OPERATIONS ON VISE PARTS.

JOHN EDGAR.*

Most of us are familiar with the flat machine vise, and we put a great deal of dependence upon its being square for the quality and accuracy of a great deal of our machine work, especially that done on the milling machine. The base must be parallel and square with the platen of the machine. The jaws must stand perpendicular with the top of the table, and lie at right angles to, or parallel with, the direction of the feed when the vise is tongued to the table. In order to fulfill all these conditions, and yet have the price of the vise reasonable, considerable planning must be done. The job of machining the parts that require the greatest accuracy is usually done on the planer. These parts are—the base, the slide, and the jaws.

The illustrations that accompany this article show how the different phases of machining these parts are done on the milling machine, and they represent the practice of a New England concern. The vises are manufactured in lots of from one hundred to three hundred. Little rigging up was necessary, and, outside of the cutters, the work called for but little

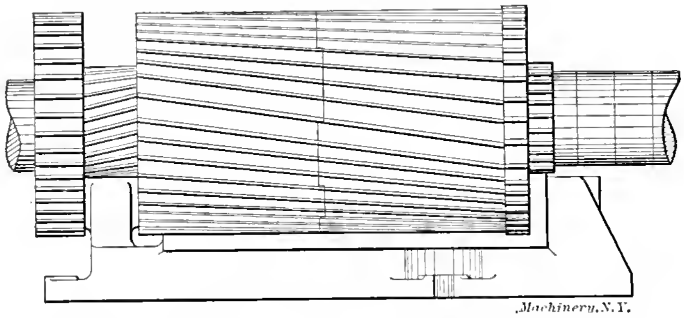


Fig. 1 Rough milling the Top of Base, Jaw Top, Jaw Backing and Screw Bosses with Gang Cutter.

extra expense for equipment. The form of the pieces is such that they are easily held on the naked platen by ordinary means—clamps and bolts. With three exceptions, no fixtures were used. The cutter gangs were for the most part made up from cutters on hand, as in but few of the operations were special gangs necessary. Had the several operations been carried on for a larger number, or for smaller lots, more frequently the case would have been different and special gangs would have been necessary. Of course, in work of this kind, the use of special gangs set up on an arbor for each gang eliminates the necessity of making up a gang and grinding same for the job to be done. However, under the circumstances, the results were, and still are, very satisfactory.

First Operation—Milling the Top of Base, Jaw Top, Jaw Backing and Screw Bosses.

The first operation on the base is shown in Fig. 1. For this, a special gang of cutters was used, as the relation of the sev-

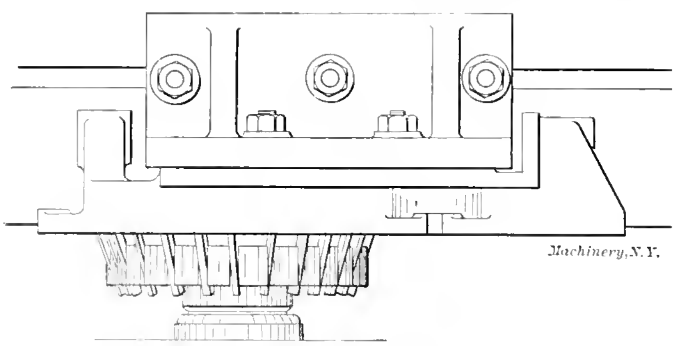


Fig. 2. Roughing Under Side of Base.

eral cutters in the gang made it necessary. This operation is that of roughing off the top of the base, the front jaw, "backing," and the bosses for the screw support. The base casting has a spot on the top of the screw support lug that is machined off so that it comes level with the top of the front jaw backing. The object of having it so is to furnish a bearing on which to rest the base when machining the bottom. The large slabbing cutter in the center of the gang is made interlocking so that the proper distance over all may be preserved. One end of this cutter is made with side teeth for milling the boss. The front jaw backing is milled by a side milling cutter made a trifle larger than the large cutter that lies alongside of it, so that a trough the width of the cutter is cut across the top of the base. The excess in diame-

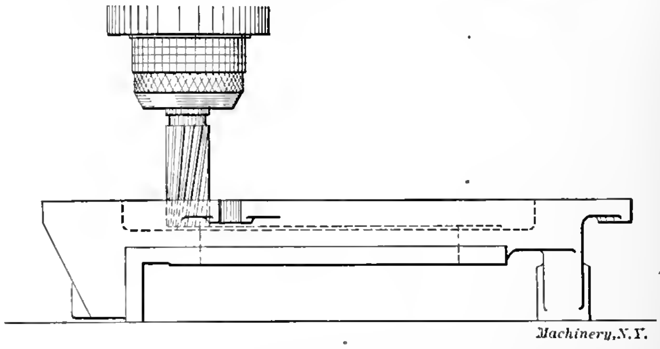


Fig. 3. Milling Under Strap Strips with End Mill, using Vertical Spindle Machine.

ter of the narrow cutter over the other is small, being about 1/32 inch. The reason for this narrow trough will be explained later on.

This operation was done on a heavy slabbing machine, and, while it was supposed to be a roughing cut, care was taken to have the finish fairly good, as the only surface re-milled was the top of the base. The pieces were strung on the platen, which was eight feet long, and were clamped as is ordinarily done on a planer. The feed was about three inches a minute, using high-speed cutters. The chip was light, only enough stock being left on the pattern to insure the removal of all the scale.

Second Operation—Roughing Under Side of Base.

The second operation was the machining of the under side of the base. This was accomplished on a horizontal milling machine, as shown in Fig. 2. The piece was held against an angle-iron bolted to the table. The reason for using the large inserted tooth cutter is that such a cutter will remove a greater amount of stock for the same expenditure of power, and will not strain the machine or holding devices so much as would a slabbing cutter. The face mill does not heat the work to the extent that a slabbing cutter does. The feed can

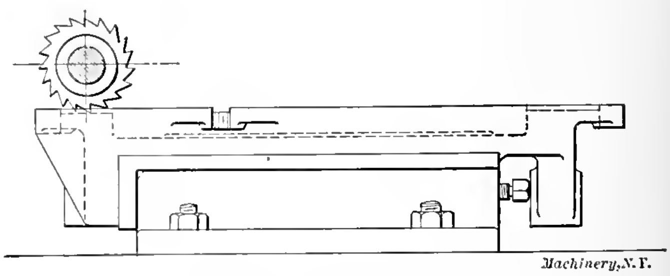


Fig. 4. "Tongueing" the Base.

be forced much faster than with the plain cutter, and the surface will not show the effects of such forcing. In all, a much better surface can be obtained with a mill of this kind on a broad surface than with the slabbing cutter. The feed, in this case, was forced to seven inches a minute, and the surface produced was all that could be desired. The feed was then dropped to five inches per minute, in order to save the cutter from repeated grindings. The bottom surface of the pattern for this piece is cut out considerably in the center, which, of course, counts for considerable in time of milling the resulting castings.

Third Operation—Milling Under Strap Strips with End Mill.

For the next operation we find ourselves among the vertical millers. Here we have the base turned bottom upward, and an end mill machining the strips for the binder straps to ride on. There are two of these strips, one on each side of the center line. Each strip has a slot running nearly its full length, through which the screws pass. The advantage of the vertical milling machine on this operation is apparent. The cut is in full view, and the ease with which the cutter can be dropped in to the proper depth is easily imagined. This

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is the class of work for which the vertical spindle machine is peculiarly adapted. The proper depth for each piece is obtained by means of a gage block which is set under the micrometer "set" screw on the side of the head. The screw is then adjusted until the cutter just touches the bottom of the base. The block is then removed, and the head is lowered until the screw strikes the shelf.

The milling cutter is as small in diameter and as short as is convenient, so that a high speed and a fine "quick" feed may be obtained, leaving a surface tnat is easily scraped. In

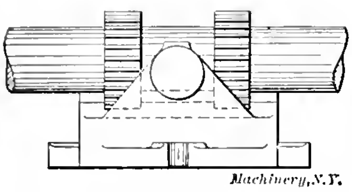

Fig. 5. Milling the Slots for the Movable Jaw.

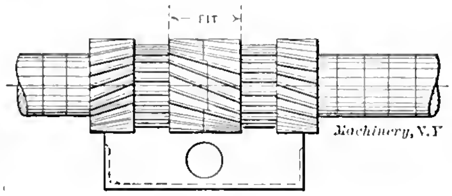

Fig. 8. Milling the Bottom Surface of the Slide and forming the Grooves.

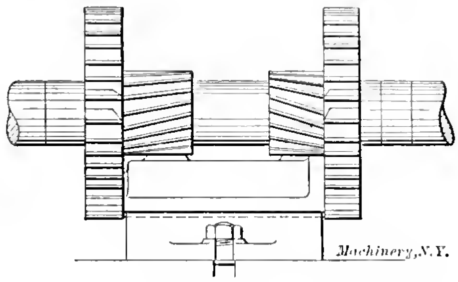

Fig. 9. Milling the Top of the Sliding Block.

this position, we use the spot spoken of in the early part of the article. The casting is clamped to the table by ordinary clamps and bolts.

Fourth Operation—Milling the Tongue Slots.

We now come to an operation, shown in Fig. 4, that requires a little care. This operation is milling the tongue slots—the most important feature of the flat vise, because should they be out of line or out of square the vise cannot be used with satisfactory results. The slots lengthwise of the base must be square with the front jaw, and the slots across the base

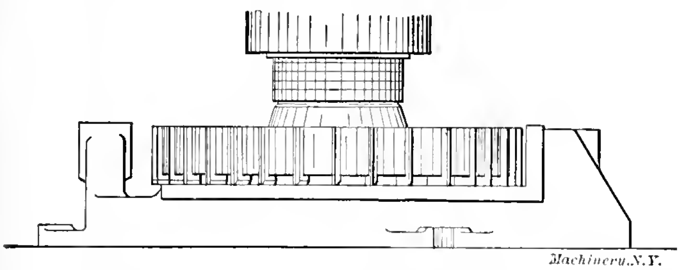

Fig. 6. Finishing the Top of the Base for the Movable Jaw.

must be parallel with that jaw and, of course, at right angles with the other slots. To procure good results in this case, the casting is set bottom up on a specially adapted block which is made perfectly square with the direction of the feed and parallel at one end with the axis of the cutter arbor. The top of the block, of course, must be parallel with the top of the table. The block is fitted with a set-screw which is brought to bear against the boss on the screw support lug, thus forcing the vise base home against the lining surface of the block. The casting is clamped to the block by means of

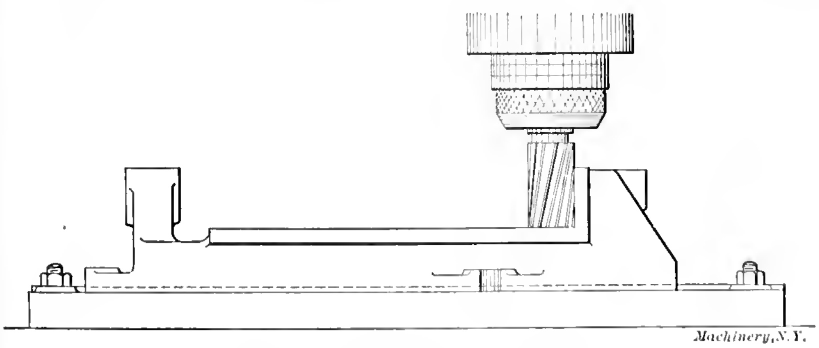

Fig. 7. Finishing the Jaw Backing Surface.

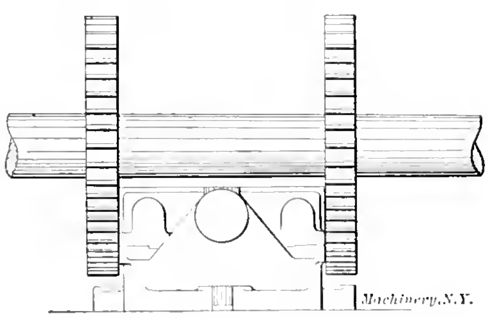

Fig. 10. Finishing the Sides of Base and Movable Jaw.

tap bolts through the slots in the casting and tapped into the block. A similar block is used to mill the cross slot, the only difference being in the location of the tongue.

The cutter used to slot the casting in this operation is a plain cutter with outside teeth. The slot is narrow, and, with the cutter properly hardened, little trouble is experienced from the corners of the teeth wearing excessively or breaking. A side milling cutter under such conditions would be under size after the first grinding. The cutter is made small in diameter, and is run at a correspondingly high speed, making it possible to obtain a good reasonable rate of speed, and still not overdo the matter.

Fifth Operation—Milling the Slots for the Movable Jaw.

The next operation, shown in Fig. 5, is also one that requires care, and on it depends the accuracy of alignment of the sliding jaw with the front jaw. This operation is that of milling the slots in the top of the base for guiding the slide. In order to reduce the labor, the guides are made to fit on the inner side of each slot only, and a clearance is left on the outer side. The work, in this case, is clamped to the table, using tongues in the table slots to line it up. The base thus rests in a natural position, and the accuracy of alignment of the machine is the only feature upon which we place any dependence. Naturally the machine used for this work is previously tested for error. The statements regarding the cutters, in the last operation, apply with equal force here.

Sixth Operation—Finishing the Top of the Base for the Movable Jaw.

The work is again placed on the vertical milling machine, and, with a large inserted tooth face milling cutter, the top of the base is given the final cut. The operation is shown in Fig. 6. The cutter used in this operation is kept in good condition, exclusively for this work; it runs very true. The speed and feed of the cutter in this operation are rather above and below—respectively—that which would be considered correct for ordinary work, surface and finish being the main object of this cut. The teeth of the cutter are broad, and the clearance is small, insuring a smooth cut. This operation takes out any twist that may have been caused by releasing the scalė on the bottom. For that reason the operation was delayed until this time.

It was for convenience in this operation that the trough was milled across the top of the base, as explained in connection with the first operation. The large face mill is set to depth so that it just scrapes the bottom of this trough, and also so as to clear the jaw backing as shown. It is obvious that should any attempt be made to mill both surfaces by a single operation, poor results would be obtained. The strain would cause chattering. By the method described, the top is milled independent of the vertical surface, and yet no corner is left that the milling cutter passes over. It also avoids the obvious difficulty of making a large cutter, screwed onto the spindle nose, run perfectly true on its periphery.

Seventh Operation—Finishing the Jaw Backing Surface.

More as a precaution than as a necessity, the operation shown in Fig. 7 is taken. The object is to straighten up the backing for the front jaw, and also to insure its being square

with the tongues, but here, again, we have to depend on the alignment of the machine. Probably it would be as well to omit this operation, for, when all conditions are looked into, the risk of throwing already accurate work out of square is great.

Eighth Operation—Milling the Bottom Surface of the Slide and Forming the Groove.

The operation of milling the bottom surface of the slide is shown in Fig. 8. This operation forms the tongues that fit the slots formed as shown in Fig. 5. The fit mentioned in dealing with that operation is indicated in Fig. 8. The cutters used in this operation are a special gang kept for the purpose. The block is clamped to the table by ordinary means.

Ninth Operation—Milling the Top of the Sliding Block.

The operation of milling the top of the sliding block is shown in Fig. 9. For this operation a casting was provided, having slots corresponding to the slots in the top of the vise base, at right angles to the tongue on the under side of this casting for lining same with the slots in the machine table. This course insures that the backing for the sliding jaw will be parallel with the line of the front jaws.

Tenth Operation—Finishing the Sides of the Base and Movable Jaws.

Fig. 10 shows the operation of milling the sides of the vise base and slide, the latter being put in position on the base and clamped to same. This operation mills the sides of both pieces so that they will be flush. This method was adopted rather than that of making special fixtures and special cutters for milling each piece separately.

As examples of operations wherein the milling machine has "butted" into the planer's territory, the above are well worth attention, and it is regretted that photographs were not available instead of the scanty line cuts. However, even these show the milling machine's superiority for such work to good advantage. They furnish, also, examples where equipment has in no way been a main point, and show that a large range of work can be handled with the ordinary means available. The various operations also show the different kinds of milling, and both styles of machines.

* * *

MOVING A SHOP.

B. HARDIE.*

It is sometimes necessary to move a manufacturing plant, particularly one renting quarters, from one place to another, either because the present place has to be vacated to give room for somebody who is willing to pay higher for the lease, or because cheaper and better quarters can be obtained elsewhere. This moving time is one of uncertainty of hours for all employed, and it makes the young apprentice swell with pride to have the superintendent approach him and ask him to work to-night, and he feels under moral obligation to tell every one he meets that "we are moving now, and I will have to work to-night."

At a time of such a shop moving, the most important thing is to have everything about the moving settled beforehand. The men in charge must determine upon exactly where every bench and machine should be placed in the new building in order to provide for the greatest convenience. The first thing to do is to obtain a drawing of the place, either from the owners renting it, or, if the place be bought, from the previous owners, or by having the draftsman sketch it up. In these plans particular attention should be paid to columns, height of ceiling, and location of cross beams, as well as the location of the windows. The location of the cross beams is very necessary in order to be able to arrange the counter-shafts correctly, and as for the columns, it is plainly in evidence that it would be inconvenient to have one of them located right in between the ways of a lathe. The same applies to the planning of closets in front of the windows, which mistake is often made in the drawing, if the windows are not plainly marked. When all these data are obtained, a plan should be laid out to as large scale as convenient. It is preferable to paste the paper on which this plan is laid out on the drawing board itself. Templets corresponding to the various machines in the shop should then be cut out of stiff cardboard, these templets being made as close to scale as possible of the actual floor space occupied by each machine. Particular attention should be paid in this instance to proper clearances, and the pasteboard pieces should be large enough to cover all projections or overhanging parts of the body of the machine, as these parts often will require larger space than do the columns or feet of the machine. Templets should also be made for benches, closets, and all other fixtures required to be installed. When this is done, the superintendent and the foremen in charge should arrange the templets as they consider best for carrying out the work in the most economical manner. When the templets have been arranged in a manner satisfactory to everybody concerned, thumb-tacks may be stuck to each templet as it is placed in position, and then another layout can be drawn up very easily, a tracing made, and blue-prints taken, so that everybody concerned in the moving can use one of these blue-prints as a guide.

One of the greatest troubles met with is the lining up of the shafting and the placing of the counter-shafts, which, if not properly done at first, will cause an endless amount of trouble later. A great deal of this difficulty is, of course, avoided in the more modern shops, where individual motor drive obviates this difficulty. Another very important point to be considered when all machines, benches and shafting are placed in position is the arrangement of the lighting fixtures, whether the lighting be by gas or electricity. This work should not be entered upon before everything else is in place, as one of the most important things in regard to light is that it be placed exactly where it will be needed the most, and this cannot very well be determined in the drafting room, but should be determined directly in the shop, when all the machines are in place.

Some shops will think it advisable to hire a few extra hands for the moving, but generally this is bad practice if it is possible to go along without extra movers. Hiring outside help for moving gives the men in the shop a chance to say that they "were not hired for moving," and may retard the work rather than facilitate it. Besides, in the case of moving it is a difficult matter to have too many men to look after, and the experienced old hands will probably know more about how to do the work properly than would extra hands. When everything is arranged right, each machine should be moved from its old place and put directly into its place in the new shop in the same order as it is moved. It is a great deal better to have each machine put in place at the time of moving than to have them all piled up and sorted out later, and if a man with a blue-print of the layout of the floor is appointed to superintend the placing of the machines in position as soon as arriving in the new place, it is an easy matter to attend to. The entire operation of moving can be more quickly accomplished if two crews are employed, one to take the machines from the floors and place them on the wagons at the old shop, and one to take them off the wagons and put them down in their place in the new shop. Thereby the time lost by the men traveling forth and back between the two shops is saved. If the moving is carried on along the lines indicated, and superintended in a proper manner, the interruption in business will not be noticed by outside customers, as each machine can be kept in running order up to the time of its removal, and be put in running order within a short time of its being placed in the new shop.

In the case of moving a shop, it is, perhaps, more necessary to create a spirit of cooperation among the men than it is at any other time, and to obtain this, many firms offer a bonus to the men for every day under a certain time that the shop is in running order, the bonus to be divided between the men in proportion to the work and responsibility assumed by each at the time of moving. This never fails to impart new energy to everybody, and even the office boy is imbued with new vigor in getting a shop cat into a bag to be taken to the new place. After the shop has been moved, the office quietly goes the same way as the shop. The main point to be considered in moving the office is to keep track of all records, as it often happens at the time of moving offices that old, and presumably useless, records are thrown away and lost.

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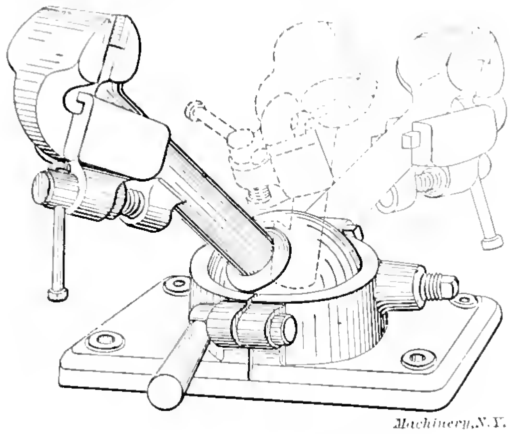
ITEMS OF MECHANICAL INTEREST.

UNIVERSAL VISE OF UNIQUE DESIGN.

At the Olympia Exposition in London, which took place during the latter part of last year, a vise of unique design was exhibited by Wadkin & Co., Leicester, England. The accompanying cut gives an idea of the manner in which this vise may be used, the general principle of the vise being plainly in

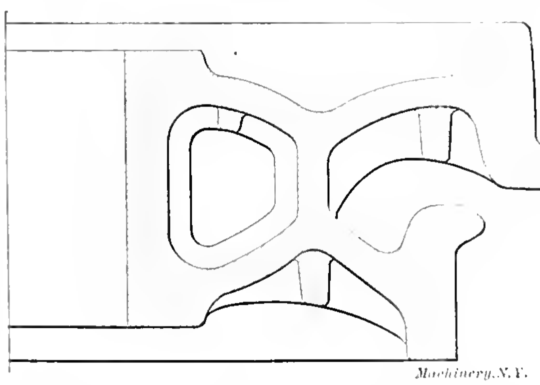


Universal Vise of Unique Design.

evidence. It can be swiveled around to almost any position, and tightened in place wherever desired. Considering its universal features the vise is said to be unusually rigid and effective for all ordinary bench work. The jaws are carried on the upper end of an arm, the lower end of which is fitted into a base having a ball and socket joint. It is of great advantage when working on irregularly-shaped pieces, as it is not necessary to change the grip of a piece in the vise or to work at the vise in an uncomfortable and awkward position, but the vise itself can be swiveled around to bring the piece clamped into the position required for convenient application of the tools used.

NEW IDEA IN CAR WHEELS.

The accompanying cut, taken from the *Railroad Gazette*, November 8, 1907, shows a new car wheel patented by Mr. P. H. Griffin, president of the New York Car Wheel Co., Buffalo, N. Y. The purpose of this wheel is to divide the destructive effects of heavy wheel loads and the wear and heating action of the brake shoe between two similar treads, and thus more than double the life of the wheel. The outer tread, as shown in the cut, is of large diameter, and rolls on the rails, carrying the load. The inner tread, of smaller diameter, is used only for braking purposes. This construc-



Car Wheel having Extra Tread for Braking Purposes

tion requires a longer hub than the ordinary wheel and adds between 200 to 250 pounds to the weight of a 700-pound wheel, or approximately from 30 per cent to 35 per cent. The objections to this wheel, however, cannot be lightly dismissed. The weight of car wheels already adds considerable to the dead weight of a car or a train, and so considerable an addition to the weight as necessary in the car wheel described naturally is an important objection. There is also another point worth considering. The wear on the tread of a car wheel caused by its rolling on the rails soon forms a groove in the tread, and the action of the brake shoe has helped to eliminate the continual deepening of this groove by wearing evenly over the whole surface of the wheel. Dividing the action of the rail and the brake shoe will eliminate the beneficial action of the brake shoe in preventing a groove to be formed on the tread of the wheel, and it is likely that the tread rolling on the rails will have to be trued up a great deal oftener than would be the case in ordinary wheels.

DIFFERENTIAL DRIVE.

The accompanying cuts, taken from an article in *Der praktische Maschinen-Konstrukteur*, show the principle and application of a differential drive, or what might be called a geared counter-shaft. While the principle in itself is by no means new, the present construction is of some interest. If we first

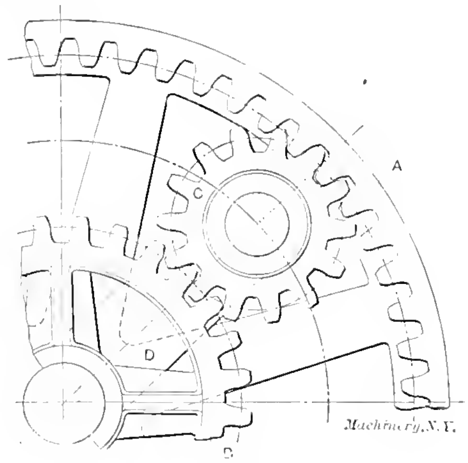


Fig. 1. Differential Drive of Interesting Construction.

refer to Fig. 1, it is clear that three cases for the use of this device may be conceived of. In the first place, the internal gear *A* may be stationary, and the gears *B* and *C* revolved; the gear *C*, of course, is simply rotated loosely on a stud fastened to an arm *D*, so that, in fact, it is the motion imparted by the arm *D* that is transferred to the gear *B*, or *vice versa*. In the second place, the arm *D* may be stationary, in which case either the internal gear *A* or the gear *B* may be the driver. Finally the gear *B* may be stationary, the power being transmitted in either direction between gear *A* and arm *D*. Fig. 2 shows a practical application of the principle. In

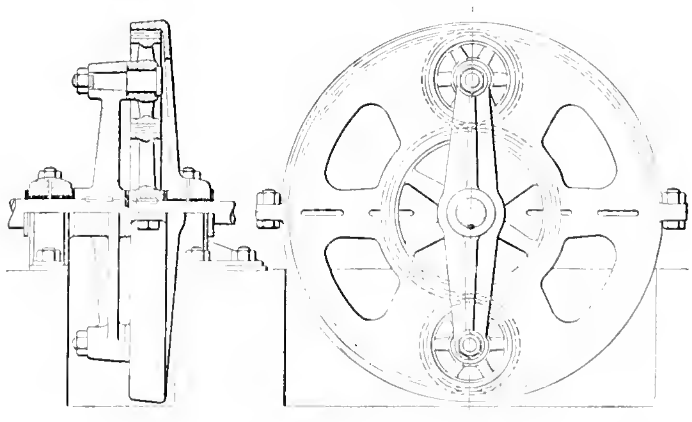


Fig. 2. A Practical Application of the Principle.

this design there are two gears corresponding to *C* in Fig. 1, mounted on an arm which in turn is keyed to the end of a shaft. The internal gear is stationary, forming part of a casing inclosing the gears, and the central gear is keyed to another shaft and drives this at a speed different from that of the driving shaft. This arrangement is a compact one, and is valuable, where space is limited, for the driving of a shaft directly in line with another shaft, but to be run at a different speed.

* * *

It is stated in *Copper and Brass* that aluminum bronzes containing less than four per cent of aluminum can be easily worked, but a greater amount produces a metal that is very hard to machine.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JANUARY, 1908.

PAID CIRCULATION FOR DECEMBER, 1907, 23,327 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE LIGHTING OF DRAFTING ROOMS.

In no part of the office is the absence of direct shadows more to be desired than in the drafting room. High studding, with windows on the north side reaching to the ceiling, or a saw-tooth roof with the glazing facing the north, give the best and most uniform light. With the former, the arrangement of tables for a left-shoulder light is more vital than with the latter. Prismatic glass in the upper window sash is often of inestimable value in lighting distant corners, but it must be avoided when it would receive the direct rays of the sun. The tone color of the walls should be warm and restful to the eye, with the maximum reflective power. Plaster is usually much to be preferred to wood. The method of artificial lighting to be employed depends largely upon the character of the work. If large drawings are the rule, the light must be thoroughly distributed, as may be best accomplished by properly shaded overhead enclosed arc lamps. If the drawings are small, calling for little change in the area to be lighted, local illumination is very satisfactory, such for instance as by means of a single 32-candle-power lamp, swung from the back of the table upon a double-jointed bracket. This light, well shaded, and usually below the level of the eye, gives maximum intensity and lighting efficiency. The general appearance of the room is much better than with suspended lights in any form.

* * *

BORROWING TOOLS.

One of the little things in the shop which causes a great deal of lost time to the employer, and much annoyance to the more thrifty and careful of the men, is that of borrowing tools. Some men seem to think it perfectly proper to have their fellow workmen supply them with almost any tools they may happen to need, from a screw-driver to a micrometer. They have always some excuse to offer why they have not supplied themselves with a certain tool, and are always saying, "Guess I will get one myself," but they seem to forget it the next minute. When the rightful owner is in need of his tools, they are not on hand, as the habitual borrower seldom remembers or cares to promptly return what he has borrowed, and sometimes does not know what he did with it. The result is a constant searching for tools, with the consequent loss of much time. Sometimes the tools are entirely lost, and the borrower will assert that he has returned them. These matters may seem trifling as a subject for editorial comment, but we are convinced that if the time lost through this practice of borrowing tools could be estimated, and expressed in dollars and cents, the aggregate would be staggering in amount, particularly in large shops with a great deal of floating help.

It is true that the machinist has to supply himself with an expensive outfit of tools if he wishes to be well supplied—so expensive, in fact, as to be rather out of proportion if compared with the average income of machinists as a class; but that is no reason why one man should take advantage of his fellows. Tools cost one workman as much as another, and the borrower usually can afford to buy them just as well as the lender. Borrowed tools are not always handled gently, and it is an imposition to expect a man's friends to pay for the tools he uses. If each man tries to be independent of the other in this respect it will add materially to the efficiency of the entire force, and when it is really necessary to borrow, or help of any kind is needed, the infrequency of the necessity will induce a greater spirit of cooperation.

* * *

ON KEEPING THINGS SEVEN YEARS.

"Keep a thing seven years and you will find a use for it" is a current saying, for which almost any one can find warrant in his own experience. People who believe thoroughly in this principle have their desks and their houses filled with a collection of articles of more or less value which they are saving for the seven years period, with the reasonable expectation that a use will be found for some of it, at least, within that time. Such collections may be arranged in orderly fashion or heaped in wild confusion, depending on the characters of those responsible for them.

This same condition may sometimes be seen in a shop where the superintendent is imbued with this idea of preservation. In such a place there will be found, in more or less orderly arrangement, large collections of scrap, which from time to time furnish material for use in repair work, and from which old pulleys and gears are dug out to be worked over into special machines. Carrying out the same idea, old machinery, which has outlived its usefulness so far as continuous production is concerned, is kept in commission for the sake of the occasional odd job for which it is particularly suited.

Now, is not this idea a fallacy, however successful it sometimes may appear to work out in practice? It takes valuable time to search through a collection of such material for the one article needed, and the material itself requires valuable room if carefully and systematically laid away. If scattered indiscriminately over the shop, as is usually the case, it is a source of confusion, and interferes with the work, and such wreckage lying around loose cannot fail to have a demoralizing effect on both superintendent and workman.

The question to be considered is whether order and system, and the ability to do the work properly, are not of greater value in the long run than the money represented by an occasional useful article which has to be sacrificed for its price as scrap.

* * *

Probably reinforced concrete building construction requires just as careful designing and supervision as any other form. An engineer connected with one of the prominent contracting engineering companies of New York says that the apparent ease with which a reinforced concrete building can be erected has caused the business to be taken up by a large number of inexperienced contractors. Essentially, a reinforced concrete structure requires careful designing and engineering, and in addition, a most thorough and conscientious system of intelligent inspection, while in course of construction. Reinforced concrete, as well as any other form of construction, should be executed only by contractors experienced in that particular line of work.

UNIFORMITY IN SHOP FORMS.

Before the advent of the cost accountant and the betterment engineer, with their cost index and numerous blanks, most shops displayed a heterogeneous collection of shop forms, devised by different individuals, suited to the needs of different departments, and printed at different times by different printers. The trend is now decidedly toward uniformity in material, size, and type. Variety in color of ink and paper is by no means as necessary as sometimes appears. Judicious selection, and reduction to the least number of varieties, will permit of greater economy in printing, inasmuch as a number of different shop forms may be run together on the same stock, or in the same color of ink. The same is true of the sizes, which may be made in multiples, so that a similar grouping will reduce cost in printing. There is always a strong tendency to make a system absolutely complete by providing a printed form for each type or class of report. This results in great and often unnecessary multiplicity. Particularly in the case of index cards always retained in a given department, all printing may be omitted when the meaning of each item or notation is perfectly clear to those who habitually refer to the cards. It is often the case that expensive ruled sheets are required for monthly or annual reports. The number is so small that carefully hand-ruled sheets, or blue-prints will serve fully as well, with a material saving in the cost as compared with type composition, printing, and machine ruling. A careful consideration of the conditions under which they are used, and a realization of the fact that they are not made for strangers to the system, will frequently result in a decrease in the number of printed forms, and a material economy in the entire expense of shop stationery.

* * *

THE DECEMBER MEETING A. S. M. E. PAPERS.

Contrary to our usual custom, we have not made a general abstract of the papers read before the December semi-annual meeting of the American Society of Mechanical Engineers. The number of papers presented would have necessitated brief paragraphs of a somewhat perfunctory nature had the abstracts been confined to ordinary limits of space, and the general character of the papers makes them of minor interest to the majority of our readers. No disparagement is intended, nor is it merited. The papers on the whole were of a high grade, and they constitute a notable lot of contributions to engineering literature; but we cannot help feeling that they possessed too little variety. Out of a total of nineteen papers presented at the December meeting, all but two were either on power production and closely kindred subjects or foundry practice. The December proceedings are rich in material for the power plant engineer and the foundryman, but rather dry picking for the machine shop superintendent or machine designer.

Undoubtedly the most effective results for a favored group can be obtained by these symposiums on given subjects, but it should be remembered by the committee on papers that the membership is made up of men representing a great variety of engineering interests. The production of power is important; in fact, it is a basic art on which all other industries depend. The manufacture of castings in a sense is also a basic art and the foundation of nearly all machine work, but there is a vast multitude of other things of interest to the mechanical engineer which also possess great importance. We should like to see more variety in the papers presented, and more of the lowly things that we all can understand and talk about. Power plants, superheated steam, gas engine development, and foundry practice are subjects of perennial interest, no doubt, but let us also have papers on machine work, machine shop practice, the drafting-room, notable examples of machine production and even shop kinks. In the same way, other fields of mechanical engineering activity can be treated so as to give the papers a diversity of interest that will make every member of the A. S. M. E. feel that his membership is profitable to him, and that it has a direct vital connection with his business.

BALANCED INDUSTRIAL CONDITIONS.

In time of peace, prepare for war! This maxim has been repeated so many times that it is now nearly universally accepted, although the feeling is growing that if we did not prepare for wars we should be less likely to have them. Whether this maxim be true or not in regard to peace and war, it is not open to denial that a similar expression can be applied to industrial conditions, and dealing with times of prosperity and of depression. As thus applied, the maxim would naturally read: In time of prosperity, prepare for depression. This, however, is a pessimistic view of industrial conditions, and the value of the suggestion is somewhat negative. We would prefer to phrase the maxim: In time of depression, prepare for prosperity. This is the optimistic view—a positive expression looking forward to increased possibilities and development, and expressing a different attitude towards the establishment of balanced industrial conditions.

Our industries, and in particular the machinery industry, have developed so rapidly that truly balanced conditions have not yet been fully accomplished. But it is no exaggeration to say that an increased confidence in the future, permitting, in times of less active business, necessary preparations to be made for the returning tide of business development and prosperity—which we all know to be ahead of us as soon as the temporary ebb has passed by—would greatly tend to balance industrial conditions. If improvements were carried out in dull times instead of being curtailed, not only could they be installed for a smaller outlay, but they would be available when active business required. We have all seen cases where our shops were unable to take proper care of their orders in good years, and time and money were wasted trying to turn out work with inadequate facilities; and while there is a natural reluctance to invest more capital in a plant when business is dull, foresight and provident business management often demand it in order to take advantage of prosperous times when they return. In every sound business the approximate relation between present expense and future requirement can easily be judged, because there can be no doubt of the ultimate return of prosperous conditions.

One of the great differences between European and American industrial management is to be found in the conditions under consideration; and it may be that the balance generally maintained on the Continent depends somewhat upon the manner in which most European shops add extensions. Unlike many of our own manufacturers—who are often forced, we admit, by the unprecedented demand for their product—European manufacturers usually add improvements when times are dull and when labor and materials, as well as interest, are low, and the demand on their facilities is light. In good times they devote themselves exclusively to the manufacturing business, being then equipped to take care of all the trade they obtain, and naturally making a larger profit on their product.

The additional expense of carrying a building or two, not yet equipped to its full capacity, for a couple of years, they claim is amply justified by the certainty of increased returns later. There is, perhaps, a lesson in this for us, which could be applied to our present conditions. Instead of increasing our plants when times are prosperous and everything expensive, and completing the installation of the equipment about the time when trade begins to fall off, would it not be possible, to some extent at least, to prepare for increased trade before the demand exists? The question has but one answer. If we look far enough ahead, we can see the tide turning, and now is the time to prepare for it, rather than to lose heart on account of present conditions.

* * *

In a report recently presented to the General Managers' Association of Chicago, it is stated that on American railroads the number of locomotives has, in the last ten years, increased by 12.8 per cent. In the same period the weight of some types of locomotives has increased 82.8 per cent, and the average weight increased 28 per cent. The number of freight cars has been increased by 51.5 per cent in this last decade, their total capacity 95.3 per cent, and average capacity 30.6 per cent.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

According to *Industritidningen Norden*, an international exposition will be held in Turin, Italy, in 1911. This exposition will be large in its scope, and will be devoted particularly to industrial products and agriculture.

It is reported from Washington that the Postmaster-General has imposed on a number of railroads the penalty stipulated in their contracts for failure to deliver the mails on time. The Great Northern Railroad has been fined more than $26,000 for slow deliveries from points in Minnesota to points in the state of Washington.

The inventor of the mono-rail gyroscopic railway car, Mr. Louis Brennan, has been granted a sum of $30,000 by the Indian government, in order to enable him to proceed with his experiments with a full-sized mono-rail car which he is now constructing for that government. The principle of Brennan's mono-rail car was described in the August issue of MACHINERY, engineering edition.

A company has been organized, and a factory for the manufacture of glass telegraph poles has been built at Grossalmerode, a town near Cassel, Germany. The glass mass of which the poles are made is strengthened by a reinforcement of steel wires. One of the principal advantages of these poles is their use in tropical countries, where wooden poles are soon destroyed by insects and where climatical influences are ruinous to wood.

Contracts were closed some months ago for the construction of floors, interior partitions, and roof of the Pennsylvania Railroad's new passenger terminal in New York City. The material used will be absolutely fireproof, and porous terra cotta has been selected as the only material that could stand the required tests. This material will be used in form of hollow blocks as a complete covering for the steel frame of the building.

A Canadian correspondent to the *Times Engineering Supplement* states that on the new National Transcontinental Railway, known also as the Grand Trunk Pacific, a section of the line, 70 miles long, will be constructed without a curve, and also without a rock cut, no obstruction being met with except rivers to be bridged. The longest tangent on any railway in the world is to be found in Argentina, where, on one road, there is in one place 175 miles of straight track.

Platinum has recently been discovered in California, and according to the *Railway Age*, the United States Geological Survey is at the present time investigating these discoveries. The investigations have gone on for a year or more, and it has developed that there is platinum in 120 places in the United States. The increased commercial use for platinum and the high price of the metal, owing to its scarcity, make these investigations very valuable. Should the natural deposits of platinum in the United States be found to be of any considerable amount, they would constitute an addition to the known natural resources of the country of no small importance.

A contributor to the *Engineering News* tells of a neat method he has followed for lettering maps and drawings which are to be reproduced photographically by the zinc process. Instead of spending the time to do the lettering carefully by hand, he has the various names, titles, etc., set in suitable type and has proofs taken on gummed paper. Strips containing the words and titles are cut from this gummed paper and pasted on the drawings. These labels do not appear in the finished cut, nothing being reproduced except the printing. This gives neat, uniform lettering at a less expense than would be required for work of a similar quality done by hand.

It is stated in the *Engineering Record* that the preservation of ties by crude oil has been successfully tried by the Atchison, Topeka & Santa Fe Railway. The company some years ago treated a few ties with California crude oil containing about 75 per cent asphaltum base, the remainder being light oils, the greater part of which vaporized when heated. The oil was heated to 180 degrees F., and forced into the wood under 150 pounds pressure per square inch, the ties taking up from 4 to 8 gallons each. They were placed in the track at the section where untreated ties will not last over two or three years, but the treated ties, when examined after having been in service for 4 years and 9 months, were found perfectly sound.

The increasing application of internal combustion engines, fed with coal gas, blast furnace gas, and other gases, has, says *Engineering*, unfortunately, been accompanied by a large number of cases of gas-poisoning. In Germany both the Imperial Insurance Office and the Board of Health have drawn the attention of manufacturers and engineers to this source of danger. The attendants of gas engines should be cautioned, and be instructed as to the measures to be adopted in accidents. The most dangerous constituent of the gases is the carbon monoxide, and cures can be effected by making the victim inhale oxygen. Oxygen cylinders provided with suitable valves should be kept where gas engines are used, and some attendants be duly trained by medical men in applying the first aid.

A feature of special interest at the Olympia exhibition in London was that of a line of compressed paper pinions, manufactured by the British Insulated & Helsby Cables Co. These pinions are intended to compete with the raw hide pinions, and it would seem from records of the samples shown that they are likely to come into great popularity. The specimens exhibited were pinions which had been in use under hard load conditions and unfavorable surroundings for periods long enough to prove their ability to stand up in hard service. The makers claim that these paper pinions are unaffected by moisture and oils. The makers have had a successful experience with compressed manila paper for insulation of cable work, and, judging from this experience, it is reasonable to expect that the paper pinion has been evolved on thoroughly firm ground, and with reasonable assurance of successful working.

In an article in the *Zeitschrift für Angewandte Chemie* a new method for manufacturing copper tubes is described. This method is in operation at the works of Langbein & Co., in Leipzig, Germany. The copper is deposited on a revolving mandrel as in the Cowper Cole's process, but the high rate of revolution of this latter process is dispensed with. The density and smoothness required in the deposit are obtained by suspending in the solution some siliceous material such as sand or quartz, which is unacted upon by the electrolyte, and which supplies the necessary degree of friction to the surface of the mandrel to remove all gas bubbles and inequalities in the deposit. Tests of the tubes made by this process have shown that the tensile strength is twice as great as that demanded by the specification for copper tubes drawn up by the authorities of the German Marine. The method can be applied to the production of plates and tubes of other metals than copper. In fact all metals that are liable to electrolytic deposition in a spongy and porous state can be obtained in a dense and coherent deposit by use of this method.

It is stated in the *Brass World* that the most frequent cause of the cracking of aluminum castings is the overheating or "burning" of the aluminum while melted. The most generally used aluminum alloy for castings, at the present time, is one which contains aluminum and zinc, and occasionally copper. The presence of zinc renders the casting more liable to crack,

but, on the other hand, the greatest strength in the metal is obtained by using zinc. If the following rules are adhered to, less trouble will be met with in aluminum castings. In the first place, the metal should be melted with a slow fire, so that the top of the metal will not be burned before the remainder of the metal is melted. When the whose mass is melted, care should be taken not to overheat. The ingots should be packed in the crucible as compactly as possible, so that portions of the metal will not stick up and become exposed to the action of the flame, and the most important rule may be said to be not to have the aluminum melted before the mold is ready. Non-observance of this last requirement is perhaps the most common source of burned metal, and consequently the most frequent cause of the cracking of aluminum castings.

The English government, according to the *Times Engineering Supplement*, is at the present time making preparations for introducing oil for fuel for steam raising purposes in the navy, on a large scale. Oil storages have been provided for in several localities. Among liquid fuels considered, is one known as "masut," which is one of the by-products of the distillation of raw petroleum, and which is now used to some extent by the Russian, German, and Italian navies. As it appears to have a high calorific value, and is said to produce but little smoke, it has some of the chief requisites for a fuel to take the place of coal. The relative cost of production of masut and of coal would probably be disadvantageous to the former, but this would be offset by the decreased cost of transportation and the conveniences attending the use of fuel in a liquid form. It is likely that the future will pay more attention to liquid fuels than has the present. The natural supply of liquid fuels is abundant, it being stated that Australia has immense deposits of oils which can be used for fuel purposes, which have as yet not been exploited at all.

In an editorial in the November issue of MACHINERY we found occasion to touch upon the future of the automobile, and we also mentioned that we expected that before long the more or less useless pleasure vehicle would be followed by vehicles for actual commercial use. It is gratifying to find that this sentiment is now voiced by automobile manufacturers themselves. In a recent issue of the *Horseless Age*, the manager of a well-known concern is quoted as having said: "I feel more and more strongly drawn to the commercial end of the business, and am convinced that in time we shall make trucks exclusively. Nevertheless, I do not think it advisable to give up the sale of pleasure cars at the present time." It is also stated that this awakening to the possibilities of the commercial vehicle is general, and that there is scarcely a company of any prominence connected with the industry which has not begun to take a more or less active interest in motor cars for trucking and general use. Some have designs under way, and others have various experimental vehicles on the road.

It is well known to anybody who has attempted to make a good photograph from a machine having bright polished surfaces as well as dark painted portions, that the bright portions cause trouble, and there is difficulty in showing these portions in a proper manner, the work of exhibiting the machine clearly being largely involved upon the retoucher. If the exposure is made of such duration that the bright portions will be clear, there will be under exposure of the dark painted portions, and if the exposure is made to suit the darker portions, then the bright portions are usually not plain, and sometimes entirely indistinguishable. In *Industritidningen Norden* we find mentioned a method for so preparing the bright portions of a machine to be photographed that a satisfactory picture can be taken, which will show all details with an equal degree of exactitude. This method consists in subjecting the bright surfaces to vapors from sal-ammoniac, which gives to the surface a fine covering which takes away the brightness of the surface. If the sal-ammoniac is pure (neutral) the vapors have no effect whatever on the machine, or on the surfaces themselves, and the covering can easily be wiped off with a cloth without using either oil or other means for removal.

FORMULAS FOR GAS ENGINE CRANK-SHAFTS.

During the last few years, although manufacturers of gas motors have materially increased the diameters of the crankshafts of their engines, these have still proven themselves too weak in many cases for the stresses imposed on them, owing to the higher compressions and heavier fly-wheels in present-day designs. While a few years ago, in gas motors, an explosion pressure of 250 pounds per square inch was seldom exceeded, in present practice 400 pounds per square inch is not uncommon. The stresses on this class of machinery are always more or less uncertain, and therefore calculations of strength are difficult, and dimensions have largely been determined by experiment, or, in other words, by trial and error. For this reason some remarks by Mr. Michael Longridge, as published in the *Mechanical Engineer*, are worth noting. According to his opinions, while reliable theoretical formulas are not deducible, the sizes which experience has shown to be desirable can be expressed fairly accurately empirically. If C is the diameter of the cylinder, D and d the diameters of the shaft and crank-pin journals, respectively, r the radius of the crank, and L the distance between the inner edges of the shaft journals, that is, the distance over-all of the crank webs, all expressed in inches, then for engines below 12 inches diameter of cylinder the value of the expression

$$\frac{C^2 (L + d)}{D^3}$$

should not exceed 12 for engines with two bearings and overhung fly-wheels, or 14, if three bearings are used. Furthermore the value of the expression

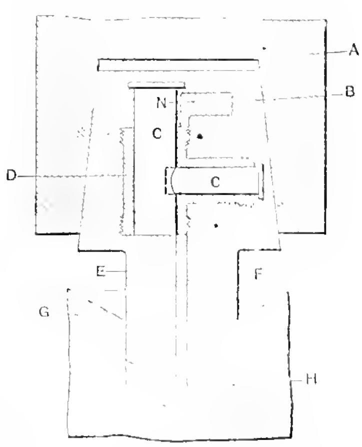
$$\frac{C^2 r}{d^3}$$

should never exceed 10. Besides, the crank webs should always be joined to the fly-wheel shaft with large fillets, as sharp corners have proven to be a common and serious source of weakness.

CASTING METALS UNDER PRESSURE.

The Mechanical Engineer, November 16, 1907.

By the process of producing castings under pressure, it is possible to make the castings of complicated shapes and with such details produced by the casting process as it has not heretofore been possible to form excepting by finishing with special tool. The processes of casting metals under pressure are divided in two groups. In the first of these groups the pressure exerted upon the material being cast is produced by means of gas, while in the other case the pressure is exerted by mechanical means. The device illustrated in a schematical form in the accompanying cut shows the appliances used in a process patented by Mr. F. Ljungström, Flemminggatan 8, Stockholm, Sweden.



Arrangement for casting Metals under Pressure

Referring to the cut, A is a piston operated by hydraulic pressure, at the lower end of which the mold B is inserted. The mold is intended for a T-pipe, C being the core of the pipe. The mold is provided at its lower end with a piston-like extension E provided with a taper at its lower end, and also with an internal passage F. This extension fits into the hole H in the part G. The hole or cavity H is filled with molten metal, and the piston A with the mold B is moved downward so that E enters H, and thus exerts a pressure upon the molten metal. The metal will then rise into the cavity D, and the desired casting will be formed under pressure. As the mouth of the passage F is located at the lowest level of the end of the piston-like extension E, the layer of oxide collecting on the surface of the molten metal in H will not enter the

passage. If, however, a few particles should penetrate into the passage they will collect in the pocket N, branching from the actual form of the piece to be cast. The advantage which is claimed for this method is that the mold does not need to be heated before the molten metal is introduced, and for this reason the frame of the mold can be made out of metal, so as to give the required streugth required by high pressures. In previous designs of this kind it has been necessary to heat the molds, before introducing the molten metal, to a temperature as high as the molten metal itself, and in cases of metals at a high fusion temperature, it has not been possible to make the molds from metal or alloys, but they have been made from plaster of paris, asbestos and similar materials which could not stand high pressure.

A YEAR'S EXPERIENCE WITH GAS ENGINES.

Abstract of paper by Mr. Paul Winsor, read before the American Street and Interurban Railway Engineering Association at Atlantic City, N. J., October 16, 1907.

The author of this paper is chief engineer of motive power and rolling stock of the Boston Elevated Railway Co., and is therefore well acquainted with the subject in hand. The gas engines in question were installed in the plant of this company early last year at the Somerville power station, the equipment consisting of two 600 B.H.P. 2-cylinder 4-cycle gas engines with generators and gas producers. The plant was started in May, 1906, and since then has given continuous, reliable, and satisfactory service, the engines being run sixteen hours per day. The fuel used for gas generation has been soft coal, the coal used per kilowatt hour averaging 2.034 pounds or 1.404 pound per B.H.P. hour. Some trouble was experienced with ignition. The igniters had originally platinum tips, and these were rather expensive to replace. For this reason the plant has been run for four months without any platinum tips, and less trouble has been experienced. During the first months, pre-ignition and back fires were rather frequent, but by lowering the compression in one of the cylinders, and changing the igniters, these troubles have been greatly reduced. The reliability of the service has proved one of its strong points. The plant can be started up at any time in less than five minutes. The gas engine station used only 46.1 per cent of the coal used at one of the steam plants of the same company per brake horse-power. For this reason the author concludes that a gas engine plant equipped with gas producers will operate fully as reliably as a steam plant, and will require from 30 to 60 per cent less fuel. The drawbacks to be considered would be the first cost which is about $200 per kilowatt when rated so as to have 33 1/3 per cent overload capacity, and also the present small size of gas engine units.

THE CRYSTALLIZATION OF STEEL.

Walter Rosenhain, in the *Times Engineering Supplement*, November 6, 1907.

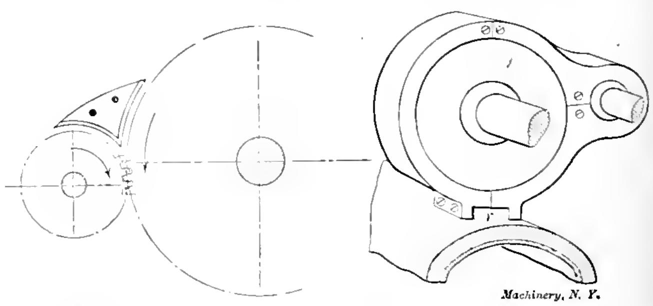
In our issue of MACHINERY, engineering edition, December, 1906, we published a short statement regarding the crystallization of steel, in which it was contended that steel does not crystallize by use, but that in cases where steel, having given away under stress, shows a crystalline structure, this crystalline condition has been inherent in the steel, and the use of the steel simply separates the faces of the crystals. In the present article the author sustains the same theory. The author states, in the first place, that microscopic study has proved beyond doubt that all metals possess, in any state, a truly crystalline structure, and that, therefore, ordinary materials of construction, particularly iron and steel, cannot be said to possess the fibrous structure, as so often has been contended. One cause of misconception regarding the character of metals lies, no doubt, in the fact that we are accustomed to regard crystal as brittle bodies, easily broken or split. This brittleness, however, is only the property of one class of crystals. It has been shown, for example, that under suitable conditions such a perfectly crystalline substance as marble can be caused to flow under stress and undergo drastic deformation without fracture. Ice is also a typical crystalline body which shows a great amount of plasticity. The fact that metals are characteristically crystalline is, however, not in any way in conflict with our knowledge of their ductility and strength. When fibrous fractures appear, it is simply because the crystals have been subjected to deformation, before the fracture occurs, by the application of the stresses in a certain manner, while on the other hand, when sudden and intensely local forces develop, the crystals will split or cleave along their natural cleavage before any amount of deformation has taken place. In such cases, we have the fractures which are claimed to have occurred on account of the crystallization of the metal, although the crystalline or fibrous character of the fracture is dependent not as much upon the character of the metal itself as upon the manner in which the fracture has been produced.

The author finally concludes that inasmuch as metals, in their normal condition, already have a truly crystalline structure, it is evident that exposure to vibration cannot produce such a structure, although it might modify the character of the crystals already existing; but there is, as far as the author knows, at the present time, no evidence at all that any change in the size or arrangement of the crystals of a metal can be produced either by vibration or fatigue. The decisive and final abandonment of the "crystallization" theory thus is evidently unavoidable, and some of our cherished misconceptions will have to be abandoned. At the same time, it must of course, be admitted that fatigue fractures reveal more clearly the crystalline structure existing in the metal, and it is also evident that fractures would appear at sudden stresses more easily in metals of coarse crystalline structure. This is in itself a point of considerable practical importance, and it explains to a great extent the prevalence of the crystallization theory, for it gives us the reason why faulty conclusions have been arrived at.

GEAR GUARDS.

Zeitschrift des Vereines deutscher Ingenieure, August 10, 1907.

In an article about the development of German machine tool design, the author, Mr. Ruppert, devotes himself also to the influence on the design of machine tools of the German laws for protecting employes from injury. He calls attention to the fact that these laws, while at first not considered to be of any consequence to the machine tool builder in any other respect than that he had to safeguard dangerous gears and belts in his own shop by a piece of stiff sheet-iron or wooden board, finally have proved to give a distinct characteristic to machine tools on which every gear and projecting revolving part is covered with a suitable guard. The law covering compensation to injured employes is far more detailed than that of the United States, and it probably is for that reason

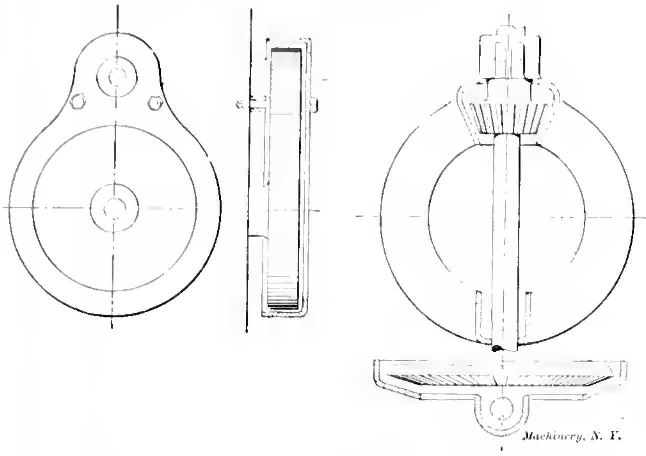


Figs. 1 and 2. Showing Old and New Forms of Gear Guards.

that foreign machine tools until lately always have been far better protected than American tools as a rule have been. The German law stipulates that the owner of any machine is responsible for any injury inflicted upon any person in his employ working with his machine. While at first, as mentioned, it was not expected that this law would influence machine tool building to as great an extent as it has, it was soon realized that machine tools had to be provided with suitable safeguards in order to sell as well as other machines well safeguarded, but not superior in other respects.

The first crude form of gear covering as used in Germany is shown in Fig. 1, and was not unfamiliar to American products a few years ago. It consists simply of a small piece of bent sheet iron, or at best, a thin casting covering the portion where two gears engage with one another. This inefficient

guard was probably adopted for economical reasons, it being considered too expensive to cover up the whole gearing. If the gears, however, are running in a direction as indicated by the arrows this guard is really almost as dangerous as the unprotected gearing, as the fingers may be pulled in



Figs. 3 and 4. Guards which cover only the Toothed Surfaces of the Gears.

between the gear and the guard almost as easily, or perhaps more easily, than they would be liable to be drawn in between the gears themselves.

A few neat designs of a more recent date, however, are shown. Some of these are not merely covers but brackets which serve as support and bearings for the gear shafts, as well as for safeguarding covers. In Fig. 2 is shown a cover which completely encloses the gears, and in order to facilitate assembling, it has been necessary, in this case, to make the gear case in several parts. The design is a remarkable example of a gear guard made up from several parts, and still giving the impression of a uniform and neat design. In Fig. 3 is shown a guard of fairly similar design. This guard encloses completely the outside of the toothed surface of the gears, while it is open on the inside and in the central portions on the outside so as to permit of easy assembling of the machine. Fig. 4 shows a cover for bevel gears in which the cover also completely encloses the toothed portions of the gears. In Fig. 5 is shown the neatest and most modern design for covering miter gears. In this, the guard itself and the bearings for the shaft carrying the gears are cast in one integral piece, the gears being assembled from the outside of the guard, which is left open. After being assembled, a cover, as shown by the dotted lines, is placed over the opening, thus completely enclosing the gears. These forms of guards for gearing are not new, but they have a particular interest as they show the development of the idea of the necessity of making the risks of industrial workers as small as possible, and some of them may contain an idea that can be employed in other cases similar to those shown

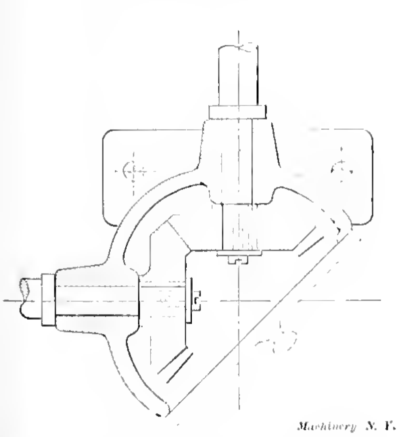


Fig. 5. Miter Gear Guard, with the Guard and the Bearing for the Shaft cast in One Piece.

as well. The designer of to-day is required to keep in mind the proper guarding of revolving machine parts, just as much as he is required to keep in mind the proper ratio of the gears themselves; and the cheapest and best guards for gearing are those which can be made up in a uniform style with the machine itself, and be designed so as to form integral parts with the machine. Wherever a guard becomes such a part of the machine it will serve its purpose to the fullest extent, inasmuch as there is then no risk of its being left off because of being inconvenient to the man operating the machine.

NOTES ON ROPE DRIVES.

Thos. Hart in the *Mechanical World*, October 11, 1907.

At the beginning of this article, the author lays down the rule that one should try to avoid arranging rope drives at

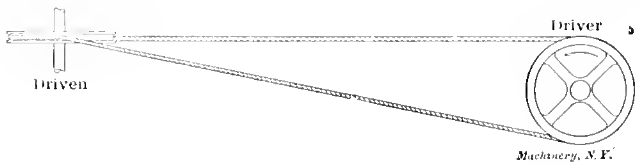


Fig. 1. Half-cross Drive.

right angles or around corners, whenever it is possible to arrange the drive so that it may run straight. A rope drive transmitting power around the corner reduces the power probably by 50 per cent, while its life is shortened by even a greater amount. From this it is evident that this kind of drive is not economical, but there are cases where such drives are imperative, and the author has attempted to show the best methods of arranging these drives.

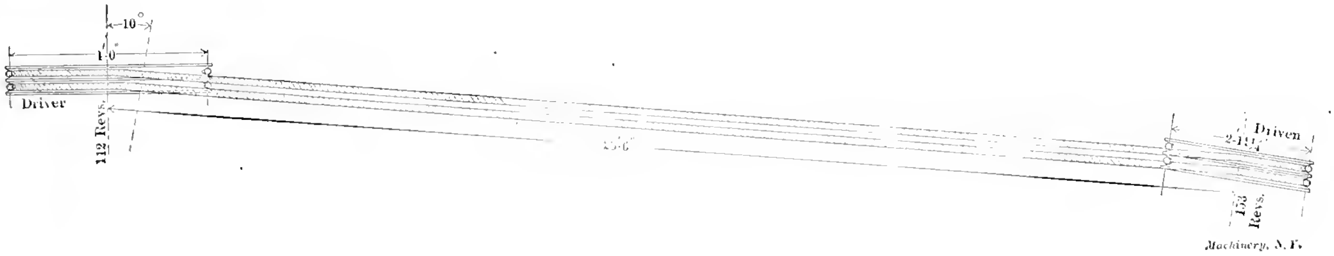


Fig. 2. Rope Drive with Shafts at an Angle of Ten Degrees.

Half-cross Drive.

Fig. 1 shows what is called the half-cross drive. In arranging such a drive, the fundamental rule is that all the angle should be given to the tight or driving side of the rope, and the slack side should run straight. If the slack side took the angle, the sagging would cause it to leave the groove at the point of entry. When installing such a drive it is often good practice to fix one pulley and to let the other one loose on the shaft for a few minutes. It will then find for itself the position in which it will work the best. It is difficult to arrange this class of drive for more than one rope, and therefore this type of drive is seldom used excepting for small powers.

Drives between Shafts which are not Parallel.

Drives where the shafts are not parallel with each other are frequently met with, but there has as yet not been any positive answer to the question of the greatest angle at which the ropes can be made to keep in the grooves and do effective work. It has been stated that where shafts form an angle with one another of three degrees or less, a rope drive may be arranged which will run well without any special arrangement, but for larger angles special deviations from the standard shape of groove must be made. In Fig. 2 is shown a rope drive where the two shafts form an angle of 10 degrees

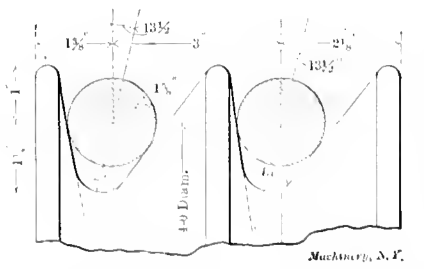


Fig. 3. Shape of Grooves for Rope Drive in Fig. 2.

with one another. It will be noticed that at the point where the rope commences to leave the groove, it requires more freedom than it can obtain in a groove of the ordinary shape, and for this reason the grooves have to be shaped in a special way. Fig. 3 shows the shape of groove adopted for the rope drive shown in Fig. 2, which is one that has been running satisfactorily for two years. In general, it may be said that rope drives of this character will give greater satisfaction if it is possible to have the pulleys of approximately the same diameter; if the distance between the pulleys is not too long, so that the sag of the slack side of the ropes becomes too great; and, finally, if the speed is not too high.

Drives at Right Angles.

The author understands drives at right angles to be drives around corners. In these, more than in any of the types previously discussed, is it necessary to assume that a great deal of power is lost through the bending of the rope in its passage from the driving to the driven pulley. In this class of drive, the driving and driven pulleys may have their grooves parallel to each other, although the ropes pass around the corner as shown in Fig. 4. This kind of drive offers no difficulties as far as the design or arrangement is concerned. A different problem is encountered in the case shown in Figs. 5 and 6. It is easily seen that the idlers here require different setting, and that careful thought is necessary to place them in the correct position. In Fig. 5 only the actual center of the driving and driven pulleys can be set true with the idler. Therefore, the greater the number of ropes, the greater is the tendency of the ropes to leave the grooves. Drives of three ropes seem to run satisfactorily with this arrangement, but when five ropes are used the first and fifth often cause

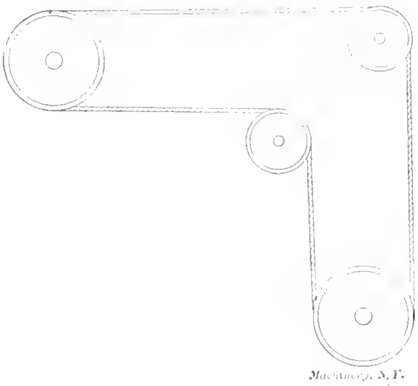


Fig. 4. Right Angle Drive, with Grooves Parallel.

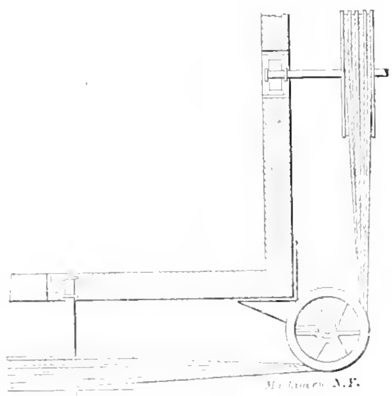


Fig. 5. Right Angle Drive, with Grooves at 90 Degrees.

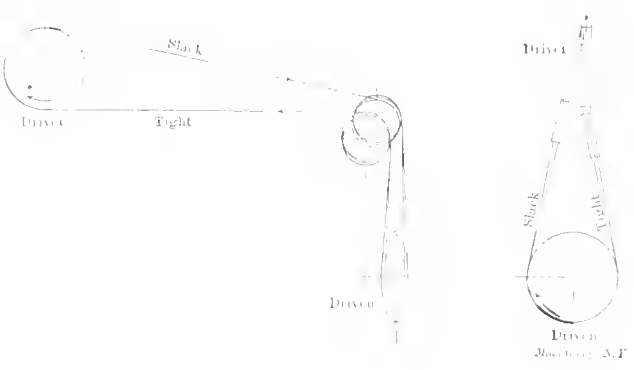


Fig. 6. Form of Drive with Two Idlers on Shafts at Different Angles.

difficulties, and they will run out of the grooves on the slack side of the drive. It is therefore advisable to make the shape of the grooves to resist the tendency of the ropes to leave the driving or driven pulleys in such cases. If one does not want to make the grooves with an inclined center line, it is well to make them very deep, as shown in Fig. 7. In Fig. 6 is shown a drive where the idlers are placed on two separate shafts in order to permit a proper position to be obtained for each of them to carry the ropes between the driving and the driven pulley. The grooves in the idler pulleys should be wide and round at the bottom, and the sides should be shaped so as to accommodate the rope at the position which it will naturally take in the groove. In the earlier days of rope drives, experiments were made with idler pulleys having no grooves, but having a flat bottom and outside flanges made to any angle suitable for the drive, as shown in Fig. 8. At first sight it appears as if this idea would be favorable to the types of drive under discussion, but on account of the sag of the ropes, particularly on the slack side, it often leads to one rope fouling the others, and possibly throwing them off the pulley altogether. The idlers should be made as large in diameter as possible, and should run in well lubricated bearings.

Loss of Power with Angular Drives.

The author concludes his notes on rope drives with repeating his reference to the loss of power in angular drives, and in that connection he refers to an actual case occurring in his practice. In this case, the drive was one of two ropes, each $1\frac{1}{2}$ inch in diameter, in a spinning mill, arranged to drive around the corner on account of an objection to using bevel gears at this point. The trouble was that the ropes stretched considerably, and after tightening, quickly wore out, all this indicating overload. An inquiry showed that the two ropes were set to transmit about 60 horsepower. This load would have been easily carried in an ordinary straight drive, the speed being 4,500 feet per minute, but, on account of the angular drive, the ropes absolutely failed to carry this load in the case referred to. In another case five ropes of $1\frac{1}{4}$ inch diameter on a straight drive performed a certain work, but, owing to some alterations, it became necessary to alter the position of the engine, and to install a right angle drive. This was installed in the most practical manner possible, but it soon became necessary, in order to transmit the required power, to increase the ropes to a diameter of $1\frac{3}{4}$ inch, and still the life of the ropes was very much reduced.

Fig. 7. Deep Grooves for Angular Drives.

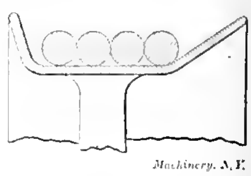


Fig. 8. Idler Pulley without Grooves.

For this reason it cannot be too strongly pointed out that drives such as those discussed should only be used under circumstances of great necessity.

BALL BEARINGS.—2.

Abstract from paper by Mr. Henry Hess, read before the American Society of Mechanical Engineers, May meeting, 1907.

Correct Ball Bearing Mounting.

The following requirements are based on correctly mounted ball bearings:

a. The proper size must be selected for the load and conditions in question. Rated capacities are usually for steady loads and speeds, but variations from these conditions demand a cutting down of the listed capacity.

b. Bearings must be lubricated. The often repeated statement that ball bearings can run without a lubricant is not correct.

c. Bearings must be kept free from grit, moisture, and acid. No lubricants developing free acids should be permitted.

d. The inner race of the bearing should be firmly secured to the shaft. This can be done by a light driving fit, reinforced by binding the race between a substantial shoulder and a nut.

e. The outer race must have a sliding fit in its seat. These conditions should under all circumstances be adhered to, and a failure to do so will result in very unsatisfactory bearings.

The two following conditions are frequently disregarded, and while the disregard of these conditions is not so serious as of those mentioned before, it is safe engineering to follow them, and a disregard of them is a standing invitation to trouble.

f. Thrusts should always be taken up whether in the same or opposite directions by the same bearing.

g. Bearings should never be dismembered, or at least never more than one at a time. That will avoid the danger of mixing the balls from different bearings; such balls from different bearings are very apt to vary more than is permissible for the individual bearing.

Illustrations of Correct Mounting.

The development of ball bearings being so recent is probably the cause that so little information as to correct mount-

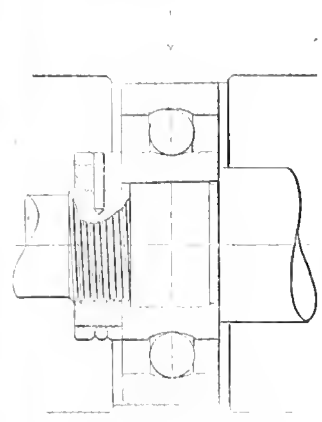


Fig. 16. Free Mounting for Radially Loaded Bearing.

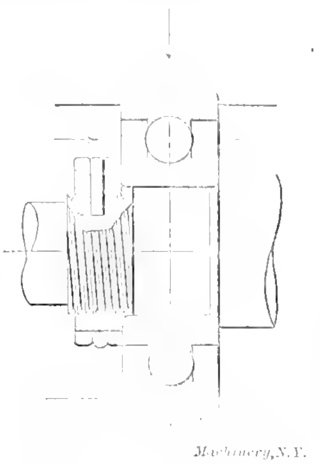


Fig. 17. Radially Loaded Bearing held against Longitudinal Motion

ings for various conditions is available. The experience of the author of this paper has been that faulty mountings are very general, and for this reason he has given illustrations of correct mountings, going more into details than would be considered necessary for a more familiar mechanical subject.

Fig. 16 shows a bearing in which the inner race has a light driving fit on the shaft, and is securely clamped between a shoulder on the shaft and a nut. The shoulder on the shaft should be high enough to get a firm grip on the surface of the side of the race. It is good practice to make this shoulder about one-half as high as the race thickness, perhaps a little less for large bearings and a little more for small bearings. The outer race has a tight sliding fit in the housing, so that the bearing as a whole may be able to respond to relative shifting of the shaft and housing without being subjected to end thrust through the balls.

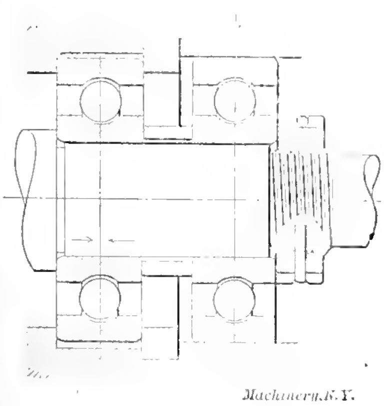
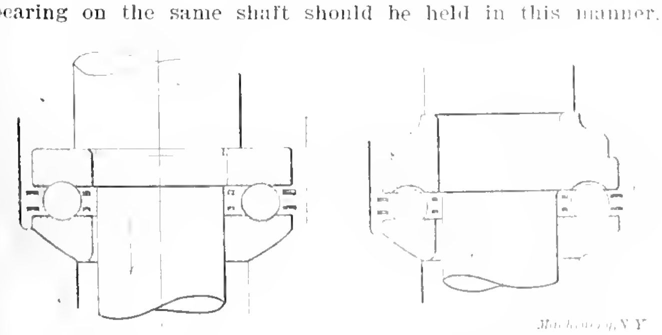


Fig. 18. Separate Radial Bearings for Radial and Thrust Loads.

Fig. 17 shows a radially loaded shaft held against endwise motion in either direction. This bearing is capable of carrying thrust load in either direction, but never more than one bearing on the same shaft should be held in this manner.



Figs. 19 and 20. Thrust Load in One Direction on Collar Bearings

This bearing differs from the preceding mounting only therein that it has the outer race secured between shoulders in the housing. This arrangement and the preceding one are usually found combined on the same shaft, which is then held endwise at one point only, so that temperature changes, or deflections of the shaft can cause no cramping.

Fig. 18 shows separate radial bearings for radial and thrust loads. This type of bearing is used when it is desirable to take thrust load on bearings of the radial type, although the space available does not permit of a single radial bearing of sufficient diameter to take both loads. One bearing is then mounted entirely free circumferentially so as to take the radial load, while the other bearing is mounted between the shoulders, and takes the thrust load.

Figs. 19 and 20 show thrust loads on a collar bearing in one direction only. Here the stationary race is provided with a spherical seat so that it will distribute the load over the complete circle of balls. In order to permit compensating shifting, the fixed seat must be radially free of the shaft or of the housing. The shoulder on the shaft should be large enough so as not to permit any bending strains on the rotating race. When it is inconvenient to provide a large enough shoulder on the shaft, a washer can be inserted between the shoulder and the race, as shown in Fig. 20. In Fig. 21 is simply shown a modification of the bearings in Figs. 19 and 20. This bearing takes thrust loads in two directions on two collar bearings. Fig. 22 shows an arrangement by which thrust load in two directions may be taken up by a single collar bearing. This arrangement is one which economizes space, cost of bearings, and number of parts. Fig. 23 shows an arrangement where a radial bearing is used for taking the radial thrust, and a collar bearing is used for taking the end thrust. Fig. 24 shows an arrangement for taking up radial load as well as thrust load in two directions, these loads being carried on one radial bearing and two collar bearings. In this design attention may be called to the distance piece inserted for binding the inner race of the radial bearing against the shoulder of the shaft.

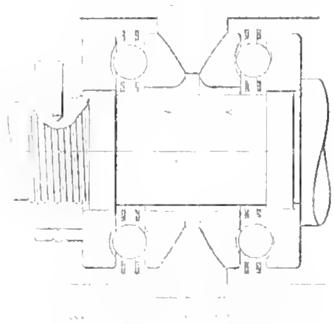


Fig. 21. Thrust Load in Two Directions on Two Collar Bearings.

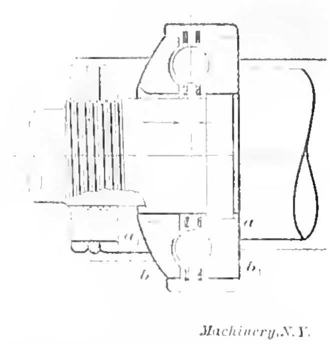


Fig. 22. Thrust Load in Two Directions on One Collar Bearing

It is occasionally inconvenient to arrange the bearing so that the parts of the inner races can be clamped to the shaft, or it may be desirable to have a shaft sliding through the bearing. In such cases a sleeve may be introduced on which the inner race of the bearing is firmly clamped endwise, the shaft simply resting in this sleeve. This gives a long bearing to the shaft, which would not be possible if the shaft was directly mounted in the ball race, because the peening effect of the vibrating loads would, even if the race itself was prolonged, be concentrated on a narrow zone of the shaft. A bearing of this kind is shown in Fig. 25.

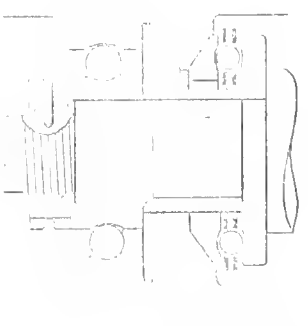


Fig. 23. Radial Load and Thrust Load in One Direction

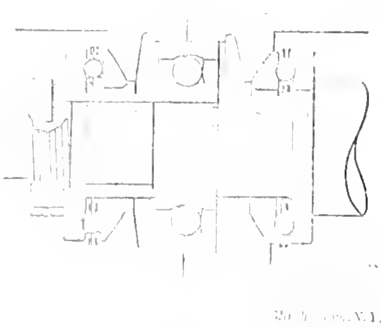


Fig. 24. Radial Load and Thrust Load in Two Directions

In Fig. 26 is shown a bearing which is intended for shafting which may not be fully to standard size. The inside of

the ball race is tapered, and a split bushing, tapered on the outside as shown, will, when tightened, bind the shaft as well as the race to it, and will compensate for all variations in size. The nut should not be used to draw the bushing in, but should merely act as a lock to hold it in place after it has been driven home with a soft hammer.

Ball bearings should always be enclosed so that lubricant will not be lost by leakage, and so that foreign matter will be excluded. Fig. 27 shows an efficient way of enclosing a ball bearing without using any packing. At the end where a shaft passes out of the enclosure, a flange should be bored out about 0.020 inch larger in diameter than the shaft. This flange should be separated into two lips by an angular groove, either cored or bored, as shown at *A*. These lips should not be less than 1/8 inch wide and should have sharp edges. The groove should be provided with a hole or narrow slot *B* at its lowest point to communicate with the bearing oil space. The groove itself should have a width of not less than 3/16 inch,

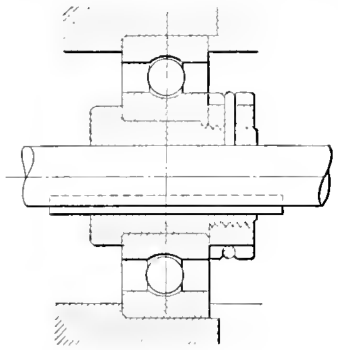


Fig. 25. Shaft Free in Longitudinal Direction in Inner Race.

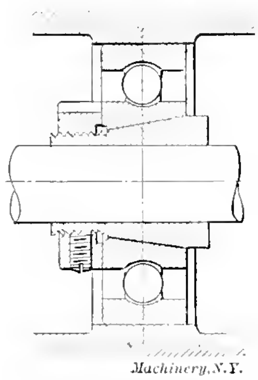


Fig. 26. Adapter Bearing for Shafting varying from Standard Size.

and a depth of about 5/16 to 3/8 inch, and should not be filled with packing material. Fig. 28 shows an arrangement of a similar kind, excepting that here is introduced a second groove and a third lip. This arrangement is employed where water may be occasionally encountered, and will prevent its entrance. What little may find its way past the outer lip into the outer groove is soon drained out again through the holes provided.

Where much grit is encountered, as in grinding machinery, a packing may be necessary, and filling the outer groove with a fairly consistent grease will provide such a packing without introducing friction. A bearing of this kind is shown in Fig. 29. A grease cup of the spring loaded piston type will automatically maintain the integrity of this packing. In some cases felt ring packings may be used, but these ought to be soaked in good soft paraffine, and a spring wire ring should be placed around the felt washer so as to force the

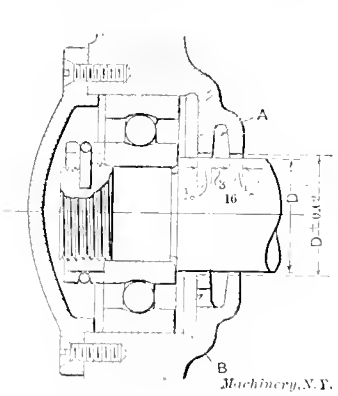


Fig. 27. Example of Enclosed Bearing.

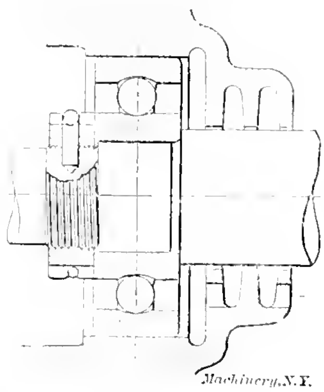


Fig 28. Bearing Enclosure with Double Groove.

outer edges of the washer outward, which will cause the felt to come into more intimate contact on the sides. Felt washers may also be applied as shown in Fig. 31. Here the washer is tapered on one or on both sides, and the sealing of the enclosure is made entirely against the sides of the surfaces against which the felt washer bears. The felt washer is pressed inwards by means of springs on the outside. The two modifications shown in Figs. 30 and 31 are intended to be inserted between the faces of the stationary boss and the rotating hub. The modification in Fig. 32, however, is enclosed entirely within one or the other. A felt ring is set into a counter bore and held in place by a light metal cap sprnng into position.

The author concluded his paper by saying that, on account of the time and space available at the society's meetings and in the society's transactions, much has been omitted in regard to ball bearings that might have been well considered, and

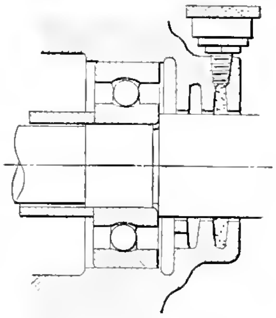


Fig. 29. Enclosed Bearing with Grease Packing.

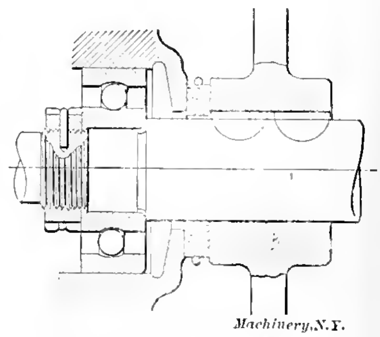


Fig. 30. Felt Ring Packing.

the author hoped in the future to make such contributions regarding the development of ball bearings as would appear to be of general interest.

* * *

In a paper regarding the economy attainable by the use of pneumatic tools, in preference to hand labor, for such operations as chipping, calking, drilling, riveting, etc., in British practice, Mr. C. P. Whitcombe states that the following comparison of the relative speed of turning out work by pneumatic tools and by hand labor has been compiled from actual results. It is not claimed that these speeds are applicable to all classes of work, but that they can be generally attained and sometimes even exceeded:

	Speeds.	
Description of Work.	By Hand.	By Pneumatic Tool.
Heavy chipping	1	2 to 4
Calking	1	3 to 4
Drilling	1	3 to 4
Rimering	1	4 to 6
Riveting	1 (3 men)	$1\frac{1}{2}$ to $2\frac{1}{2}$ (2 men)

Figures recently prepared by a leading English firm for their own information showed that a weekly saving of more than \$2 was being effected in wages for every \$1 of running

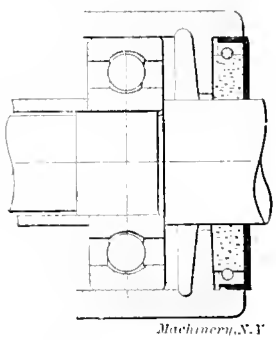


Fig. 31. Angular Felt Ring Packing.

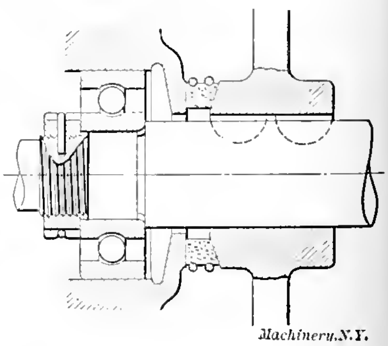


Fig. 32. Modification of Felt Ring Packing in Fig. 30.

cost of the pneumatic plant, the latter including interest on capital outlay, depreciation, power charges, maintenance and repairs.

* * *

In the article "A Draftsman's Tool Chest," by I. G. Bayley, published in the October issue, the fourth line of the second paragraph from the bottom of the second column should be changed to read: "An elastic band holds the door shut," etc. Also change "Instep's" tables on the following page of same article to "Inskip's" tables, etc.

* * *

A new example of the reliability feature of motor cars is given by the recent trials of a six-cylinder Hotchkiss car, which, according to the *Practical Engineer*, during its tests accomplished 21,250 miles, the longest trial on record, being 6,250 miles more than has been attempted by any other car. Of this distance, 10,474 miles was covered without a single involuntary stop.

TESTING THE DIVIDING HEAD OF THE CINCINNATI MILLING MACHINE.

The matter of inspecting work properly is a difficult problem to deal with, whether that work consist of parts of machinery, finished machines, drawings, calculations, or what not. There are so many ways in which a thing may be wrong that it is easily possible to neglect looking for one of the many in the course of a long day's work. Again, it is remarkably easy to follow another man's mistakes. Besides this, it takes remarkable strength of will to inspect as carefully and honestly at the end of nine or ten hours of work as at the beginning, or at the end of a year's work as at the commencement of it. The greatest aid an inspector can have in passing on the correctness of machine parts, machines or drawings is a regular laid out schedule telling him what to look out for, and establishing, in the case of machinery, the allowable limits of error. With a carefully planned schedule of this kind, the inspector can examine and check off each point item by item, and thus be able to do this work acceptably with no greater strain than the expenditure of that degree of care and intelligence which must be part of his equipment, if he is at all fit for his position.

The Cincinnati Milling Machine Co.

TEST SHEET FOR DIV. HEADS.

	Assembler's Check	Inspector's Check
Eccentric works freely	ok	ok
Spindle runs freely without worm	✓	✓
Split ring clamps spindle easily	✓	✓
Crank works freely with worm engaged	✓	✓
No shake in spindle	✓	✓
Index pins fit holes in index plates	✓	✓
No noise in gears, mitre gear bearing	✓	✓
Stop for side plate locks plate firmly	✓	✓
No back lash in gears, Limit ½ hole in side plate	✓	✓
Vernier flush with swivel block	✓	✓
No marred screws or oil cups	✓	✓
Block swivels 5 degrees below horizontal and 50 degrees beyond vertical	✓	✓
Smooth bole in spindle	✓	✓
Tail stock has zero line on swivel block	✓	✓
Elevating center baa zero marks	✓	✓
Center in head has good bearing	✓	✓

	Maximum Error Allowed	Test in Thousandths	
Froot taper hole true in spindle at outer end of 18″ test bar	.0015″	1	
Front taper hole in spiadle true at nose	.00025″	1/4	
Spindle io line with tee slot in table at outer end of 18″ test bar	.001″	1	
		F	B
Spiodle central with tee slot in table front or back	.002″	1	
Tail stock centera in line with Head center using zero marks — Large end	.001″		1/2
Tail stock centera in line with Head center using zero marks — Small end	.001″		1/2
Back taper hole in spindle true 4″ test bar	.005″	4	
Spindle perpendicular to table at outer end of 18″ test bar	.0015″	1	
Error in worm wheel. 8″ dia. test plate	.0015″	1/2	
Center runs true on point	.00025″	1/4	

Shop Order 3547 *Size* 10″ *Div. Head Number* 69-2887

Date Assembled Sept 5/07

Assembler's Number 311 *Name* R. Engel

Date Inspected Sept 18/07 *Inspector* H. Holz

Fig 1. A Sample Inspection Sheet for Cincinnati Dividing Head.

We illustrate and describe herewith the method pursued by the Cincinnati Milling Machine Co. in inspecting its dividing heads for workmanship and accuracy. The method of inspection pursued involves not only the regular schedule of investigation of which we have just spoken, but a carefully laid out series of inspection operations as well, with appropriate tools provided for the purpose.

The printed schedule is shown in Fig. 1. As may be seen, this is divided into two sections, the first of them dealing with items of fitting and workmanship which have to be checked by both the assembler and inspector; the second part gives a list of the maximum errors allowed in certain measurements and alignments, with a blank column in which the inspector records the results of his tests of these various dimensions. We are told by the manufacturers that this inspector's test sheet was drawn at random from a lot of fifty, it being the result of the inspection of a 10-inch dividing head examined on September 18, 1907. The inspection is made as nearly as practicable in the order listed on this sheet.

As previously stated, attention is first of all given to the workmanship on the different parts of the mechanism, each of which must come up to the required standard before the workman passes the head on to the inspector. At first glance, it might appear that these items need not be on the test sheets, since any good workman would naturally give these details his attention when assembling the head. However, experience has proven that it is best not to leave this to the workman's memory, it being better to remind him of the standard of excellence required and the test to be made on each of these parts by detailing each item on the test sheet. It is evident that the accuracy tests cannot be made until all of the mechanism has passed inspection.

For the tests relating to accuracy, various special tools are provided, with carefully worked out methods of procedure. The first test relates to the accuracy of the front taper hole in the spindle. Fig. 2 shows the operation with the special devices used. A test plate or table is provided, having a T-slot accurately made to standard size, into which the tongue of the dividing head fits. This table has a rearward extension provided with a knee the use of which will be explained later. In the front taper hole of the spindle is inserted a hollow test bar, with a taper shank carefully fitting the standard taper to which the hole is finished, and carefully made so that it is known to be straight, true to diameter and concentric, far within the usual limits of error in such work. The gage used is one of the American Watch Tool Co.'s test indicators—used on all their other accuracy tests as well. It is graduated to read to thousandths of an inch, and the graduations are so far apart that it is easy for an experienced workman to estimate halves and quarters of a thousandth. The shank of the hollow test bar having been carefully cleaned and lightly driven into the carefully cleaned taper hole of the diving head spindle, the indicator point is brought to bear on its outer end at a distance of 18 inches from the nose of the spindle. When the bar is revolved through the indexing mechanism, the error may be read direct from the indicator dial. The maximum error allowed is 0.0015 inch. In the present instance, the head showed an error of 0.001 inch, that is to say, 0.0005 on each side of the true position.

The second test determines the truth of the front taper hole by resting the indicator point against the side of the hole, the reading being taken in the same manner as before. The maximum error allowed on this test is 0.00025 inch, and in the present case the head tested within this limit.

The third test relates to the alignment of the spindle with the T-slot on the table. A little thought will show that in measuring this from the test arbor there is danger of introducing into the measurements the error of the untruth of the taper hole, previously determined, unless some provision is taken to eliminate that error. This is done very simply. First the test arbor is rotated with the indicator bearing on its side, until the "high point" is found. This position having been located, the spindle of the head is rotated 90 degrees, so that in Fig. 3 the "high point" would be at either the top or the under side of the bar. Under these conditions it is obvious that the two sides of the bar are for all practical purposes parallel with the axis of the spindle. The special standard on which the test indicator is mounted in Fig. 3 has a tongue which engages the T-slot of the fixture table. Readings with the indicator are taken at different points on one side of the bar. The difference between the largest and smallest of these readings gives the amount by which the arbor (and therefore the taper hole in the spindle) is out of alignment. In the present instance this error was found to be 0.001 inch in 18 inches. The maximum error allowed is 0.001 inch.

This is followed by a test to determine whether the center of the spindle is in the same vertical plane with the center of the T-slot. It is a repetition of the preceding test, except

that in this case the readings are taken at several points along both sides of the bar, the base in which the indicator is mounted being turned around in the slot to bring the measuring point on the other side of the spindle for this purpose. The readings on both sides for each position are noted and their difference taken; the difference determines the error. In the present instance there was an error of 0.001 inch in 18 inches, while a maximum of 0.002 inch is allowed.

Following this, comes a test to determine the alignment of the head- and tail-stock centers. This is shown in Fig. 4, and is a repetition in most respects of the test shown in Fig. 3, except that in this case an accurate test bar 12 inches long is held between centers. The tail-stock has a reversible center bar with a large center on one end and a smaller center adapted for the lighter classes of work of small diameter on the other end. Both of these are tested for alignment, and in the present case showed an error of only 0.0005 inch.

Since it is expected that the dividing head will sometimes be used with the work spindle clamped in any position between the limits through which it may be swiveled, a test is also made to determine whether or not the spindle swivels in a plane perpendicular to the top of the table. In this test the head is set so as to bring the spindle in a vertical position. The test bar is inserted in the spindle as shown in Fig. 2. The indicator is then mounted on a stand similar to that shown in Fig. 3. This is rested against the face of the vertical surface of the test block, and by taking several readings along the side of the test bar, the parallel relation of the bar with the face of the vertical surface of the test block is at once determined. In the present instance the error found was 0.001 inch, while the maximum allowed error is 0.0015.

Perhaps the most ingenious and interesting of the tests is that used to determine the accuracy of the indexing. To test this, the apparatus shown in Fig. 5 is used. An arbor is placed in the taper hole of the spindle and on this arbor are clamped two disks, having nicely finished ground edges of the same diameter, matching each other so as to form an unbroken surface. To the testing plate is fastened a bracket carrying a marking device which, by the operation of the

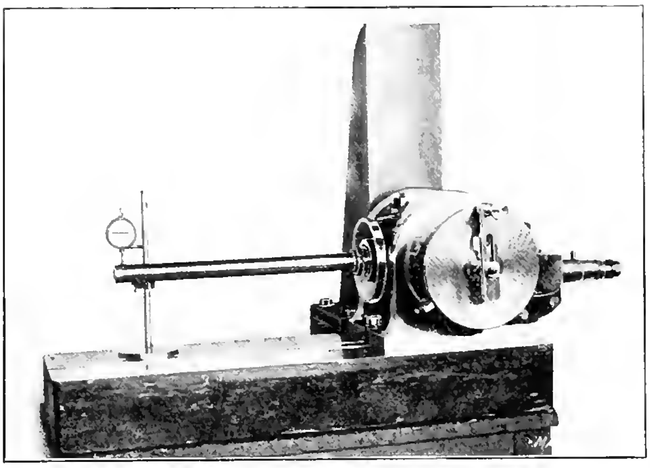


Fig. 2. Does the Taper Hole run True?

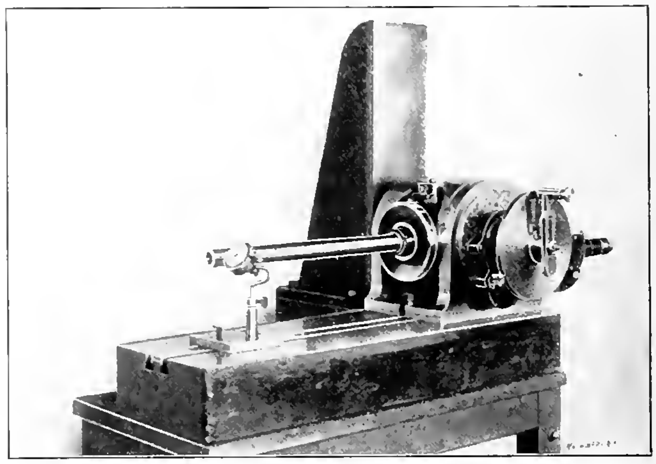


Fig. 3. Is the Axis of the Taper Hole True with the T-slot?

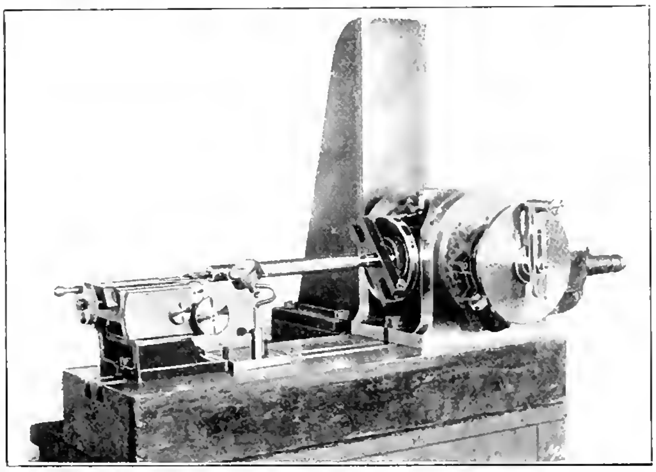


Fig. 4. Do the Head- and Tail-stock Centers line up with the T-slot?

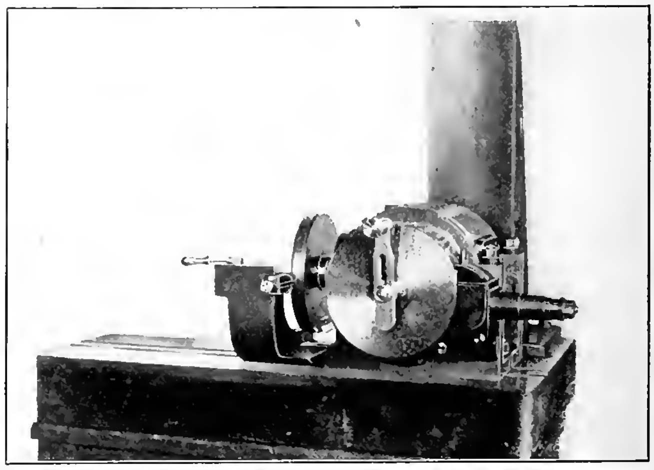


Fig. 5. How Accurate is the Index Worm-wheel?

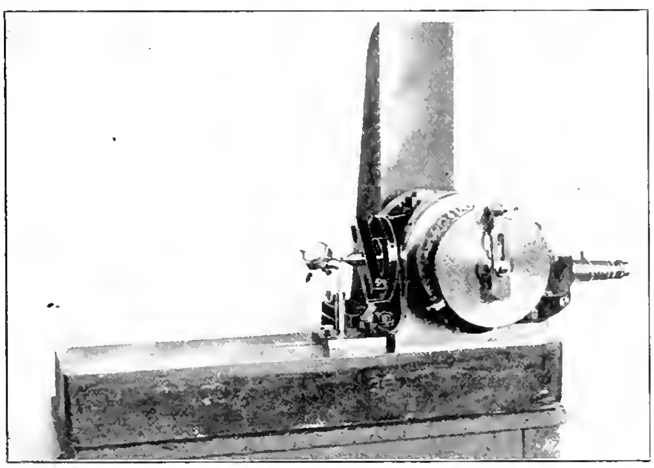


Fig. 6. Does the Center run True?

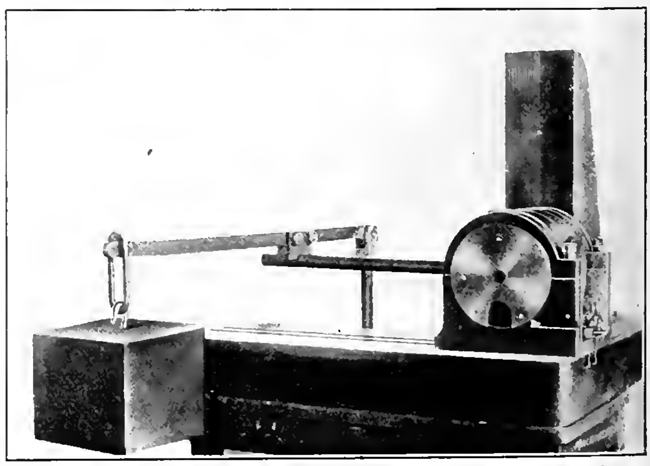


Fig. 7. Do the Clamp Bolts hold the Head firmly from Turning?

small lever shown, scribes a fine line of uniform thickness across the edge of the two disks. The spindle is indexed for forty divisions and a line scribed after each indexing. Then the arbor holding the disks is removed from the dividing head, grasped in a vise, the clamp bolt is loosened, and one of the disks is rotated successively to seven different positions, each one-eighth of the circumference ahead of the preceding one so that in each case the first line scribed on it exactly matches the line on the other disk, corresponding with the selected position, and for each position the lines in the one-fourth of the circumference immediately ahead are examined for alignment under a strong magnifying glass. Their non-alignment indicates the error in the index mechanism, and may be estimated by an experienced man to very close limits. In the present instance the maximum accumulative error found in any one-fourth of the circumference of the disks was 0.0005 inch.

The above method of testing is frequently checked by the following plan: Instead of scribing hair lines across disks in Fig. 5, slots 1/4 inch wide and 1/4 inch deep are milled into them. Pains are taken to make these slots exactly to gage. Then the work is removed from the dividing head and the slots are compared by lining up any two of them the same way as in the previous test, except that in this case it is done by inserting a standard gage of sufficient length to fill both slots. The alignment of the other slots is then compared by testing with special gages. These gages are made 0.00025, 0.0005, 0.00075, 0.001 inch, etc., below standard, and obviously the amount that any given gage is below standard indicates the error or amount of non-alignment of those two slots into which it fits snugly.

Since accuracy in the other parts of a dividing head is of no great value when doing work between centers unless the head center itself runs true, this part is also tested, as shown in Fig. 6. This is a repetition of former tests, except that here the indicator point rests against the point of the head center, and when this is revolved through the index mechanism, the error may be read from the indicator. The maximum error allowed on this test is 0.00025 inch.

Besides these thorough inspection tests, others are made of the separate parts in the course of manufacture, and in the preliminary stages of the assembling. One of the most interesting of these, shown in Fig. 7, is employed for testing the rigidity of the clamping device by which the head is held at the proper angle. As shown, a bar 24 inches long is placed in the hole of the work spindle. A lever carrying a 200-pound weight on one end is then brought to bear on this bar at a point 22 inches from the swiveling center. The arms of this lever are in the ratio of 3 to 1, so that the total pressure brought to bear on the bar is 600 pounds, at a point 22 inches from the center of swivel. Every head must undergo this test without any evidence whatever of failure on the part of the clamps to rigidly hold the swivel block in position.

The dividing head is a most important part of the equipment of the milling machine, particularly in the case of the universal type. Its accuracy is trusted implicitly in many operations, and on its accuracy depends the accuracy of the work. We think it will be agreed that dividing heads that have successfully passed the tests outlined above are worthy of reliance in all ordinary operations.

* * *

There is very little literature on drop forging or "machine blacksmithing," which seems strange considering the importance of the art. The editor would gladly receive a good contribution on the subject. Any reader of MACHINERY who feels that he could write such an article will please communicate.

* * *

There are some curious misnomers in common use as, for example, "cork" legs, the name commonly applied to artificial limbs, which are not made of cork at all, but wood, the qualifying adjective being the name of the inventor. John Cork made the first wooden legs in the early part of the 19th century, his product being the first successful substitute for the "peg-leg." No artificial legs are made of cork, elm or willow being almost always used in preference to any other material.

TESTING THE LEAD OF TAPS AND SCREWS.

ERIK OBERG.*

In cases where there is no necessity of ascertaining the exact error in the lead of a screw or tap, and when only a limited number are to be tested, a fairly good test is afforded by simply screwing the thread into a female gage. The threaded portion of this latter should then, however, be fairly long, so that errors in lead, which are liable to be very small in a short distance, may be detected by taking account of the error in the comparatively long length. Ordinarily, however, when quantities of taps are to be tested, the errors in lead are most easily ascertained by some device particularly in-

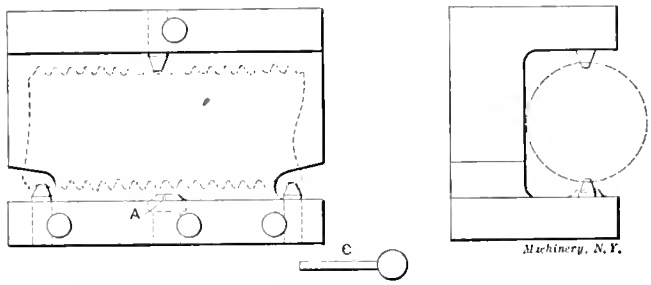


Fig. 1. British Gage for Simultaneous Testing of Lead and Angle Diameter.

tended for the testing of the lead of a screw thread alone. Some devices which test both the lead and the diameter within certain limits are also in use. Of these latter, two examples are shown in a report on British standard systems for Limit Gages for Screw Threads, presented to the Engineering Standards Committee of Great Britain.

Testing the Lead by Gages.

The first of these gages is shown in Fig. 1. In this gage, allowance is made for a permissible error in angle diameter and lead. As is plainly shown in the cut, the screw thread enters between three fixed points, shaped like the thread, two of which are located in the lower jaw of the gage, and one in the upper. The distance between the two points on the lower part of the gage should be equal to about twice the diameter of the screw. The fixed point in the upper jaw should, of course, be placed midway between the points in the lower jaw. At *A* is shown a ground flat face which is so adjusted that the small cylinder *C*, of such diameter that it will touch the thread about half way down its depth, will barely enter between the flat face and the thread of the bolt for the *minimum permissible* diameter, but will "not go" as a general rule. This device then gives a practical test for both diameter and lead. If the lead were out too much, the screw would not enter the gage, because the two points in the lower jaw would not fit the pitch of the thread, these points being, of course, set to a standard gage. If, again, it could be conceived that the diameter was so much smaller than the standard that the screw or tap could be placed in the gage in spite of the lead being an appreciable amount long or short, then the feeler *C* would enter so freely between the face *A* and the screw as to indicate that the screw was not within permissible limits. It will be noticed that provision is made for getting the points entering the threads placed exactly in the center of the screw. In the end view, the screw is indicated resting up against the back of the gage with one side, the distance from the back of the gage to the center of the points being equal to half the diameter of the screw. It is

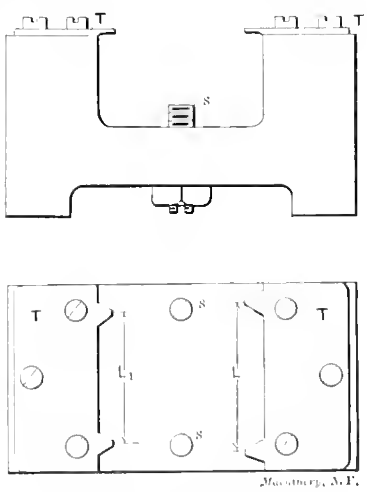


Fig. 2. Maximum and Minimum Gage for Lead and Angle Diameter

* Associate Editor of MACHINERY

evident that gages of this kind will have to be made for each separate diameter and pitch.

Another form of gage intended to deal with shorter lengths of thread than the one just described is shown in Fig. 2. In this case, two separate gages are applied, one minimum and one maximum. The screw is supposed to enter into the one and refuse to enter into the other. In this gage the top plates T are made of hardened steel and contain V-teeth set as shown, the distance L representing the next even number of threads immediately above the number contained in a length of screw equal to the diameter of the thread, while the distance L_1 is one thread shorter. The plates are screwed, and preferably doweled, to a base plate, and are, of course, made and adjusted to a standard plug. At s are shown screws which can be so adjusted that the measurement can be made exactly at the center of the screw, the distance from the faces of screws s to the center of the gage plates being equal to one-half the diameter of the screw.

Comparators for the Lead of Taps and Screws.

When it is wanted, however, to determine the errors in pitch with some exactitude, and not only to find out whether the error is between certain limits, then the instrument termed thread comparator is used. This consists, in its simplest form (see Fig. 3), of a fixed block A and a sliding block B provided with ball points. The sliding block operates a pointer C, which on a large scale indexes the errors of lead. The manner of using this instrument is as follows. A standard plug is first placed against the device so that the ball points enter in threads, say one inch apart. The position of the pointer on the scale is noted when the standard plug engages the ball points, the free block B adjusting itself to the thread into which its ball point enters, and carrying with it the pointer C. Next, the tap or screw to be tested is placed in position against the device. If the lead of this screw or tap is correct, and is the same as that of the plug, the pointer will evidently occupy the same position in relation to the scale as in the case of the plug. If the tap or screw is long or short in the lead, the pointer will show the amount on the scale by swinging either to the left or to the right. The scale should, of course, preferably be graduated so as to show thousandths of an inch.

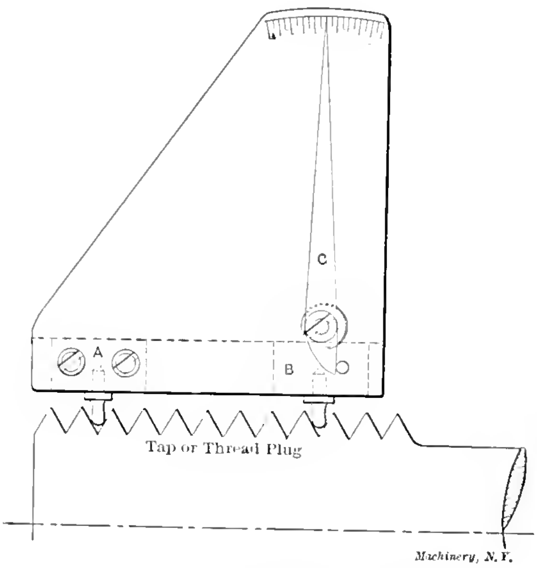
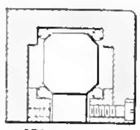


Fig. 3. Simple Form of Comparator for Lead of Screw Thread.



SECTION IN S-S

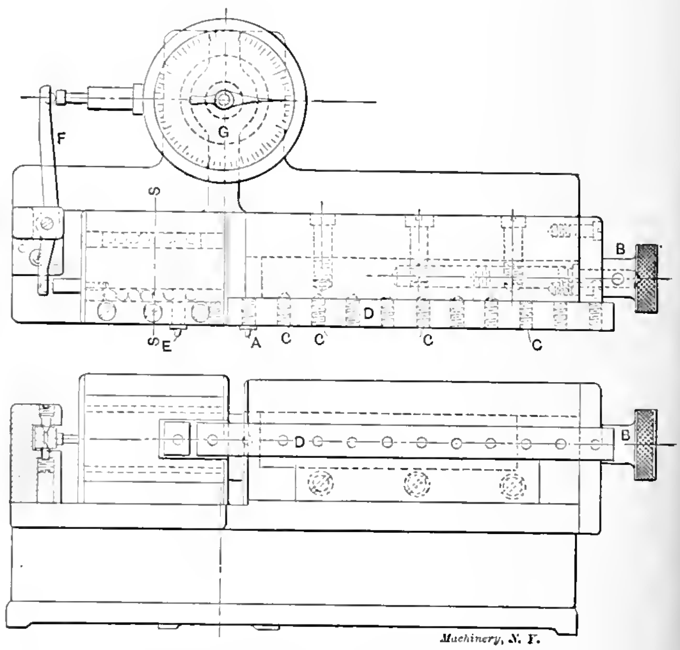


Fig. 4. Comparator for Testing Lead of Taps and Screws.

A more elaborate device for measuring the errors in lead of taps is shown in Fig. 4. Here one ball point A, which we may call the fixed, is mounted in a slide D, which latter is operated by a knurled head screw B. Ball point A may be screwed into any of the holes C, which may be ½ inch apart; thus one may, with this device, measure the lead in one inch, or in any length up to six inches, as may be desired, by moving the ball point A to different positions in the slide D. The ball point E is inserted in a movable block resting on a ball bearing. This block, in turn, is connected through the lever F with the indicator or sensitive gage G, which should be so arranged and graduated that each thousandth inch can be easily read. When the standard plug is placed against this device, the ball points entering between threads in the same way as in the former device described, the slide D can be so adjusted by the knurled head screw B that the indicator points to zero. When the screw or tap to be tested is placed against the ball points, any error will then be apparent by the motion imparted by too long or too short lead to the movable ball point E. This motion, of course, is, through the lever arm F, carried to the indicator. If the latter is graduated in thousandths of an inch, the graduations below or above zero will indicate the amount in thousandths of an inch that a tap or screw is short or long in the lead in the distance originally measured on the plug, *i. e.*, the distance between the ball points when the plug was placed in position against the device. In the device shown, the length of the lever F, between its pivot and that end which is operated by the movable block, is half of the length between the pivot and the end operating the gage. Consequently, if the gage be graduated to show movements of 0.001 inch on its own plunger, it will indicate a motion of 0.001 inch on the movable ball point by moving two graduations on its own scale. Very close measurements are consequently possible.

Of course, this device is only one modification of the many possible for obtaining the same results. Very likely there are others equally good, but this one is shown as an example of a satisfactory design, and at the same time as an indication of the principles involved in the design of comparators for the lead of screw and tap threads.

* * *

MACHINERY'S REFERENCE SERIES.

In the advertising section of this issue, announcement is made of a series of valuable reprints from MACHINERY. During the past fourteen years a large number of articles on machine design and shop practice has been published in its columns, all well worth preservation in permanent form. A number of well-known books first appeared by installments in MACHINERY, but these represent a comparatively small part of the valuable technical material that has appeared therein. The remainder represents the shorter contributions of many designers and others connected with the best constructive work. In order to make it generally available, we have selected the representative articles and divided them into groups, each group devoted to one subject, which will be published in 6 x 9-inch pamphlets, ranging from 32 to 48 pages. These pamphlets will contain only such articles as are considered to be of the most practical use, and they will be edited and condensed so as to be "all wheat."

LETTERS UPON PRACTICAL SUBJECTS.

REDUCING THE DIAMETER OF TOOL STEEL UNDER THE STEAM HAMMER.

It is often necessary to reduce the diameter of a piece of tool steel from its original size to perhaps one-half that diameter. This is very common in the making of taps and reamers of large diameters, where it is wanted to have the shank of considerable smaller diameter than the main part of the tool itself. It is evident that it is a great deal cheaper to forge down the diameter of the shank in such cases, than to use solid stock of the full diameter of the tool, and reduce it by turning, but it is necessary that the work of reducing the diameter under the steam hammer is done in the proper manner. Many blacksmiths do not seem to know how this work should be properly accomplished. I have seen many of them take a bar of steel, put it into the fire, leaving it there until the bottom side had arrived at a red heat, and then turn it and leave it in the fire until the other side got heated, paying no attention to the uniformity of the heat of the piece. The work is then taken to the steam hammer and reduced by continually rolling it around on the sides until it is reduced to the size wanted.

The result of this procedure is always a forging with a spongy or "piped" center. When this sponginess is finally detected in the tool, the steel is blamed as being poor, but as a matter of fact, in most cases, the steel has been satisfactory to start with, and the fault is to be found in improper treatment in the blacksmith shop.

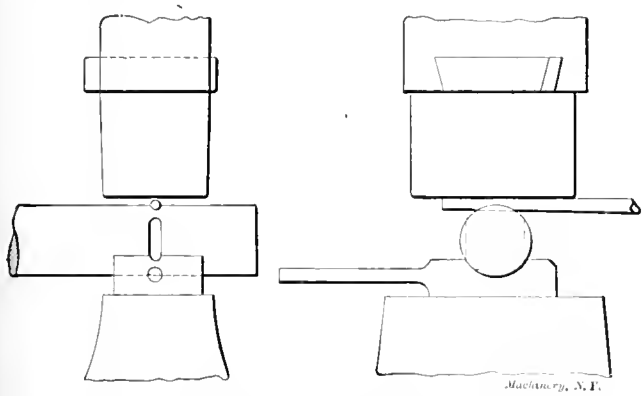


Fig. 1. First Operation in reducing the Diameter of a Tool Steel Bar under the Steam Hammer.

The proper way to reduce the diameter of a piece of tool steel is to first heat it uniformly, and then place it in the steam hammer as shown in Fig. 1. The blacksmith then proceeds to mark the bar on all four sides with a $\frac{3}{4}$-inch round machine steel bar, long enough to hold by the hand. This marking is intended to give a guidance as to the amount of reduction necessary. When the four sides have been marked as in Fig. 1, then proceed to mark the four corners in the same manner. The piece is turned around from one side to the diametrically opposite, receiving a blow each time, until a groove all around the piece is made to the proper depth. Then the diameter is reduced by hammering first on one side, and then on the opposite side of the piece, until a square of the size wanted is produced, as shown in Fig. 3. Then the four corners are hammered in a uniform manner until the piece gets an octagon shape, as in Fig. 4. Next the eight corners of the octagon are hammered down, making sixteen sides, always making sure that the next corner hammered down is diametrically opposite the one just operated upon. Finally, if a swage of the proper size is on hand, the piece can be rounded with this; otherwise when all the corners have been reduced so that they are hardly visible, it is possible to round the piece nicely with even hammer blows until the correct size is arrived at. In Fig. 2 are shown the consecutive shapes assumed by a piece of steel worked down in the manner described.

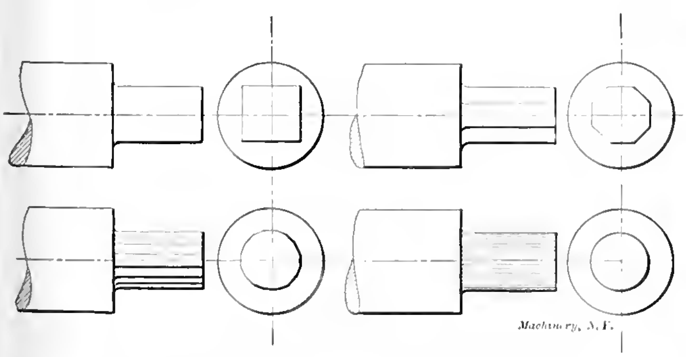
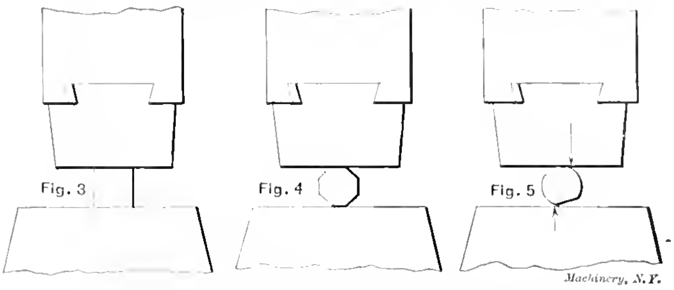


Fig. 2. Successive Steps in reducing the Diameter.



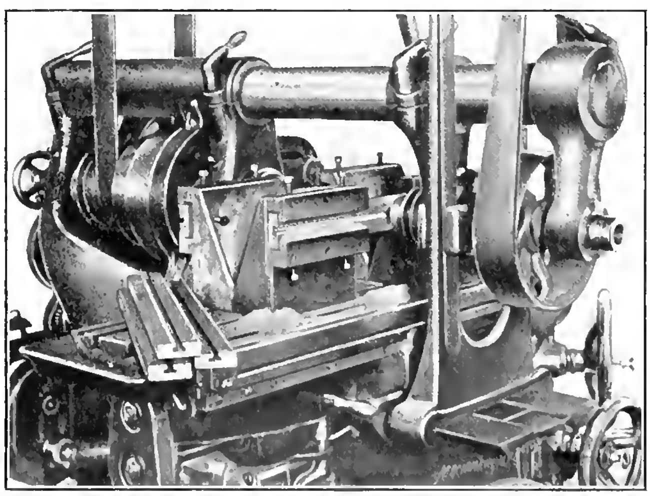
Figs. 3, 4 and 5. Illustrating Corrrect and Incorrect Methods of reducing the Diameter.

It is evident that by rounding continually after the first blow is struck, the blow, as shown in Fig. 5, is not directed on a point that has a firm support directly under it, and a kind of twisting action takes place, causing one-half of the bar to have a tendency to slide in relation to the other half of the bar, the result being that the center of the bar is spoiled, and a spongy or, perhaps, a piped center results. In some cases this hollow center is of no consequence, as, for instance, when a hole is drilled through the piece, but it is evident that all efforts should be directed to avoiding results of this kind.

Decatur, Ill. GEO. T. COLES.

DOUBLING THE CAPACITY OF THE MILLING MACHINE.

The half-tone shows an improvised duplex milling machine. The machine, a Becker-Brainard No. 3, was provided with two arbor supports so designed that the arbor passed through them allowing the supports to be adjusted close to the cutter. The extra spindle is journaled in the outer arbor support, and in addition to this there is an inner journal which is supported by a bracket which is clamped to the knee of the machine. In this way the spindle is rigidly supported. This inner journal, and the bracket which is clamped to the knee, is clearly shown in the illustration. The spindle was taken from a heavy vertical milling attachment, and it was driven by the pulley as shown. An extra pulley on the counter-shaft was, of course, needed. This rig gave much satisfaction, and it was entirely a shop get-up. Few of us who profess to be machine designers would ever think of any such rig as this. The man on the job simply had so much work of a certain



Attachment for Milling Two Pieces Simultaneously.

class to do, that he sought for some way of doing the work more rapidly, and this attachment was the result.

The work, as can be seen, was that of milling tee-slots in strips which were used for holding trip dogs. These strips were about 20 inches long. The fixtures for holding the work are also worthy of mention. They are simple, but effective, as they hold the work securely. Because of their simplicity, they are easily operated, and they are not likely to get out of order. The work which is not finished on the edges, is milled on the top and slotted. The fixture is so arranged that this milled surface is used to line the work up sideways. The screws, which are shown in the illustration, are used to adjust the work lengthwise until the slot is parallel with the table. This work might be done on a vertical machine, but there is an advantage in having it in the position shown, as the cutter can more readily free itself of chips. This advantage is more marked when the cutter is fed in such a direction that it cuts into the metal from underneath so that the teeth carry the chips up over it and drop them in its wake, instead of contiuually dragging them into the cut, as would be the case should the cutter run over and into the work.

Work, other than that shown, might be done to advantage in this way, as the fixture is quite inexpensive even when made specially for the work, the only parts necessary outside of the regular equipment, being the spindle and pulley. I trust that some of the readers of MACHINERY have been looking for something of this kind; if not, it may suggest something else which will prove to be a time saver, and give just as good satisfaction. JOHN EDGAR.

Hyde Park, Mass.

[A similar scheme for doubling the effective capacity of small milling machines was illustrated in the article "The Manufacture of Colt's Automatic Army Pistol," May, 1906, issue.—EDITOR.]

NOVEL METHOD OF PRODUCING THREADS.

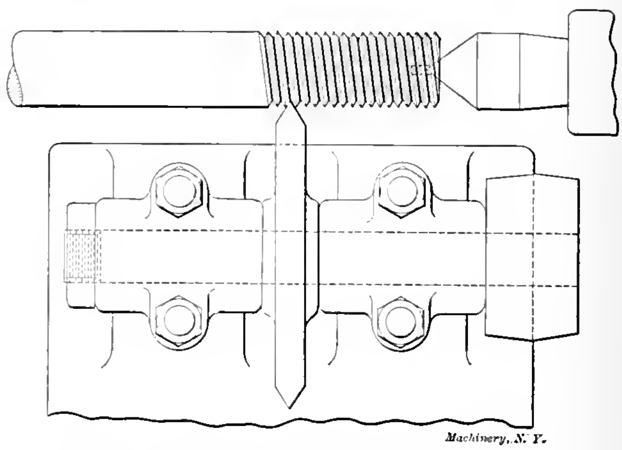
The accompanying cut illustrates a method used for threading studs, pins, etc., of manganese steel, this material being so hard that it cannot be cut by any kind of tool steel. A plain, hardened tool steel disk, having the edge made according to the angle of thread, is employed. This disk is revolved at a high speed, and at the same time forced into the work, which is revolved slowly. Due to the friction between the edge of the disk and the work, and the softening of the material, owing to the heat generated by the friction, the disk wears away the stock, and, by means of this, creates the thread. The stock is coming off in very small, thin scales like chips, which to some extent remind one of the scales of a fish. An ordinary lathe has been rigged up for the purpose of removing the tool-post and top-rest, and substituting for them the fixture shown in the cut. The disk must be driven independently by an overhead drum, or some similar arrangement.

The peripheral speed of the disk is usually between 3,000 and 4,000 feet per minute. The operation is unavoidably slow and expensive, and the method is used only when no other way is possible. The writer thinks, however, that the efficiency can be increased to some extent by increasing the peripheral speed of the disk, perhaps as high as 24,000 feet per minute, same as used on friction saws.

It is likely that high-speed steel would be preferable to ordinary tool steel as material for the disks, but, as the process described is necessarily slow, and is used only when no other way of threading is possible, it has not as yet been developed to the limit of its capacity. There is a certain point in the gradual development of the method above which it becomes economically preferable to employ high-speed steel for the disk, but below this point of development, although high-speed steel may be the best, the ordinary tool steel disk, owing to its smaller first cost, is economically the one to be preferred. A preference for the one or the other kind of steel is influenced by a number of factors, *viz.*, the number of pieces to be threaded per unit of time; the peripheral speed of the disk; the pressure between disk and work; and the efficiency of the system of cooling.

The question of cooling is in itself an interesting one. The reason why the heat does not draw the temper of the tool steel in the disk while the heat is so great that it softens the metal of the work, is that the disk is revolving at a high speed and the work only revolving very slowly, so that a unit of length of the periphery of the disk is in contact with the work but a very short time, while every point on the work, at the place where it is cut, is in contact with the disk a comparatively long time. Owing to this the disk has ample time to cool off, while the work accumulates the generated heat. The high speed of the disk also throws the film of air nearest to the disk outward, owing to the centrifugal force, and new cool air comes constantly in at the center, a current of air thus at all times tending to cool the disk.

The cooling thus obtained is found to be satisfactory at the present speed at which the disk is run, but at a higher speed



Cutting Thread by a rapidly revolving Hardened Steel Disk.

a system of cooling by an air jet, or still better, perhaps, by water, could be employed to advantage. This would also increase the limits within which an ordinary tool-steel disk could be used to advantage. For increasing the peripheral speed of the disk as previously mentioned, undoubtedly the best way would be to increase the diameter of the disk, permitting the number of revolutions to remain the same as before; but at the present stage of the development of this device there are some limitations to the size of the disk, inasmuch as it is used in an ordinary lathe, and the space possible to utilize for the disk is not very great. Another difficulty in increasing the diameter, rather than the number of revolutions, is that for a large diameter disk it is necessary to arrange the disk on an inclined angle in relation to the work in order to get a perfect thread, and this necessarily means a more expensive rigging.

The principle involved in this method of cutting threads is the same as that involved in the friction saw. But the principle of the latter machine cannot be carried out to its full extent in the present case, because the steel to be threaded must not be heated more than to a certain degree. Above this limit, increased heating would mean injury to the quality of the steel. The heat also must not be so high that it burns the thread.

If the call for threaded parts of this kind of steel would be great enough so that a special machine would be warranted to be built, then the efficiency of the method could be increased by a careful taking care of all the points previously referred to, but, at the present time, the demand is not large enough to warrant the expenditure of building such a machine.

High Bridge, N. J. OSKAR KYLIN.

TEMPERING DROP FORGING DIES.

It has always been a source of wonder to the writer, why so many drop forging dies are cracked in hardening, because it is not at all necessary that this should happen. Uneven heating, and uneven cooling with consequent uneven contraction is the cause of the trouble.

If drop forging dies are made from machine steel, they should be packed in No. 1 raw bone and fine wood charcoal, three parts charcoal being used for each two parts raw bone. They are then heated in an oven for eight hours, at a temperature of 1600 degrees F., and are then dipped the same as

described in the following for tool steel. When the dies are made of tool steel, let us first notice that the heating of dies or any kind of tools made from high carbon steel in an open furnace, even if covered with coke, is very injurious to the steel, especially so in the case of drop forging dies, as the carbon leaves the surface of the steel, and the dies will not harden on the outside, but will be harder further in. This

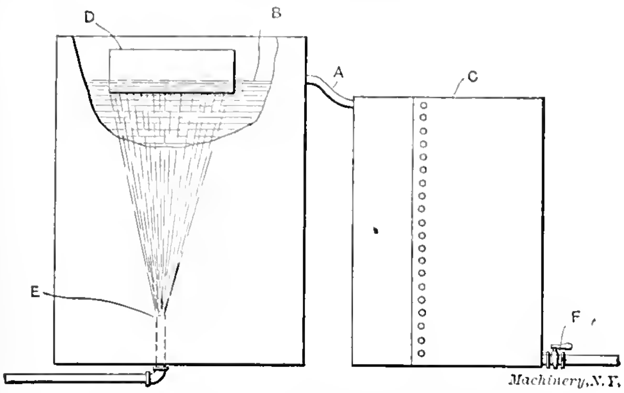


Fig. 1. Arrangement of Brine Tank for Hardening.

does not matter so much with tools that are to be ground to size after hardening, but it is a poor practice with any kind of tool-steel tools. Tool-steel dies should be packed in fine wood charcoal in a box large enough to allow plenty of charcoal between the die and the box walls, say about two inches or more. Seal the cover on tightly with asbestos cement, place the box containing the die in the furnace, and, if a pyrometer is attached to the furnace, hold the furnace at about 1,500 degrees F., leaving the die in for at least four hours. For a small die, shorter time will be sufficient, but a die weighing 50 pounds or more should be allowed four hours to heat slowly and uniformly. Then, instead of dumping the

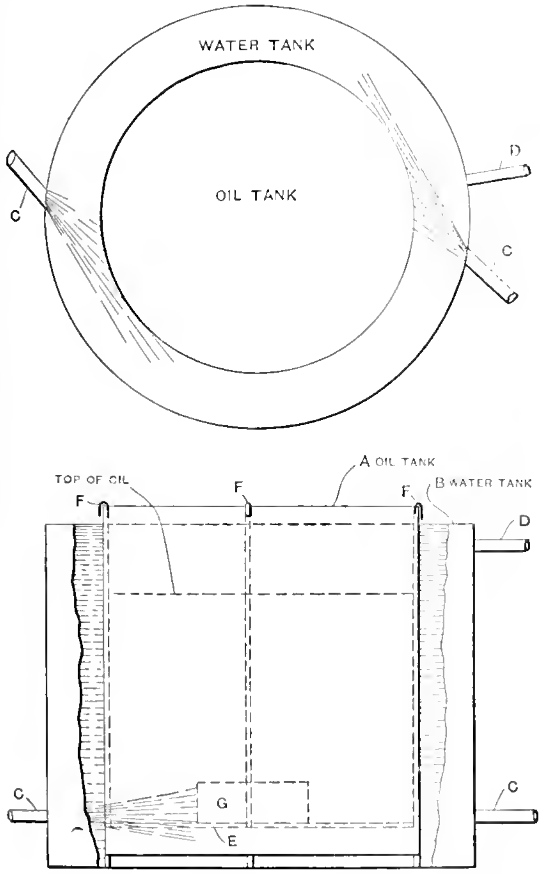


Fig. 2. Oil Tank for Hardening Room

whole die in a tank of cold, clear water, have two tanks, a large one and a smaller one, as shown in Fig. 1. An overflow pipe or hose *A* from the water line *B* in the large tank should connect it with the small tank *C*. When ready to dip the die *D*, place the face only in the water. Plenty of salt should be well dissolved in the water, about 4 pounds to the gallon; this extracts the heat from the die quicker than clear water, and prevents steam formation on the face of the die. A water pipe *E* should be carried in at the center of the large tank at the bottom, and should be supplied with water at fairly high pressure. When placing the die in the bath, open the valve of the pipe *E*, thus forcing the cold solution against the face of the die, while the warm water passes into the smaller tank. The solution collecting in the smaller tank, when cool enough, can be used for smaller tools, and, when so desired, can be run off by outlet *F*. Another bath, in an oil tank, inside of a water tank, as shown in Fig. 2 should be provided. The size of the tanks must be determined by the size of the dies to be hardened. Fish oil should be used in this latter tank, and the tank should have two water inlets *C*, at opposite sides of tank, and so arranged as to allow water to flow around all sides of the oil tank as indicated in the plan view. Pipe *D* is the overflow. A coarse mesh sieve *E* is suspended in the oil tank, and held by rods *F*. The oil tank should have four legs about 6 inches long, to allow water underneath the tank. When the die face has been cooled in the salt water solution, remove the die quickly to the oil tank, and lower it until it rests on the sieve (see *G*, Fig. 2). Let the die remain in this position until cold. It requires no further attention than removal from the oil. Dies hardened in this manner will not crack.

Lansing, Mich. J. F. Sallows.

BORING DRIVING BOX BRASSES.

The jigs illustrated in the accompanying cuts are used for holding driving boxes while their brasses are being bored. It is not claimed that these jigs, or the methods of boring boxes, which will be described, are the best in use, still they are preferable to the tools and methods employed in many shops for doing this work. Fig. 1 shows a jig which is used on a vertical boring mill. This jig is composed principally of two castings in the form of angle plates. The distance between these angle plates, or jaws, is made to suit the largest box in use, and the jaw to the left is made adjustable so that the jig can be used for the smaller boxes. When the jaw is to be adjusted, the four cap-screws which hold it are

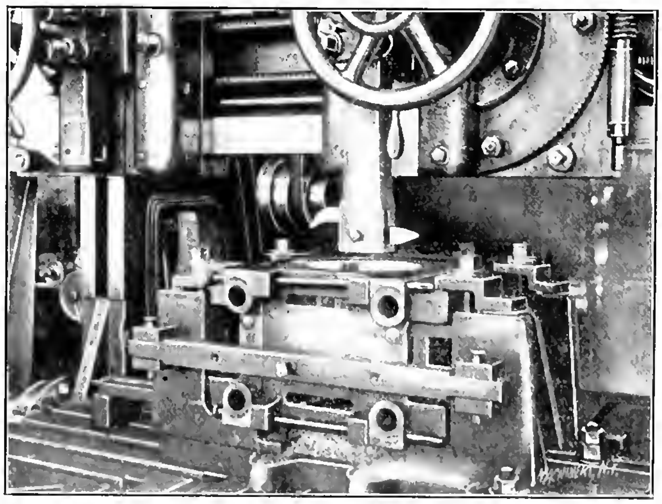


Fig. 1. Jig for Boring Driving Boxes on a Vertical Boring Mill

removed, the angle piece moved in, and the cap-screws inserted into another set of holes which were previously drilled and tapped in the proper place. The jig is provided with two tie bars, one across each end. These tie bars, one of which is shown in Fig. 1, are for the purpose of taking the end thrust when heavy cuts are being taken, and they also facilitate the adjustment of the box. The forged lugs, which hold the tie bars, are held in place by nuts, which are on the inside of the jaws. A shoe, which can be seen in the illustration, is fastened to the right jaw. The shoe faces of all driving boxes are clamped against this shoe. When a set of boxes is to be bored, one is first laid out central with the shoe and wedge faces, then this box is clamped in the jig and the jig is set by it. All the boxes are then bored without shifting the jig. The roughing and finishing tools are, as shown in Fig. 1, both clamped in one tool holder, and the roughing

and finishing cuts taken simultaneously, one cut usually being sufficient to complete the operation.

Fig. 2 shows a jig which is used when boring driving-box brasses on a horizontal boring mill. A detail of this jig is also shown in Fig. 3. The set-screws *A* provide means for adjustment, and also help to hold the box in place. The shoe face of the box is clamped firmly to the face *B* on the jig by bolts which fit into the tee slots *D*, and by a clamp which passes across the wedge face of the box. These bolts and the clamp are shown in Fig. 2. When a narrow box is to be bored, it is set central with the face *B* on the jig by

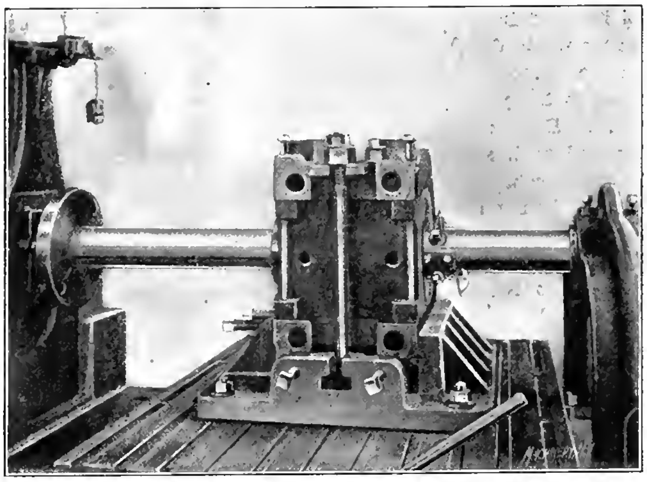


Fig. 2. Jig for Boring Boxes on a Horizontal Boring Mill.

bolting a parallel piece along the face *C*. This jig is set by practically the same method described for the vertical mill. One box is first laid out central and clamped in the jig, the jig is then set on the table, and the table set to the proper height and clamped. All the boxes are then bored without altering the position of the table. In this way, the distance from the bore to the shoe face of each box is exactly the same. Many prefer to set up each box separately, but I have found

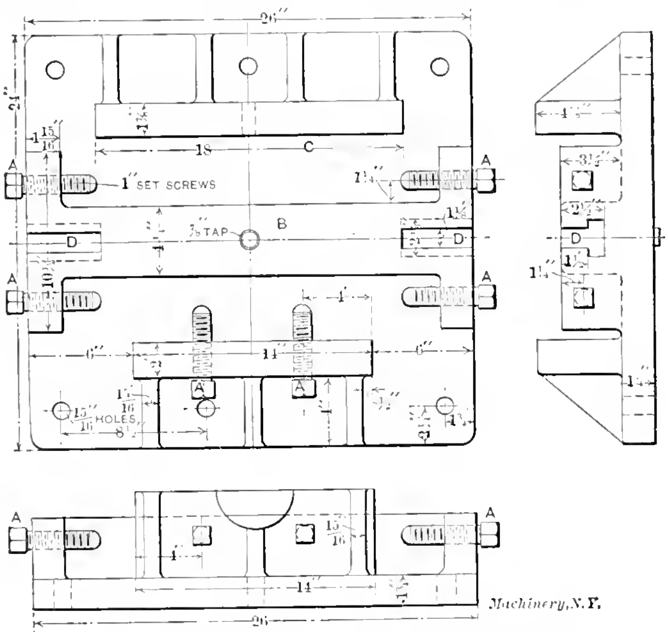


Fig. 3. Detail of Jig used on Horizontal Boring Mill.

the method described to give the best results. This boring bar also contains two tools, each tool having an adjustment which saves much time in setting the tools.

Port Huron, Mich. M. H. WESTBROOK.

THE MARVELOUS CO_2 ENGINE.

Inventive genius cannot be suppressed, not even, or particularly not, in Philadelphia. Time and again has that city seen the birth and death of the most stupendous labor-saving inventions. Though its inventors have not exactly hitched their car to a star, they have harnessed nature's forces and confined them to new and fearsome ways to do their bidding. It it not so long ago that we had Keeley with us, and not a few still lament his demise before he was able to impart the full secret of the connection between the interstellar vibrations, his fiddle, and an engine that would endlessly produce power after Keeley drew his bow.

But in the drawing of the big bow worthy successors have arisen. The confiding public is asked to subscribe to the stock of a development company, whose purpose is the creation of sub-companies, that are in turn to run engines with carbonic acid gas. The development company asks only the trifle of $10,000,000 in subscriptions. Just what is to be done with the $10,000,000 is not quite clear, unless it be presumed that the projectors consider the difficulty of inducing participation in the sub-companies such as to demand such payment. But hold! The prospectus does say: "The company has purchased from the inventor the sole ownership of the invention and all foreign and American patents pertaining to same." Possibly the company is signalizing its wide departure from nature's laws by a similar departure from the usual ones of greedy high finance, and donating a substantial portion of this $10,000,000 to the inventor as a small recognition of his genius.

One of the sub-companies to be formed is for automobile development in adapting the carbonic acid gas engine (CO_2 engine sounds more mysterious, and so spells greater possibilities) to the automobile. Who would not immediately mortgage his house, his salary, and his socks to buy a few shares at par, particularly when informed that "Last year, in the United States alone, over 160,000 automobiles were sold. If this company derived a royalty of but $100 per machine, we would earn $16,000,000." That the royalty of $100 per machine is very modest indeed must be clear, when it is realized that "an automobile will be reduced to about one-quarter of its present weight." In the automobile of to-day, the gasoline motor (so soon to be relegated into the limbo of forgotten toys), with the change gear box and radiator does take up somewhat less than three-fourths of the weight of the car. It follows that the CO_2 engine must weigh some more or less indefinite amount less than nothing. Surely a royalty of only $100 for a motor weighing less than nothing is a very modest one. Consider that a weight of less than nothing is a negative gravity, that one of our noted scientific novelists showed some years ago that a box of "negative gravity" worn on the back of its owner would set him afloat in the air, and the CO_2 company would seem to have solved the problem not only of the automobile but of aerial navigation as well, at one fell swoop. If there is any gratitude still extant in these degenerate days, the company cannot do less than immediately double its capital stock and issue half to me as a modest recognition for pointing out this unsuspected fact.

Does anybody still doubt? Hear the company: "A group of well-known, practical expert engineers in the city of Philadelphia has witnessed a demonstration of our generator and have stamped it with their approval." Are these expert engineers mere men of theory, whose investigations and opinions the world has so far been deluded into accepting as having weight? Not a bit of it! It is "the most scrutinizing inspection of practical men" that is wanted, not the preconceived notion of theoretical faddists wedded to foolish belief in accepted natural laws. "The layman can have little hesitancy" after hearing a report from one of these practical scrutinizers: "I have no doubt—not the slightest—the CO_2 generator does all that is claimed for it. I have seen the engine with the invention attached and studied it, and failed to find a single defect. Why it does it, of course, I don't know—its possibilities are limitless."

Does the company want to secure for itself all of the filthy lucre derivable from these "limitless possibilities?" No! In a noble manifestation of altruistic spirit it prefers to let the others who will form the sub-companies garner the gold. All it wants is $10,000,000 for granting this privilege to these fortunate sub-companies. Oh, proud Philadelphia, potent indeed is the spirit of brotherly love within thy borders when even the exploiter of such marvels (or shall we say marvelous exploiter) can so share with others!

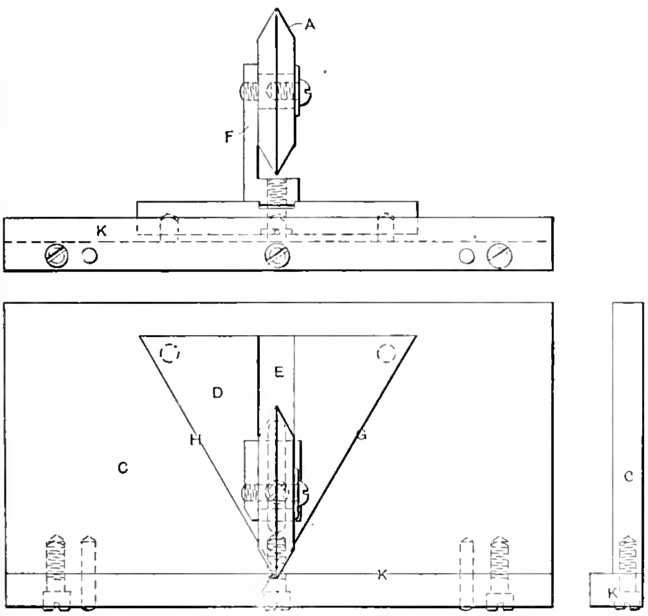
A printed pamphlet with beautiful illustrations of a CO_2 automobile, of a CO_2 100 H. P. engine, of a CO_2 railway car, and

of a residence equipped with a CO_2 system can be had on demand—not a penny, not a postage stamp even, is asked in payment. HENRY HESS.

Philadelphia, Pa.

FIXTURE FOR GRINDING ANGULAR MILLING CUTTERS.

The accompanying cut shows a little device which has proved itself very useful in grinding angular milling cutters when a perfect angle is required. The radius at the point of the angle can also be ground, radius and angle being ground at one setting. This fixture consists of a base-plate *C*, which is clamped to the grinder table so that it can be fed to and from the wheel by the feed arrangement on the grinder. On this base-plate rests a triangular plate *D*, carried on three feet. This latter plate is free to move in all directions, simply sliding on its feet on the plate *C*, and is guided only by the hands of the operator. In this triangular plate *D* there is a slot *E*, into which a tongue of the bracket *F* is fitted, this bracket then being movable back and forth on the plate *D*, and having arrangement for clamping in any position. The cutters *A* are clamped to this bracket *F* by a suitable screw and washer. For different widths of cutters, either different



Fixture for Grinding Angular Milling Cutters.

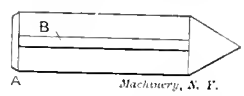
brackets must be employed or washers may be interposed between the bracket and the cutter, because it is evident that the center line of the cutter must always coincide with the center line of the triangular plate *D*. The cutter can be set to any given radius between the two angular faces by placing a gage block, having the same thickness as the radius wanted, against the point *B* of the triangular block, and placing a square against the gage, and adjusting the cutter so that the blade of the square just touches the point of the teeth of the cutter *A*. If I, for instance, have a cutter that I want to grind to a 60-degree angle, and want 1/16 inch radius at the point, I simply set my cutter central with the triangular block, and place a 1/16-inch gage block between the square and the point *B* of the block, and then adjust the cutter until it touches the blade of the square. The cutter is then clamped in place. The grinding itself is performed by sliding the plate *D* first to one side and then to the other, so that the sides *G* and *H* alternately rest up against the guide *K* on the bed-plate *C*, the side of the teeth of the cutter being meanwhile moved back and forth across the face of the grinding wheel. The turning around of the triangular block from one side to the other with the point *B* against the guide *K* evidently produces a radius at the point of the cutter between the two angular sides. The height of the cutter tooth in a horizontal direction, when setting, is determined by a gage block of such a height that the tooth face is in a horizontal plane with the center line of the cutter. The cutters are formed closely, before hardening and grinding, to the desired shape, so that there is but a few thousandths inch left to be removed when grinding. P. YORGENSEN.

Hartford, Conn.

[The manner of determining the radius to be ground is not quite correct. When a gage block 1/16 inch thick is used, as described by our correspondent, the resulting radius of the cutter is not 1/16 inch, but, for a 60-degree cutter, having a 30-degree angularity on each side of the center line, only one-half of 1/16, or 1/32. If the *exact* radius is required to be determined, the gage block should not be placed against the point of triangular block *D*, but against the side, and the blade of the square should rest against the angular face of the cutter instead of against the point. Then the resulting radius would be exactly equal to the thickness of the gage block. The method explained by our correspondent is, of course, convenient as a *relative* measurement, and is used as such where these fixtures are employed, but it does not give the real length of the resulting radius.—EDITOR.]

LATHE CENTERS WITH HIGH-SPEED STEEL POINTS.

In speed lathes and engine lathes used for turning small work at high rotative speeds, considerable trouble can be avoided by the use of dead centers that will stand considerable heat without softening. This can be accomplished by the use of machine steel centers with inserted high-speed steel points. The points are best made from about ½ inch round stock, having a cylindrical fit about 1 inch long. If the steel is cut 1¾ inch long, there will be ample stock for the tapered portion, and for truing up, and also for insuring a firm joint that will give no trouble from loosening or springing. For making centers of this description the following is suggested, and in my experience has proved to be a very satisfactory way. If a cutter grinder or grinding machine is available, mount the bar of round high-speed steel in the chuck, after first roughing out the cone point on a rough grinder, and grind it true and parallel. Then, swivel the head, and grind the cone point. Remove the bar from the chuck, nick it on a thin wheel, and break off the end to the length wanted. Then square up the end and bevel the corner *A*. This facilitates the pressing in place later. Finally grind a small flat on the side of the center at *B* to let the air escape when pressing it into place. If made in quantities, it is advisable to have the diameter a definite figure, so that the centers will fit a hole reamed with a standard reamer. FOSTER F. HILLIX.



La Fayette, Ind.

OBTAINING ANGULAR MOVEMENTS WITH THE INDEXING HEAD.

In the September, 1907, issue of MACHINERY, there appeared a criticism of the article on indexing, published in the February issue, in which the critic, Mr. John Edgar, claims to have presented a clearer explanation of the relationship existing between the movements of the crank, or worm spindle, and the angular movements of the work spindle. It may be that he has done so, but I am inclined to think that the method which I shall give is preferable. Take the number of degrees passed through by the work spindle in one revolution and divide this number by the number of teeth in the worm-wheel, or, what amounts to the same thing, the number of turns of the crank necessary to effect such a movement. The quotient will equal the number of degrees that the work spindle will move, for one revolution of the crank. In this way the relationship between the work spindle and the crank is shown as clearly as can be shown. In the criticism referred to, it was stated that a division of one degree is made by a movement of two holes in an 18-hole circle. This will be obvious from the rule which I have given, as 360 degrees divided by 40 teeth, equals 9 degrees for one turn of the crank. If the number of degrees that is to be indexed is divided by nine, the quotient will equal the number of turns that the index crank must make.

The following example is the one given by Mr. Edgar to illustrate his method of indexing: "Should it be desired to

index, say, 27 degrees, we would multiply 27 by 2 and obtain the number of holes necessary for such a movement. As 54 is a greater number than the number of holes in the circle, we would have as the movement of the index crank $54/18 = 3$ turns to make a 27 degrees division or indexing." This same result can be obtained by simply dividing 27 by 9. On the Brown & Sharpe milling machine the smallest fraction of a degree that it is possible to index exactly, by simple indexing, is 1/3 of a degree. By compound indexing, however, it it possible to index exactly 1/60 of a degree, or in other words, angles may be indexed, progressing by one minute. According to the article referred to, a division of 1/4 or 1/6 of a degree should be fine enough for even the closest jig work. Then a 1/60-degree division is evidently intended for work which must be closer than the closest jig work. But are the quarters or sixths of a degree division fine enough? Taking even the smaller fraction, the error on a 6-inch diameter is liable to be 0.0043 inch in one indexing. The error could not be more than 0.0043, as this equals the length of the arc of an angle of five minutes, the radius being 3 inches. If the work had to be indexed a few times, this error would be increased, and in that case I do not believe any one would be accused of splitting thousandths to an exaggerated degree.

Stamford, Conn. J. PRICE.

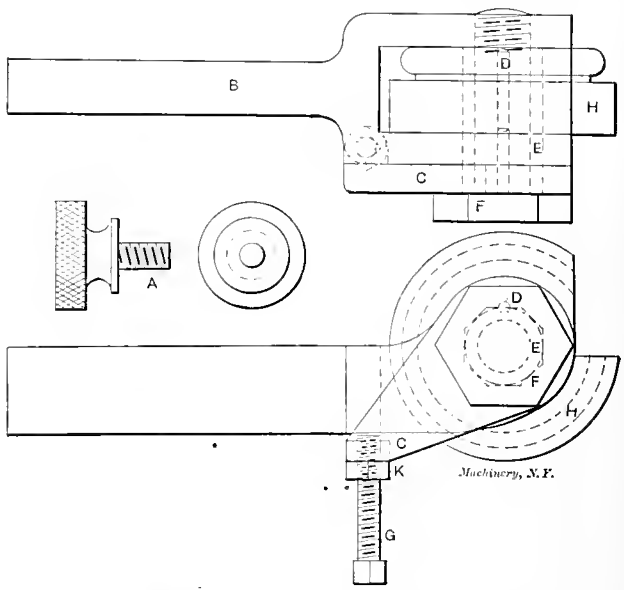
[The methods advocated by Mr. Price and Mr. Edgar are both correct, of course, and it is merely a matter of opinion which one should be preferred. To the average machinist, most likely, the fact that two holes in the 18-hole index circle represent one degree, is the one easiest to remember, and the one least likely to cause mistakes or confusion. In regard to the matter of how close angular movements may be carried on the milling machine with ordinary index heads, a certain reserve is advisable. While with compound indexing, movements of one minute are obtainable, theoretically, that does not say that with an ordinary index head such accuracy is possible when indexing, say, 30 degrees. Mr. Edgar, being a practical milling machine designer, most likely is aware of the limitations of the index head. In fact, any one who has tried to mill a side milling cutter, by using an ordinary milling machine index head, knows that when the teeth are milled on the face, and the cutter then turned so as to mill the teeth on the side, the second indexing around will not coincide exactly with the first, at least not if the indexing is not started in exactly the same relative position between cutter and index head, as when milling the teeth on the face. This indicates the practical limitations for accuracy of the index head.—EDITOR.]

IMPROVED CIRCULAR FORMED TOOL-HOLDER.

The cut herewith shows at A a formed knurled head screw, of which a large number had to be made, and a circular forming tool with its holder. Not having an automatic screw machine to take the size stock required, it was decided to make these screws on a lathe, using the circular tool and holder mentioned. The circular forming tool and forked tool-holder were made, and a bolt used to bind the prongs of the holder against the forming tool, no means being devised for adjusting, or preventing the tool from slipping.

The foreman of the tool-room, after experimenting in one way or another to stop the tool from slipping under the heavy strain of the cutter, thought it would be a good idea to drive a "maple wedge" in the space between the cutter and the holder. As the screws were made of cold rolled steel, and oil used for turning them, it is easily imagined to what extent the "maple wedge," after being soaked with oil, would stop the cutter from slipping. The tool was thrown aside as useless, and, after lying in its resting place for a week or more, the idea embodied in the cut occurred to me. I suggested it to the foreman, it was approved, the holder finished, and the job completed to the satisfaction of everybody.

In the cut, H is the formed circular tool; B, the forked tool-holder; C, a yoke with an octagon hole to fit the head of sleeve E, which has a keyway to fit the key D, the length of which is the same as the width of the inside space of the prongs of B. In the assembling of the tool, D is placed in the corresponding keyway in the hole of tool H, and tool and key placed in holder B. Then sleeve E is put into place, and yoke C is placed on the octagon head of the sleeve E. The hexagon clamping bolt F binds all together. G is the adjusting screw for setting the cutting edge of H, provided with a check nut K. The hole in the yoke C, and the head on the sleeve E being octagon, allows an adjustment of 45 degrees, before shifting the position of the yoke. Narrow cutters may



Improved Circular Formed Tool-holder.

be used in the same holder by placing washers or collars in the vacant space, or a gang of formed tools could also be used. This tool has been in practical service for five years, has never slipped, and has given entire satisfaction on every job used. FRANK G. STERLING.

Lowell, Mass.

PNEUMATIC DOLLY.

The small pneumatic dolly illustrated herewith, is used for "holding on" while riveting ball joint rings on the ends of locomotive dry pipes. This is not an entirely new device, but there are, doubtless, a number of shops not provided with this useful tool. The dolly is shown in detail in Fig. 1. It consists of a cylinder A, into which the leather-packed

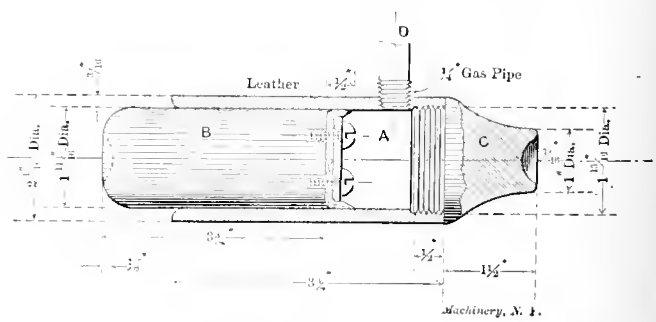


Fig. 1. Pneumatic Dolly.

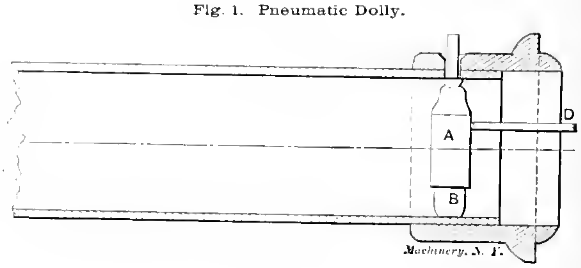


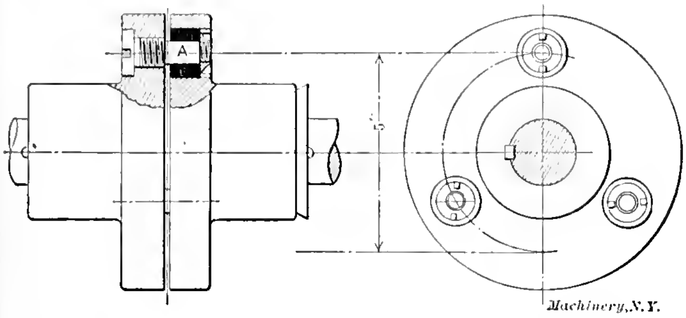
Fig. 2. The Pneumatic Dolly holding Rivet in Place.

plunger B is fitted. A head C, which is cupped to fit the head of the rivet, is held against it, as illustrated in Fig. 2, and the compressed air is admitted to the cylinder A by the pipe D. The air forces the plunger B against either the wall of the pipe or the head of a rivet opposite, holding the rivet to be hammered securely in place. M. H. WESTBROOK.

Port Huron, Mich.

A SIMPLE FLEXIBLE COUPLING.

At the high speeds prevailing in steam turbine practice, it it evident that careful alignment becomes necessary on direct-connected drives. A small amount of cramping and frictional retardation, due to mal-alignment, would absorb considerable power at such high speeds. One maker of these turbines of the medium and small sizes, direct connected to pumps, fan blowers and dynamos, mounts each complete outfit on a substantial bed plate, and uses a flexible coupling of the design shown in the cut. The solid black sections indicate rubber bushings, the elasticity of which permit the necessary adjustment for alignment the drive being through the bolts *A* and the bushings. With some such coupling, any springing of bed plate or differences of shaft level, due to unequal wear in bearings of



A Flexible Coupling of Simple Design.

component parts of the outfit, will not affect the friction load appreciably. The observed example is to be found on the second motion shaft of the De Laval No. 1 B engine, rated capacity 15 H. P., running at 2,400 R. P. M., and driving a Sturtevant No. 6 Monogram fan.

Figuring back to the bolt circle, with its three yielding rubber rings, the above power and speed apportions 52½ pounds maximum pressure on each ring.

$$\frac{15 \times 33{,}000 \times 12}{5 \times \pi \times 3 \times 2{,}400} = 52.5 \text{ pounds.}$$

Apparently this pressure is below the squashing limit of the rubber, as an examination of the rubber bushings after two years' use in a warm engine room showed that they still fitted closely on the pin and in the bore of the coupling.

The groove on the hub of the coupling on the driven half, to prevent the oil from the bearing from working up and out to the flange where it might rot the rubber, should be noticed, and also the gap between the halves of the coupling for allowing adjustment of alignment, and increase of length of shafts due to temperature changes. A wedge gage or feeler tried at various places in this gap, and a straight-edge test over the edge of the flanges would quickly tell of changes in the positions of the shafts which might render a re-aligning desirable. The freedom from any projecting bolt heads seems also a good point. Other advantages may be known to the makers, but the above appear most readily to an observer.

New Britain, Conn. ROBERT S. BROWN.

[Some flexible couplings of interesting design were shown in the December, 1906, issue of MACHINERY, page 202, engineering edition, and in the June, 1907, issue, page 560, engineering edition.—EDITOR.]

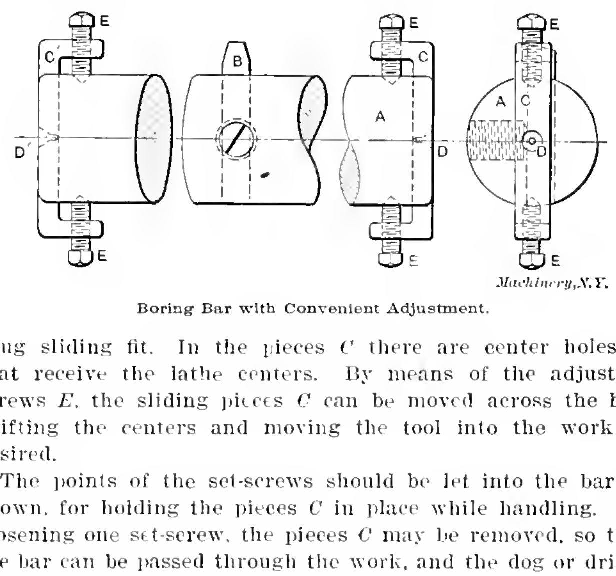
THE COLLAPSING OF HARDENED TOOLS.

In the November, 1907, issue of MACHINERY two half-tones were shown of a mandrel broken by internal stresses produced by the hardening process. An occurrence of this kind can, in most cases, be prevented, if tools are hardened in the proper manner. If we heat a piece of tool steel to a high heat, say 1,600 degrees F., and quench it in clear water until it gets entirely cold, that piece of steel is sure to become useless. Take, for instance, a mandrel or any solid tool heated and quenched in this manner. When the outside commences to cool off it shrinks, and consequently forces the mass of metal at the center together, the metal at the center still being red hot. After a while, however, the center of the piece starts to cool off also, and in cooling it will shrink. This shrinking produces tremendous strains between the outside and the center portion of the metal, because the outside portion is already cooled off, and is in a perfectly solid state, and the inside portion cannot shrink except by producing cracks in the metal. The cracks may not appear immediately, but the internal strains are in operation just the same, and will finally cause the collapse of the tool. This final collapse can be somewhat delayed by softening the mandrel on the outside, thereby relieving the strains to a certain extent, but a tool treated in this way would in most cases be too soft for the purpose for which it is intended. The proper way of hardening is, of course, to dip the heated piece of steel in cold salt water only for so long a time as to harden the outside deep enough to allow for grinding, and then place the piece in fish oil to let it cool slowly. The piece should be heated to about 1,500 degrees F. Of course we all know that if the piece is simply cooled off in water long enough to harden the outside, and then laid aside on the bench or on the floor until it cools off, it will be too soft, because the heat at the center drives the hardening from the surface. The proper method outlined, however, will insure success.

Lansing, Mich. J. F. SALLOWS.

A HANDY BORING BAR.

Although the plain boring bar with a single cutter is out of date for duplicate work, it is often useful in the tool-room, experimental room and job shop. The machinist often finds it difficult to adjust the tool of a plain boring bar to the required accuracy, and hold it rigid. The writer has found the bar which is shown in the accompanying cut, to be very useful. It consists of a straight bar *A*, of suitable diameter and length for the work at hand, in the center of which the cutting tool *B* is held in the usual manner. Each end of the bar is milled to receive the bent pieces *C*, which are made a



Boring Bar with Convenient Adjustment.

snug sliding fit. In the pieces *C* there are center holes *D* that receive the lathe centers. By means of the adjusting screws *E*, the sliding pieces *C* can be moved across the bar, shifting the centers and moving the tool into the work as desired.

The points of the set-screws should be let into the bar as shown, for holding the pieces *C* in place while handling. By loosening one set-screw, the pieces *C* may be removed, so that the bar can be passed through the work, and the dog or driver put in place. This bar will be found of special value when cutting threads into large nuts. ARTHUR NICHOLS.

Lansing, Mich.

DRIVING THREADED STUDS IN A LATHE WITHOUT MARRING THE THREADS.

Various devices are resorted to for driving a stud held between lathe centers, or for holding a bolt or other threaded piece in a vise without marring the threads. One of the simplest and most effective methods is to saw an ordinary nut of the same diameter and pitch as the stud in two parts, cutting in a plane coinciding with the center line, or exactly as the lead-screw nut of a lathe is split. If a stock of these split nuts to fit all standard threads is kept on hand, any piece of standard size can be gripped quickly, tightly, and without damage to the threads. A nut cut through one side only is also possible to use, but has to be screwed on and off—a decided waste of time, even on short threads.

Middletown, N. Y. DONALD A. HAMPSON.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

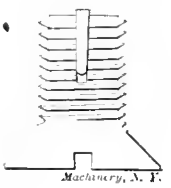
OILING CENTERS.

A very simple method for keeping the centers of a lathe properly lubricated is to tie a thoroughly oiled piece of waste around the center, so that the waste rubs against the end of the work. The pressure of the cut, of course, forces the piece of work somewhat toward one side of the center, allowing enough space to permit the oil to constantly flow into and lubricate the center hole in the work being turned. This simple method will do away with a great deal of wear on the centers, and will prevent all other unpleasant experiences which result from heated centers, not properly lubricated.

Birmingham, Ala. JOHN McLEOD.

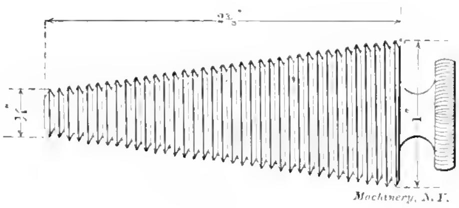
HOW TO TIGHTEN A LOOSE SCREW.

I was called upon to tighten a loose screw in a printing press. The screw was too small for the hole, and not being able to obtain one of suitable size and shape, I resorted to the following: The old screw was held between two pieces of wood in the vise, and a slot made, as shown in the sketch; the slot was opened a little, and a flat iron wedge driven in. The screw was then returned to its place, and it is now there for keeps. This method can be used also with bolts where the nut will not stay. X. Y. Z.



TOOL FOR CALIPERING TAPER TAPPED HOLES.

The tool shown in the cut is used for calipering taper tapped holes in boilers when fitting studs. It is a simple, though very useful and economical tool, and it will doubtless be appreciated by those having much work of this kind to do.

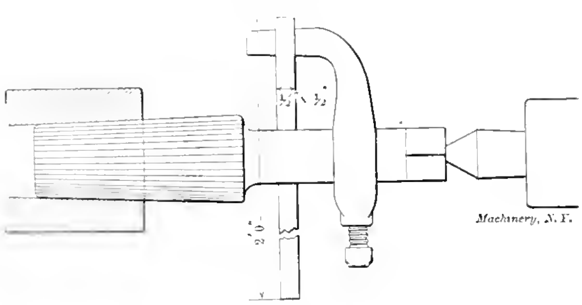


The hole in which the stud is to be fitted is calipered by filling the threads of the plug with chalk, and then screwing the plug in the hole. When the plug is removed the chalk will show exactly the largest diameter of the hole.

Brighton, Mass. F. RATTEK.

REAMING A TAPER SLEEVE.

I have seen many mechanics fuss around for hours when reaming a taper sleeve, and, finally, go to the boss for help. When doing work of this kind, the reamer is supported and guided by the dead center, and kept from turning by a lathe

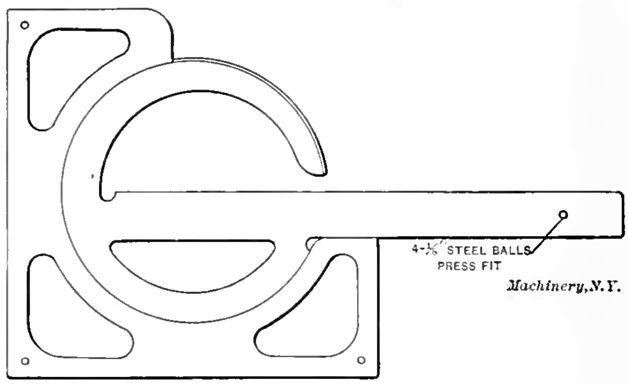


dog which is fastened to it. When held in this manner, the reamer tends to feed into the work and tear itself from the dead center. This can be prevented by the following method: After roughing the work to the desired size, prepare to ream the hole as usual. Then procure a light pine stick about ½ inch square by 2 feet long, and place this stick in the position shown in the cut. Hold the stick with the left hand, and pull slightly toward the dead center. Start the lathe slowly, and with the right hand feed the reamer into the work. This stick will enable one to feel the cutting of the reamer, and the feed can be judged accordingly. If the reamer should bind, the stick will strike the lathe and break, and the work and reamer will be free to turn. If a little care is given to the feed and speed, this method of holding a reamer will be found satisfactory. W. H. ADDIS.

Decatur, Ill.

RAISING DRAFTSMAN'S PROTRACTOR ABOVE THE SURFACE OF THE DRAWING.

Anyone who uses a Brown & Sharpe draftsman's protractor is familiar with the way it soils the drawing, when put to any extended use, in spite of the utmost care on the draftsman's part. The cut herewith shows a scheme which, I believe, is original with Mr. Geo. L. Merrill, of this city, for



raising the surface of the protractor slightly from the drawing. Four steel balls are made a press fit in the device at about the positions shown, the balls being about ⅛ inch diameter, projecting an equal amount on both sides, thus giving the same results no matter which side of the instrument is up. This addition to the instrument in no way affects its accuracy, and, as it bears only on four points, it rubs less dirt into the drawing than an ordinary triangle.

Detroit, Mich. M. R. KAVANAGH.

MULTIPLE THREAD CUTTING ON THE ENGINE LATHE.

Where there are many multiple-thread screws of *coarse* pitches and leads to be cut it is a valuable kink for a machine department foreman to know that engine lathes having lead-screws even multiples in pitch of the screws to be cut, are the most convenient to use, other things being equal. When given a multiple-thread screw to cut, most mechanics divide the change gear on the stud into as many parts as there are threads, say two for double, three for triple, and so on. This applies when the stud and spindle run at the same rate. After cutting one thread, the parallel thread or threads are located by slipping the change gear and setting for the new positions by the chalk marks on the change gear. This method takes time and is liable to cause mistakes. Quite often it happens that a change gear cannot be used having a number of teeth that is an exact multiple of the multiple thread. For example, a triple thread would require the change gear to have such number of teeth as will be exactly divisible by 3. If such gears are not available, then there is trouble.

If, instead of sending all such thread cutting to one lathe, we distribute it according to the character of the lead-screws, there will be considerable gain of time and less chance for spoiled work. Suppose, for example, that we have a quadruple-thread screw, 1 inch lead, to cut. If a lathe having a 4-threads-per-inch lead-screw can be used, the setting of the tool for each of the parallel threads will simply be a matter of opening the split nut and moving the lathe carriage one thread of the lead-screw and then closing the nut. If the screw to be cut was a triple thread of 1 inch lead, a 6-pitch lead-screw could be used, moving the carriage two threads of the lead-screw, and so on. R. H. MITCHELL.

New Castle, Ind.

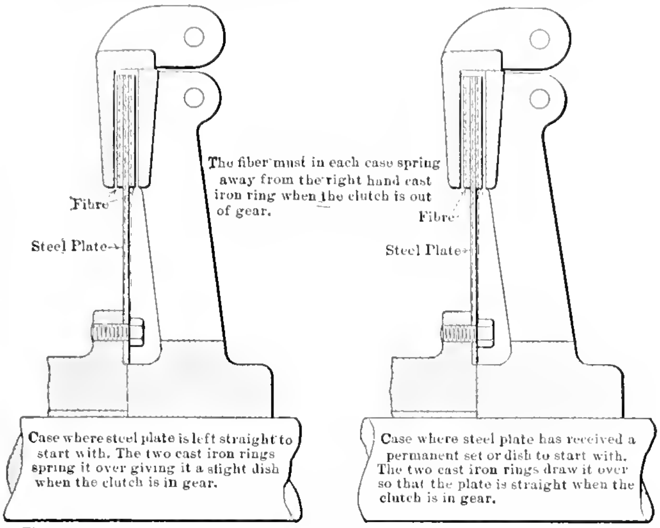
HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

DESIGN OF STEEL PLATE FRICTION CLUTCH.

D. G. M.—In the case of a steel plate friction clutch in which the steel plate with its fiber covering springs away from the cast iron face when it is out of engagement, which is the better practice: to give the plate a slight dish so that when the clutch is engaged it will straighten the plate into a perfectly flat disk, or to leave it straight and to spring it into a slightly dished shape when the clutch is engaged? The cuts Figs. 1 and 2 will illustrate the meaning clearly.



The dotted lines in each case indicate the positions of the plates with their fibre coverings when the clutch is in gear. Clutches are shown out of gear. *Machinery, N.Y.*

Figs. 1 and 2.

A.—Our preference would be to leave the plate flat and to spring it into the required shape and position by the action of closing the clutch. This will avoid the difficulty of making the plate run true after dishing it. The available clearance being small, it is essential that it run very true, and this condition is best obtained with a flat plate. The practical action otherwise should be about the same. The question is submitted to our readers for suggestion and comment.

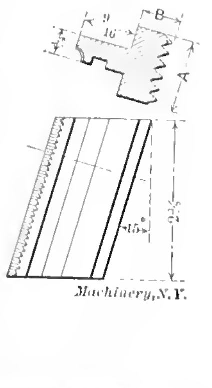
THREADING CHASERS.

Tool-maker.—Is there any rule regarding the number of threads with which ordinary threading chasers should be provided on their face? I have seen chasers with as many as 20 threads or teeth on their face, but usually they seem to be provided with only six or seven.

A.—We infer that when speaking of threading chasers our correspondent refers to such as are held in standard threading tool holders. The chaser which is shown in connection with the accompanying table, is of the type used in the thread tool holder manufactured by the Pratt & Whitney Co. Of course, the data given herewith apply to any class of threading chaser of a similar type. There is no rule governing the number of teeth with which a chaser should be provided, but it is customary to increase the number of teeth for finer pitches as compared with the coarser ones. The accompanying table gives all dimensions necessary for these tools. The dimensions given conform to accepted practice.

DIMENSIONS OF THREADING CHASERS.

No of Threads per inch.	A	B	No. of Teeth in Chaser.	No. of Threads per inch.	A	B	No. of Teeth in Chaser.
3	1.333	3/4	4	12	0.667	5/16	8
3¼	1.231	3/4	4	13	0.615	5/16	8
3½	1.143	3/4	4	14	0.571	1/4	8
4	1.000	5/8	4	16	0.500	1/4	8
4½	1.111	5/8	5	18	0.500	1/4	9
5	1.000	1/2	5	20	0.450	1/4	9
5½	0.909	1/2	5	22	0.409	3/16	9
6	0.833	1/2	5	24	0.375	3/16	9
7	0.714	3/8	5	26	0.385	3/16	10
8	0.750	3/8	6	28	0.357	3/16	10
9	0.667	3/8	6	30	0.333	3/16	10
10	0.700	3/8	7	32	0.312	1/8	10
11	0.636	3/8	7	36	0.278	1/8	10
11½	0.696	3/8	8	48	0.250	1/8	12



FIGURING LATHE CHANGE GEARS.

Apprentice. Please state in a simple manner the way of figuring change gears for a lathe. I have seen some text books on the subject, but they all seem to make the subject so complicated that I do not fully understand the methods explained.

A.—While the principles and rules governing the calculation of change gears are very simple, they, of course, presuppose some fundamental knowledge of the use of common fractions. If such knowledge is at hand, the subject of figuring change gears, if once thoroughly understood, can hardly ever be forgotten. It should be impressed upon the minds of all apprentices that the subject in itself is extremely simple, and that the difficulty usually presents itself because the matter is not approached in a logical manner, and is usually grasped by the memory rather than by the intellect. Before answering the question in regard to any rules for figuring change gears, let us therefore analyze the subject. The lead-screw *B* of the lathe (see Fig. 1) must be recognized as our first factor, and the spindle as the second. If the lead-screw has six threads per inch, then, if the lead-screw makes six revolutions, the carriage travels one inch, and the thread-cutting tool travels one inch along the piece to be threaded. If the spindle makes the same number of revolutions in a given time as the lead-screw, it is clear the tool will cut six threads per inch. In such a case the gear *D* on the spindle stud *J*, and gear *E* on the lead-screw are alike. If the spindle makes twice the number of revolutions of the lead-screw, the spindle revolves twelve times while the tool moves one inch, and consequently twelve threads per inch will be cut. But in order to make the spindle revolve twice as fast as the lead-screw, it is necessary that a gear be put on the spindle stud of only half the diameter of the gear on the lead-screw, so that when the lead-screw revolves once the spindle stud gear makes two revolutions.

Simple Gearing.

Suppose we wish to cut nine threads per inch with a lead-screw of six threads per inch, as referred to above. Then the six threads of the lead-screw correspond to nine threads on the piece to be threaded, which is the same as to say that six revolutions of the lead-screw correspond to nine revolutions of the spindle; or in other words, one revolution of the lead-screw corresponds to 1½ of the spindle. From this it is evident that the gear on the lead-screw must make only one revolution while the spindle stud gear makes 1½. Thus, if the lead-screw gear has, for instance, 36 teeth, the gear on the spindle stud should have only 24; the smaller gear, of course, revolving faster than the larger. If we express what has been previously said in a formula we have:

$$\frac{\text{threads per inch of lead-screw}}{\text{threads per inch to be cut}} = \frac{\text{teeth in gear on spindle stud}}{\text{teeth in gear on lead-screw}}$$

Applying this to the case above, we have:

$$\frac{6}{9} = \frac{24}{36}$$

The values 24 and 36 are obtained by multiplying 6 and 9, respectively by 4. By multiplying both the numerator and the denominator by the same number, we do not change the proportion. As a general rule we may then say that the change gears necessary to cut a certain number of threads per inch are found by placing the number of threads in the lead-screw in the numerator, the number of threads to be cut in the denominator, and then multiply numerator as well as denominator by the *same* number, by trial, until two gears are obtained, the number of teeth of which are both to be found in the set of gears accompanying the lathe. The gear with the number of teeth designated by the new numerator is to be placed on the spindle stud (at *J*, Fig. 1), and the

gear with the number of teeth corresponding to the denominator on the lead-screw *B*.

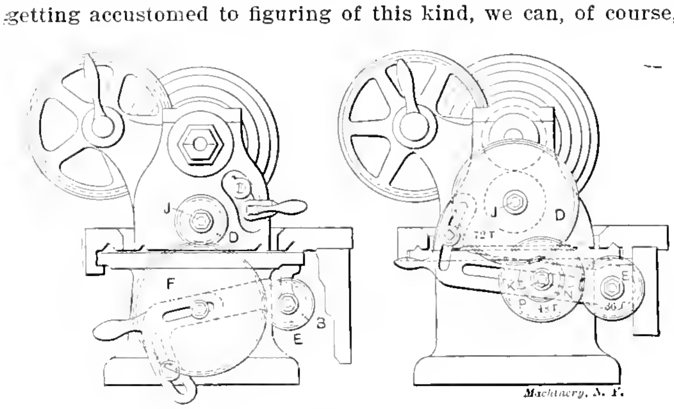
A few examples of this will more clearly define the rule. Suppose the number of teeth of the change gears of a lathe are 24, 28, 32, 36, and so forth, increasing by 4 teeth up to 100. Assume that the lead-screw is provided with 6 threads per inch, and that 10 threads per inch are to be cut. Then,

$$\frac{6}{10}=\frac{6\times 4}{10\times 4}=\frac{24}{40}$$

By multiplying both numerator and denominator by 4, we obtain two available gears with 24 and 40 teeth, respectively. The 24-tooth gear goes on the spindle stud, and the 40-tooth gear on the lead-screw. Assuming the same lathe and gears, let us find the gears for cutting $11\frac{1}{2}$ threads per inch, this being the standard number of threads for certain sizes of pipe thread. Then,

$$\frac{6}{11\frac{1}{2}}=\frac{6\times 8}{11\frac{1}{2}\times 8}=\frac{48}{92}$$

It will be found that multiplying with any other number than eight would, in this case, not have given us gears with such number of teeth as we have in our set with this lathe. Until getting accustomed to figuring of this kind, we can, of course,



Figs. 1 and 2.

only by trial find out the correct number by which to multiply numerator and denominator. The number of teeth in the *intermediate* gear *F*, Fig. 1, which meshes with both the spindle stud gear and the lead-screw gear is of no consequence.

Lathes with Reduction Gears in Head-stock.

In some lathes, however, there is a reduction gearing in the head-stock of the lathe, so that if equal gears are placed on the lead-screw and the spindle stud, the spindle does not make the same number of revolutions as the lead screw, but a greater number. Usually in such lathes the ratio of the gearing in the head-stock is 2 to 1, so that with equal gears the spindle makes two revolutions to one of the lead-screw. This is particularly common in lathes intended for cutting fine pitches or, in general, in small lathes. In figuring the gears this must, of course, be taken into consideration. As the spindle makes twice as many revolutions as the lead-screw with equal gears, if the ratio of the gears be 2 to 1, that means that if the head-stock gearing were eliminated, and the lead-screw instead had twice the number of threads per inch as it has, with equal gears the spindle would still revolve the same as before for each inch of travel along the piece to be threaded. In other words, the gearing in the head-stock may be *disregarded, if the number of threads of the lead-screw is multiplied by the ratio of this gearing.* Suppose, for instance, that in a lathe the lead-screw has eight threads per inch, that the lathe is geared in the head-stock with a ratio of 2 to 1, and that 20 threads are to be cut. Then

$$\frac{2\times 8}{20}=\frac{16}{20}=\frac{16\times 4}{20\times 4}=\frac{64}{80},$$

which two last values signify the number of teeth in the gears to use.

Sometimes the ratio of the gearing in the head-stock cannot be determined by counting the teeth in the gears because the gears are so placed that they cannot be plainly seen. In such a case, equal gears are placed on the lead-screw and the spindle stud, and a thread cut on a piece in the lathe. The number of threads per inch of this piece should be used for the numerator in our calculation instead of the actual number of threads of the lead-screw. The ratio of the gearing in the head-stock is equal to the ratio between the number of threads cut on the piece in the lathe and the actual number of threads per inch of the lead screw.

Compound Gearing.

The cases with only two gears in a train referred to are termed simple gearing. Sometimes it is not possible to obtain the correct ratio excepting by introducing two more gears in the train, which is termed compound gearing. This class of gearing is shown in Fig. 2. The rules for figuring compound gearing are exactly the same as for simple gearing excepting that we must divide both our numerator and denominator into two factors, each two of which are multiplied with the same number in order to obtain the change gears.

Suppose a lathe has a lead-screw with six threads per inch, that the number of the teeth in the gears available are 30, 35, 40 and so forth, increasing by 5 up to 100. Assume that it is desired to cut 24 threads per inch. We have then,

$$\frac{6}{24}=\text{ratio},$$

By dividing up the numerator and denominator in factors, and multiplying *each pair of factors by the same number*, we find the gears:

$$\frac{6}{24}=\frac{2\times 3}{4\times 6}=\frac{(2\times 20)\times(3\times 10)}{(4\times 20)\times(6\times 10)}=\frac{40\times 30}{80\times 60}$$

The last four numbers indicate the gears which should be used. The upper two, 40 and 30, are driving gears, the lower two, with 80 and 60 teeth, are driven gears. Driving gears are, of course, the gear *D*, Fig. 2, on the spindle stud, and the gear *P* on the intermediate stud *K*, meshing with the lead-screw gear. Driven gears are the lead-screw gear, *E*, and the gear *N* on the intermediate stud meshing with the spindle stud gear. It makes no difference which of the driving gears is placed on the spindle stud, or which of the driven is placed on the lead-screw.

Suppose, for a final example that we wish to cut $1\frac{3}{4}$ threads per inch on a lathe with a lead-screw having six threads per inch, and that the gears run from 24 and up to 100 teeth, increasing by 4. Proceeding as before, we have

$$\frac{6}{1\frac{3}{4}}=\frac{2\times 3}{1\times 1\frac{3}{4}}=\frac{(2\times 36)\times(3\times 16)}{(1\times 36)\times(1\frac{3}{4}\times 16)}=\frac{72\times 48}{36\times 28}.$$

This is the case directly illustrated in Fig. 2. The gear with 72 teeth is placed on the spindle stud *J*, the one with 48 on the intermediate stud *K*, meshing with the lead-screw gear. These two gears (72- and 48-teeth) are the *driving* gears. The gears with 36 and 28 teeth are placed on the lead-screw, and on the intermediate stud as shown, and are the *driven* gears.

* * *

Interesting experiments on the shrinkage of wood due to the loss of moisture have recently been completed by the Forest Service at its timber testing station at Yale University. These experiments show that green wood does not shrink at all in drying until the amount of moisture in it has been reduced to about one-third of the dry weight of the wood. From this point on to the absolutely dry condition, the shrinkage in the area of cross-section of the wood is directly proportional to the amount of moisture removed. The shrinkage of wood in a direction parallel to the grain is very small; so small in comparison with the shrinkage at right angles to the grain, that in computing the total shrinkage in volume, the longitudinal shrinkage may be neglected entirely. The volumetric shrinkage varies with different woods, being about 26 per cent of the dry volume for the species of eucalyptus known as blue gum, and only about 7 per cent for red cedar. For hickory, the shrinkage is about 20 per cent of the dry volume, and for long leaf pine about 15 per cent. In the usual air-dry condition, from 12 to 15 per cent of moisture still remains in the wood, so that the shrinkage from the green condition to the air-dry condition is only a trifle over half of that from the green to the absolutely dry state.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

CHANDLER CLUTCH-DRIVEN PLANER.

The Chandler Planer Co. of Ayer, Mass., has developed a clutch-driven planer of remarkable interest. It is shown in the accompanying half-tone. As may be seen, the driving mechanism, which is the principal feature of the improvement, has been applied to a planer of the frog and switch type, a machine which is subjected to about the hardest service that is ever imposed on a planer, thus giving a first-rate opportunity to try out the value of the new mechanism.

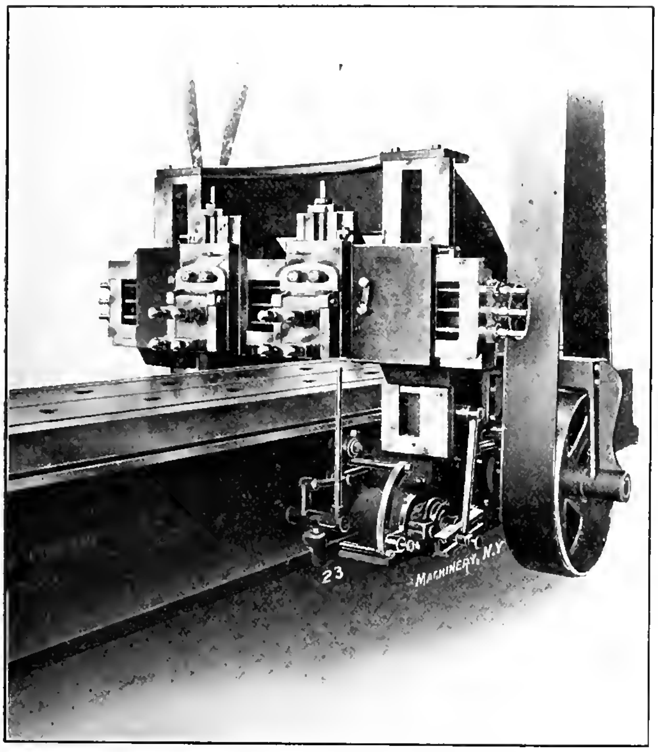


Fig. 1. The Chandler Clutch-driven Planer.

The problem of driving a planer becomes serious as the size of the machine and the severity of the duty is increased. Wide belts are required to transmit the tremendous power required for taking heavy chips at the high speeds possible with modern steels, and for reversing the table and work at these high speeds. The width of the belt can be reduced to some extent by increasing its velocity, but the fast running of the driving pulleys thus made necessary tends to defeat the object for which it was used, by increasing the momentum of the rotating parts and making the reversal much more difficult than it was before. This matter is very serious, since it has been found that the greater part of the power required for reversal (which is the greater part of the power required for driving the machine) is expended in overcoming the inertia of the rotating pulleys and gears.

There being a limit, then, to the speed at which belts can be run, and the increased power necessitating the widening of the belts, the problem of shifting them from the tight to the loose pulley and *vice versa* becomes exceedingly serious in heavy service. To obviate this difficulty, the use of clutches has been proposed for reversing in the place of shifting belts. Two forms of these clutches have been used more or less successfully—the electromagnetic and the pneumatically operated. The first has been found in practice to offer difficulties in the way of giving sufficient holding power, getting rid of residual magnetism and avoiding wear on contact faces. The pneumatic clutch has been tried on a considerably larger scale, and has been considerably used. Among its disadvantages is the fact that it requires an air-compressing plant—something which every shop does not possess, and which may have to be put in separately as an adjunct to the machine. Furthermore, it is not positive and invariable in its action, but may be changed, adjusted and regulated to suit the whim of the operator who, very likely, is better acquainted with the operation of the planer than with that of compressed-air machinery. Finally it acts with a given force which may or may not be enough to transmit the power desired. If not, the machine has to be stopped and the mechanism adjusted, this being necessary occasionally as the parts wear and conditions of lubrication, humidity of the atmosphere, etc., change.

In the machine under consideration, the clutch is operated mechanically. The problem to be solved is that of making a clutch and operating mechanism which will be strong enough to drive the heaviest cut the tools used will stand, and reverse the heaviest work at the highest speed the planer will ever be called on to work at—this to be done without shock, and without wear of the contact areas due to slipping. Of course there must be some slip to stop the planer table gently, and start it back on its return trip without violent shock. The problem is to allow just enough slip to effect this without giving so much that the contact surfaces rub on each other for a considerable period of time, thus wearing each other away.

The mechanism used in this machine effects all this in a remarkably ingenious fashion. The amount which the contact surfaces slip on each other before gripping is regulated by the design, and this amount is maintained under all conditions of lubrication and atmospheric moisture. Furthermore, it is as impossible for the clutch to slip as it is for a positive clutch. Something would have to break first. The way in which this is done may be briefly described by saying that the planer dogs do not directly operate the main clutches which connect the machine with the forward or reverse driving pulleys. The shifting of the reversing mechanism first throws a supplementary clutch into action with the driving shaft. The difference in motion between this supplementary clutch and the main driving clutch, by means of suitable mechanism, operates to engage the latter by power until the two parts are moving together. If slip occurs at any time, the

Fig. 2. An Example of Chips taken on the Clutch-driven Planer—Full Size.

slipping only serves to tighten the connection the firmer. In reversing, the throwing of the secondary clutch operates first to release the main clutch previously in operation, and then to engage the other one.

The writer witnessed a test of the frog and switch planer to which this mechanism has been applied. It was interesting to a high degree and at times really exciting. The test was intended to show that the planer had been developed to a point where it exceeded the capabilities of the steels with which it was used. In other words, in any work which it may be desired to perform on the planer, the cutting speed, and the depth and width of the cut will be limited by the tool, rather than by the machine. In demonstration of this, tools of high-speed steel of approved form and temper and unusual size were repeatedly tested to destruction. One way of doing this was by placing a 40-point carbon steel forged slab on the planer bed, and taking a series of wide and deep chips from it, one after the other, stopping each chip a little before the conclusion of the previous one. After five or six of these cuts had been made, the tool was again started in and the planer table allowed to continue its full stroke. The tool, thus catching up with one stopping point after another, took a gradually heavier and heavier chip until it finally had more than it could bear and broke short off at the shank. One of those broken measured 2½ x 3 inches at the broken section.

The chips thus produced, of which we show samples in Fig. 2, were interesting not only on account of their unusual size, but as well in showing the way in which chips are produced. This was fully explained in Mr. Taylor's paper "On the Art of Cutting Metals," the action being illustrated in Figs. 1, 2 and 3 in the February, 1907, issue of MACHINERY. As there explained, the chip is separated from the main body of the metal by alternate compressing and shearing, the different shearing planes separating the chip into sections more or less completely, depending on the heaviness of the cut taken. These separate sections are plainly shown. In many cases during the test the cuts were so heavy that these sections separated entirely, there being no continuous chip, but instead, a series of chunks of metal which flew in a stream from the tool, striking against a nearby pile of castings with a rattle like the discharge of a rapid-fire gun. The operation, in fact, seemed distinctly dangerous, and suggested the use of an armor-plate shield for the man operating the machine. Of course, these are extreme conditions, and were only undertaken to show the utmost capabilities of the machine.

During the tests the cutting speed of the table was 20 feet per minute, with a return of 4 to 1. The double cutting belt is 10 inches wide and runs at a speed of 1,860 feet per minute. The reversing belt is 5 inches wide, running at 3,900 feet per minute. The planer removed the side of the head up to the web on a pair of extra hard 70-pound relay switch points, cutting back 9 feet, in less than six minutes. At the same cutting speed it removed a chip ¾ inch deep and ¾ inch feed in a 40-point carbon steel forging. In doing this work, the tool required about 6 to 7 horse-power on the stroke and about 20 horse-power for reversing.

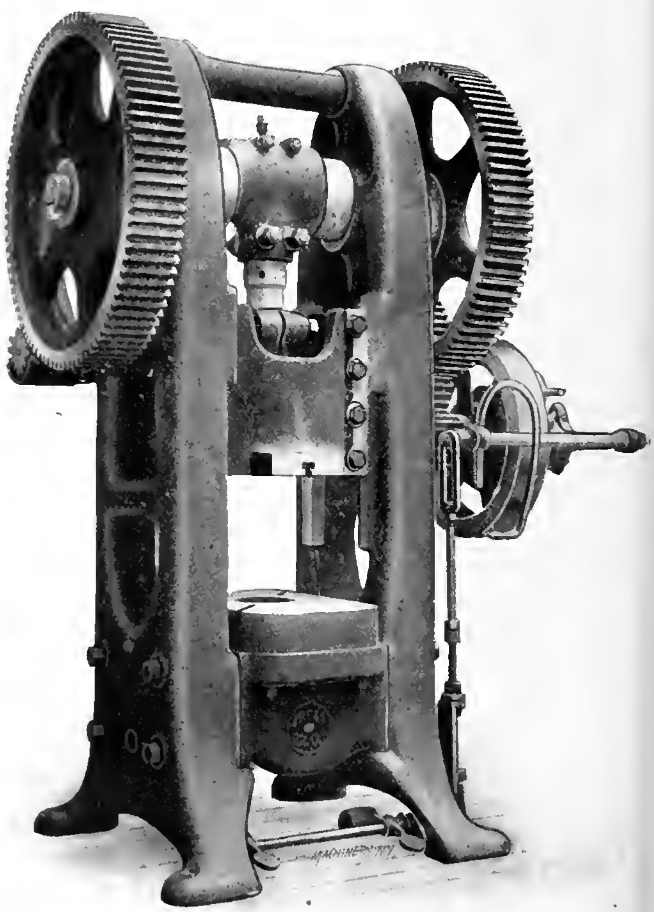
This planer has been in operation now for about three months, and has so far shown no tendency toward deterioration in the wearing parts of the clutch, which is of the multiple disk type. The disks which form its bearing surfaces are of cast iron permanently submerged in a bath of oil. After running for this length of time, the disks have been disassembled and examined, and the cast iron bearing surfaces have been found to be glazed, showing practically no signs of wear. This is, of course, the best condition for wearing in the case of cast iron surfaces in contact. It is stated that when the clutch has been disassembled while still tightly engaged under service conditions, and with the oil drained from the clutch, a layer of oil has been found between each of the separate disks, tending to show that they do not actually come in contact at all, there always being a film of lubricant between them.

The inventor of this machine is Mr. D. L. Chandler, superintendent of the firm and inventor of the three-belt planer as regularly built by this firm, and described in the July, 1904, and December, 1907, issues of MACHINERY.

FERRACUTE SINGLE-CRANK PRESS.

The accompanying illustration shows a massive single-crank press just built by the Ferracute Machine Co., of Bridgeton, N. J. In common with other machines of this kind, the press has a long stroke which adapts it for drawing cold from heavy sheet steel, deep drawn seamless shells, automobile hubs, cups for ball-bearings, and similar work. It can be built with shorter stroke for heavy blanking, trimming, shearing and embossing. A somewhat larger press of this series recently built by the Ferracute Machine Co. for the United States government is being used in the manufacture of cartridge shells for cannon.

The castings which compose the frame of this machine are exceedingly heavy, with neatly rounded corners which add considerably to the appearance of the press. Other striking features are the heavily trussed bed and the wide-faced twin gears on each side of the press. These gears are cut from the solid. Having two gears on the crank-shaft instead of one, tends to relieve the torsional stress of the shaft and affords an even pressure, besides dividing the load between



A Single-crank Press built by Ferracute Machine Co.

them. The back-shaft, with its two pinions which engage the large gears, is a single steel forging, made strong enough to obviate any torsional effect.

The main shaft is forged from high carbon steel. The clutch and fly-wheel are mounted on a stud which is rigidly attached to the frame, thereby preventing the disturbance of alignment which is apt to occur when such supports are detached and bolted to the floor. The press is equipped with a "multi-disk" friction clutch of a new and effective design. It is of the automatic stop type, but can be quickly adjusted for stopping the ram by hand at any point of its descent or ascent; or, if desired, it can be set for continuous running. Positive knockouts are provided when desired, the press being designed so they can be readily attached.

The distance between columns is 28 inches. The stroke is 3 inches, but can be made, if ordered, of any length up to 17 inches. The height from the bed to the ram when raised is 19½ inches, the adjustment of the ram being 6 inches. The fly-wheel is 35 inches in diameter with a 6-inch face;

and weighs 750 pounds. The press occupies a floor space of 8 feet 7 inches from right to left and 5 feet 5 inches front to back, and is 10 feet 7 inches high. It weighs 25,000 pounds, and exerts a pressure of 200 tons.

"LEKTRO" PORTABLE UNIVERSAL GRINDER.

This little portable tool is designed to perform, in combination with standard machine tools, all the functions of the various kinds of grinding machines in common use. It may be used on the lathe, milling machine or planer, for cylindrical, internal and surface grinding, and for sharpening of

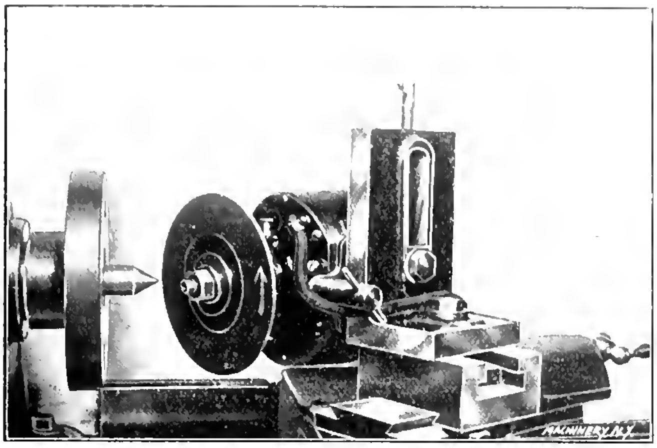


Fig. 1. The "Lektro" Portable Grinder truing up a Lathe Center.

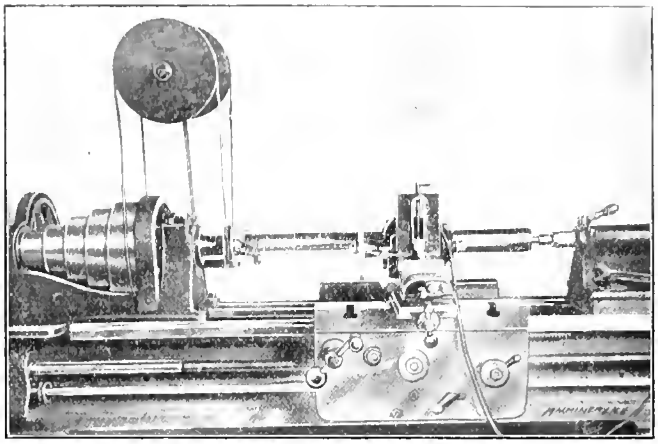


Fig. 2. Cylindrical Grinding in the Lathe.

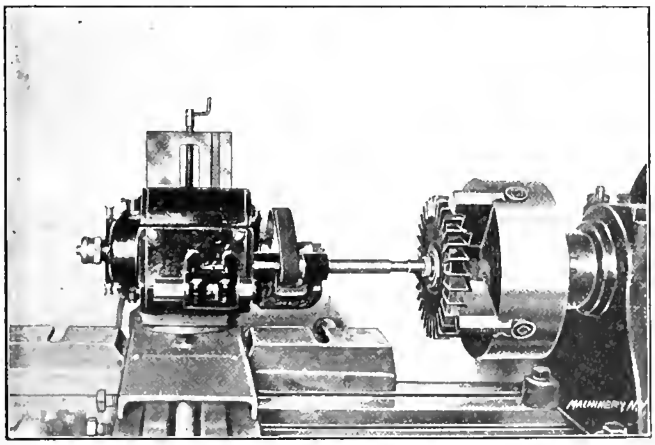


Fig. 3. Internal Grinding Attachment. The Spindle runs 14,000 R. P. M.

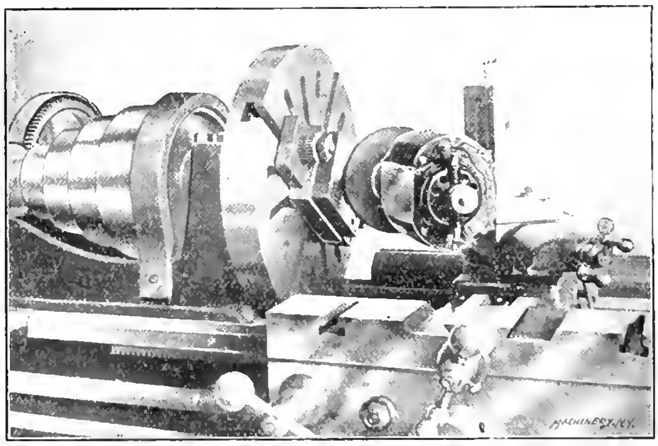


Fig. 4. Grinding a Blanking Die on the Face-plate.

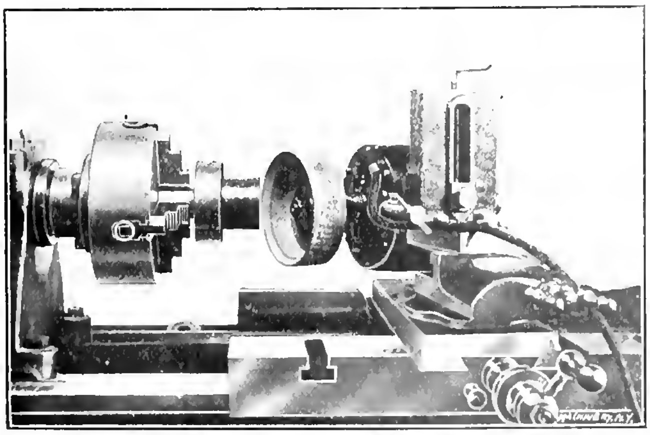


Fig. 5. Grinding a Punch with a Cup Wheel to give Shear.

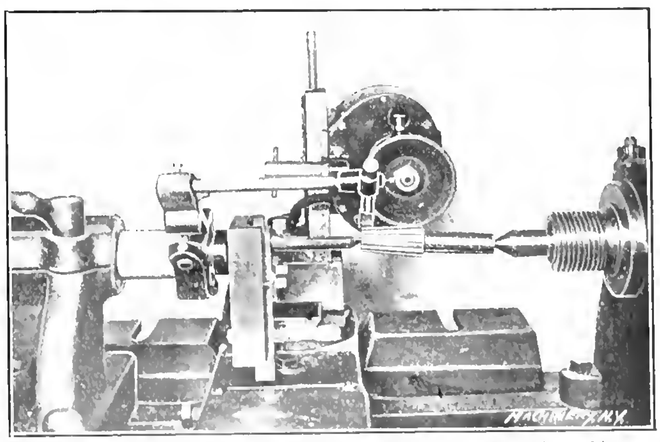


Fig. 6. Sharpening a Taper Reamer in the Lathe using Adjustable Tail Center

all sorts of tools, such as milling cutters, reamers, counterbores, circular forming tools, etc. Cutters may be ground while in place on the milling machine when so desired.

This attachment consists primarily, as may be seen in Fig. 1, of an electric motor mounted on an angle plate or knee, on which it may be raised or lowered by means of the elevating screw shown. The motor is especially designed for this work, the end motion of the spindle being prevented by an accurately made thrust bearing. The motor shaft is of tool steel, hardened, ground and lapped to size. The armature disks are ground on separate arbors before being assembled on the finished armature shaft, and are balanced after winding to insure smooth running. The commutator is balanced separately, and the whole armature tested for balance when assembled. The bearings are in phosphor bronze bushings, tapered and split, and adjusted by threaded collars. Oil cups are provided on both sides of this bearing, so as to allow the motor to run in an inverted position. The field magnet of the motor is so compactly arranged as to allow work to be brought within 1 9/16 inch of the axis of the shaft on the front or working side of the tool. The whole motor can be swung on the knee which carries it to any desired angle, and can be completely turned around in the opposite direction if desired.

The half-tone engravings shown herewith are nearly self-explanatory, and serve to illustrate a few of the varied uses to which the tool can be adapted. In Fig. 1 the live center of a lathe is being trued up, the compound rest being set at the proper angle for that purpose. In Fig. 2 is shown an example of cylindrical grinding on the lathe, this being done on dead centers, a special drive being arranged for the purpose. The spindle cone is disconnected from the spindle, and a bushing is clamped to the live center, carrying a pulley

loosely revolving on it. This is belted over the quarter turn counter-shaft shown, to the large step of the spindle cone. A spring-supported dead center is provided similar to that used in grinding machine practice.

In Fig. 3 the tool is being used with an internal attachment which is supplied with it. This attachment consists of a bracket fastened to the front face of the motor, and carrying a holder having bearings for the small internal spindle, which is driven by a short belt from a pulley mounted on the motor shaft in place of the usual emery wheel. In this operation, the hole in a hardened cutter is being ground to size.

Figs. 4 and 5 show examples of the grinding of press tools. Fig. 4 is practically a surface grinding operation. The die which is being sharpened is clamped to the face-plate, and a facing cut taken over it by the grinding wheel. Fig. 5 shows a cup wheel being used for grinding a round punch. The angle at which it is set makes it possible to grind the cutting edge with any desired amount of shear.

clearance desired for the cutting edge of the face. The cut is taken by working the longitudinal feed of the slide. A hook stop is used, and the belt is preferably run off from the cone pulley, which is operated by hand to index the work against the stop. In Fig. 9 the outside cutting edges are being sharpened. In this case the stop is mounted on the table, and the cross-feed of the saddle is used for the grinding operation. Fig. 10 is unusually interesting in showing the ability of the device to perform grinding operations of a delicate character. Here we have an end mill of very small diameter, having the teeth on its end sharpened. The operation is essentially the same as that of Fig. 8, the added difficulties being due to the small size of the work.

Of course these ten figures merely give an idea of a few of the operations for which the device may be used. Its use as a surface grinder in connection with the planer will be readily suggested, while its application to internal and external grinding of all kinds, and the sharpening of cutters, reamers, taps, mills, etc., is well nigh universal. This machine is manufactured by the "Lektro" Mfg. Co., 44 Walnut St., Cincinnati, O.

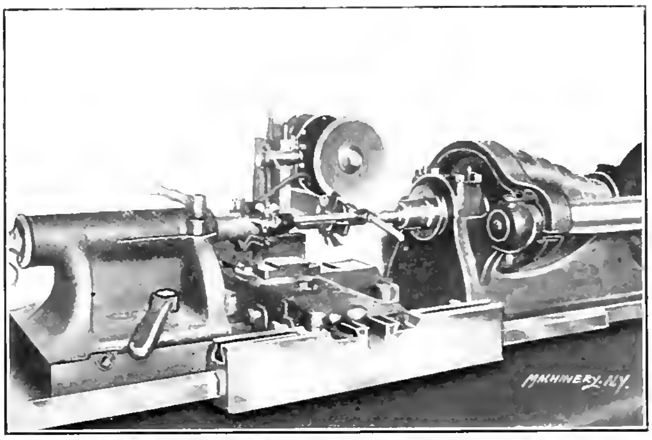


Fig. 7. Sharpening a Gear Cutter in the Lathe with Tooth Rest clamped to the Tail-stock Spindle.

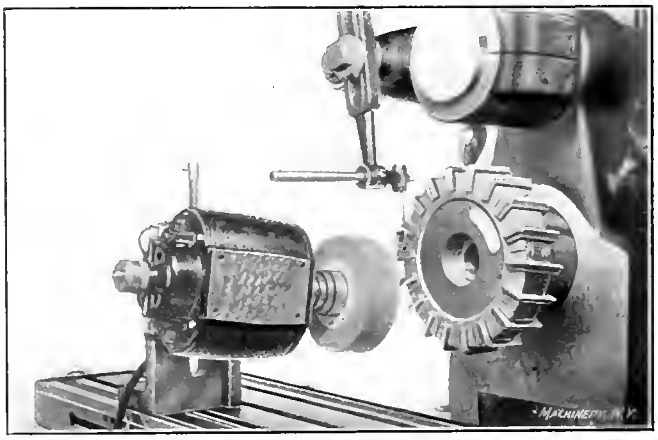


Fig. 8. Sharpening the Face of a Heavy Face Mill in place on the Milling Machine.

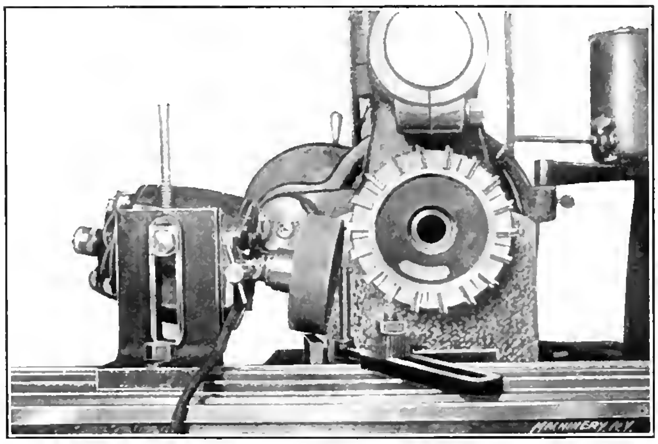


Fig. 9. Sharpening the Periphery of a Face Mill, the Blades of which are set at a Slight Angle.

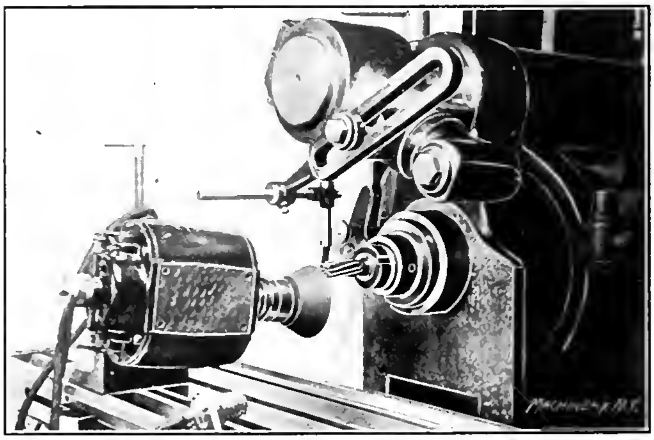


Fig. 10. Sharpening the End Teeth of a Small End Mill in place in the Milling Machine Spindle.

The next two figures show the machine used for sharpening small tools in the lathe in combination with attachments provided for the purpose. In Fig. 6 an adjustable center is used in place of the regular solid center. It may be raised or lowered to suit the taper it is desired to grind. A taper reamer is shown in place between the centers. A tooth-rest or stop is provided, held by clamping straps to the tail-stock spindle. This may be adjusted in various ways to suit different kinds of cutter and reamer work. In Fig. 7 a formed gear cutter is being ground, in this case on an arbor between the regular centers. The tooth-rest is again shown in operation. These cuts are, of course, taken by actuating the carriage by the usual hand-wheel.

Figs. 8, 9 and 10 show another class of cutter grinding for which this tool is particularly adapted—namely, the sharpening of cutters in place on the milling machine, under such circumstances as to insure their running true, with every tooth doing its duty. In this case the tooth-rest is supported in any convenient way to suit the case in question. In Fig. 8 it is supported from the overhanging arm. The large face mill is being sharpened in this case. A cup wheel is used on the grinder, which is set at the proper angle to give the

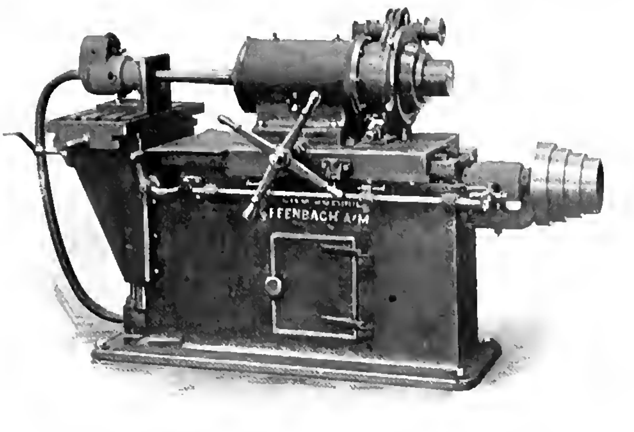
AUTOMATIC CYLINDER GRINDER.

The illustration shows an automatic cylinder grinding machine, manufactured by Mayer & Schmidt, Offenbach-on-Main, Germany, which was exhibited at the Olympia Exposition, London. The photograph was received too late to permit it to be included in Mr. James Vose's notes on the exposition, published last month.

This machine is designed to work completely automatically in all its movements, and an attainable accuracy within 0.00025 inch is claimed. The grinding head, which, judging from the cut is unusually rigid, is mounted on a carriage which moves back and forth during the grinding operation. The cylinder to be ground is mounted on a table which has adjustment both sideways and in a vertical direction, which provision makes it easy to get the axis of the cylinder in line with the axis of the grinding head. During the grinding operation, however, the cylinder is stationary.

The wheel-carrying arbor or spindle of the grinding head

has, besides its rotary motion, also a motion around the axis of the grinding head, the grinding spindle being eccentric in relation to this. The amount of this eccentricity is easily adjustable. The machine is also provided with a scale by means of which an automatic stop can be engaged when the desired diameter in the cylinder has been reached, at which time a bell rings, and the grinding spindle recedes automatically from the work. All feeds are automatic, and a cone feed pulley is provided so that a great variation of the forward and



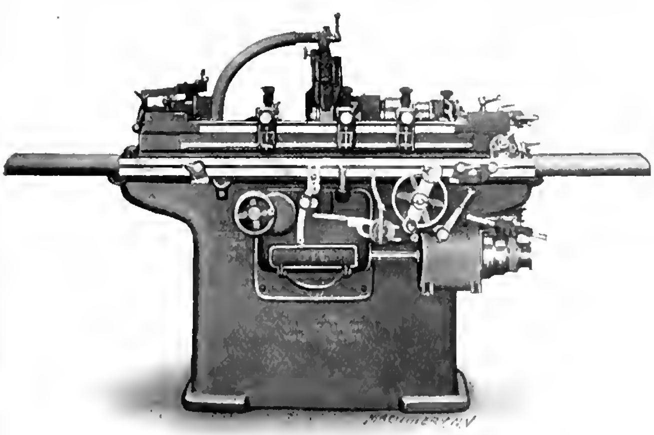
Automatic Cylinder Grinder.

reverse carriage feeds is obtainable. The grinding spindle is driven through a movable counter-shaft which follows the eccentric motion of the spindle. With the exception of the grinding spindle itself, which, of course, must be long enough to reach through the work, over-hanging parts have been avoided so far as possible, and this, together with the perfect rest during the operation of the cylinder which is to be ground, makes a high degree of accuracy possible. These machines are built in sizes to grind from 4 inches to 12 inches inside diameter, by 8 inches up to 44 inches in length.

SMALL NORTON GRINDING MACHINE.

We show herewith a new size of the well-known line of grinding machines made by the Norton Grinding Co. of Worcester, Mass. This machine is the smallest of the line, as built at the present time. It is made to swing the work up to 6 inches in diameter and 32 inches long, though its ordinary working range is for work from ½ to 2½ inches in diameter, the steady-rests being of suitable design for shafts of this character.

The well-known Norton system of universal steady-rests is used. Three of these appliances are furnished with the



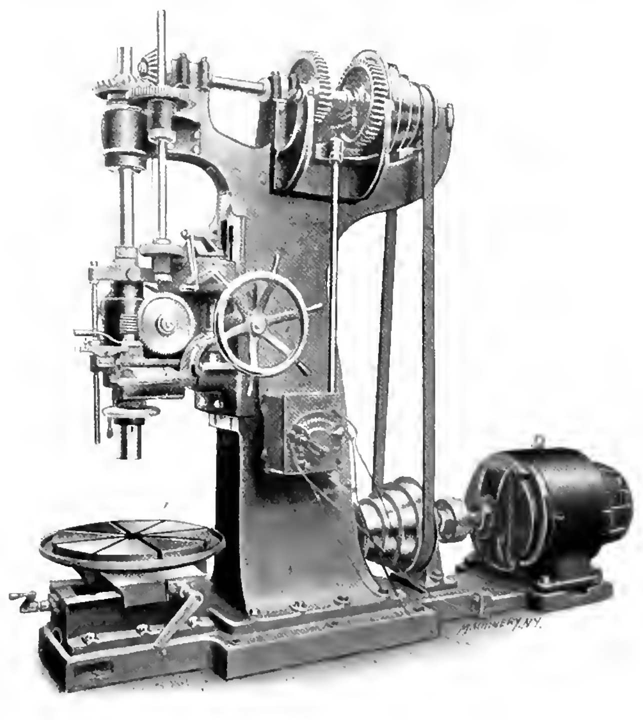
A New Addition to the Line of Norton Grinders.

machine, supplied with a set of work shoes for one diameter of work. Other sizes can be made from blue-prints furnished with the machine. These shoes are designed with a view to quick change from one size work to another. They all furnish a good rigid support for long work, within the range of sizes given. Provision is made for grinding tapers up to 2 inches per foot. A center grinding attachment is furnished with this machine, arranged to grind center points round, true, and to an accurate 60-degree angle. If a different angle is required, a special attachment can be made.

The over-head works furnished with the machine is of improved design, with shafts made of the best material, ground on centers. The hangers have large, self-oiling bearings. The weight of the machine with the over-head works, is about 3,600 pounds. The tool is arranged for belt drive only.

AN ENGLISH HIGH-SPEED DRILL PRESS.

The half-tone illustrates a drilling and boring machine built by J. Butler & Co., Halifax, England. This style of machine is built in two sizes, taking 30 inches and 36 inches diameter, respectively. Among the points included in the construction may be mentioned a fixed and rigid work table with adjustments in each direction by quick pitch screws, and through which the weight is taken solidly on the base plate; a strong drill head-stock fitted to the vertical column and balanced for quick and easy adjustment to the height of the work; and a very substantial spindle, which is supported in a steel sleeve with gun metal lining and ball thrust bearings at top and bottom. The sleeve has a slow hand traverse and a quick hand adjustment, each instantly disengaged or engaged, and governed by an automatic trip motion. The positive feed is



An English High-speed Drill Press.

driven by spur gears from the spindle, and is variable either by a three-speed feed box, or quadrant plate with change gears as desired. Further points are the powerful drive by a pair of steel bevel gears—the one on the spindle having a long sleeve in the upper bearing, and driving by two long keys. The driving shaft has capped bearings with gun metal bushings, and is driven by the speed cones directly, or through the double gear. As will be seen, the machine is self-contained, the counter-shaft being fixed on the base of the machine with starting lever close at hand, the illustration showing the machine driven by electric motor, direct. In the case of belt driving from the main shaft, the motor is replaced by fast and loose pulleys with belt shifting device. The machines may be made to drive by speed cones only, or with the double gear arrangement, enabling heavy boring to be done. In this case the speeds are arranged to give as gradual a progression as possible. Some details of the machines are appended.

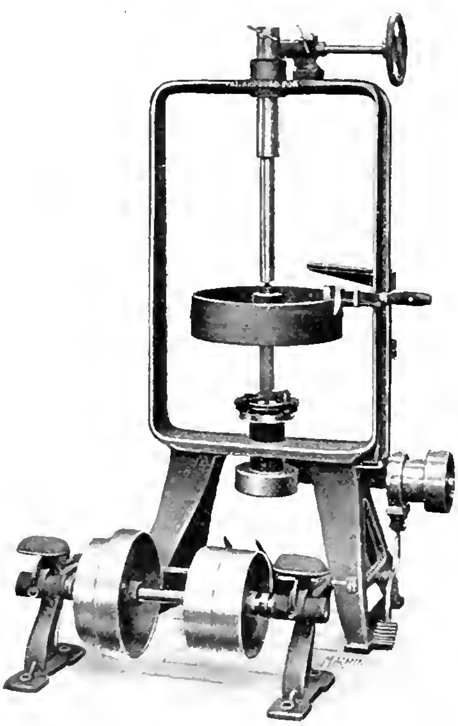
The 30-inch machine admits from spindle end to top of table 24 inches, and to base plate 42 inches. The 36-inch machine admits 28 inches and 46 inches. The diameters of the spindles at the driving end are 2 and 2¾ inches respectively; the diameters in the sleeves 2¼ and 3 inches, and the diameters of the sleeves 4½ and 6 inches, the bores of the

spindles being Nos. 4 and 5 Morse taper. The travels of the spindles are 12 and 16 inches, and the vertical range of the drill head on face of uprights 12 inches. The table diameters are 24 and 30 inches. In the 30-inch machine, the number of speeds on the cone is three, and in the 36-inch machine, four, the widths being 3 and 3½ inches, and the largest diameters 18 and 20 inches. The ungeared 30-inch machine will drill from ½ to 1½ inch holes at 600 to 270 revolutions per minute, and the 36-inch size will drill from ¾ to 3 inch holes at 600 to 183 revolutions per minute. When geared, 3 and 6 inch holes represent the duty recommended, the speeds varying from 600 to 83 revolutions in one machine, and from 600 to 39 in the other. The machines weigh 7,280 and 9,850 pounds respectively. Though the duty given is that which high-class high-speed drills will perform, the machines themselves are powerful and speedy enough to ruin any twist drill within their capacity. One of the machines was used for demonstrating the capacity of high-speed drills at the Olympia Exhibition, and in one test a ¾-inch drill was fed at the rate of 25 inches per minute, and a 2½-inch drill at 2½ inches per minute. J. V.

CURRIER REAMING MACHINE.

The machine illustrated in the accompanying half-tone is of an entirely new design, and is intended for performing reaming operations by mechanical means, at a great saving of time and with greater accuracy than is possible to be had when reaming by hand. The obstacles to be overcome in a reaming machine are mainly the difficulty of starting the reamer in the hole without roughing the end of the hole, which also includes the difficulty of starting the reamer straight, and the troubles met with from the digging in of the teeth of the reamer, which cannot as easily be provided for in a reaming machine as in hand reaming. Both of these difficulties have, however, been taken care of in the present machine, the work being guided until the reamer has fully entered the hole, and an equalizing drive, referred to later, provided to insure uniformity and ease of cutting action.

In the upper and lower ends of the frame 2½-inch holes are bored in perfect alignment. The lower end is fitted with a spindle, which is driven by a worm-gear drive. This spindle



A Machine for Reaming by Power.

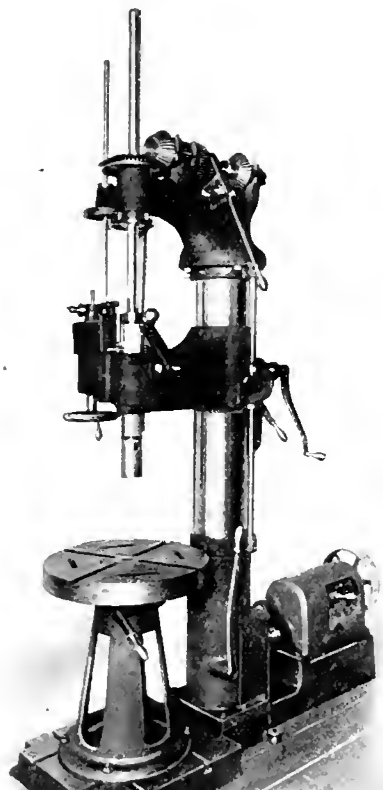
is in turn fitted with a center and an equalizing carrier for driving the reamer. At the upper end of the frame a sleeve is fitted, which is operated vertically by a rack and pinion. In this sleeve a bar is held, upon which the work to be reamed is placed until the reamer is put on the centers, one end of this bar containing what we might call the tail center. A brake attached to the lower side of the right-hand leg makes it possible to stop the machine instantly by foot power.

The work to be reamed is first chucked in the usual manner and reamed, leaving from 0.004 to 0.005 inch. The work is then placed on the guide bar, and a swinging arm, shown on the right-hand upright, brought forward to prevent the work from dropping while the reamer is placed on the centers. When the reamer is in place, the machine is started, the swinging arm is thrown to one side, and the gravity of the work feeds it slowly down over the reamer. To prevent the work from turning, it may be held by a wrench, as shown in the cut, or by any similar suitable device. It will be noticed also that the reamer is fluted through the shank; this provision is made in order to permit the chips to fall through easily. The simplicity of the machine permits it to be run by a great deal cheaper help than could be employed for hand reaming.

The machine will take in work up to 24 inches diameter. It is built by J. E. Snyder & Son, Worcester, Mass., and is furnished with counter-shaft, six carrier wrenches, and one guide bar of any size from 1 inch to 2½ inches. The speed of the counter-shaft is 400 R. P. M., and the weight of the machine is 430 pounds.

DRILL PRESS OF NOVEL DESIGN.

The cut herewith shows a 24-inch upright drill press, built by the National Machine Tool Co., Cincinnati, Ohio, termed by the makers their 1907 design. As will be noticed, it is



The National Machine Tool Co.'s 24-inch Drill Press.

designed differently from the ordinary type of upright drills, being without back support or top braces. But none the less, for a machine of its size, this drill is particularly rigid.

The head of the drill rotates with the sleeve about the column, an arrangement which will be found advantageous for heavy work. The vertical adjustment for the head is by means of a crank, bevel gearing and screw, as plainly shown in the cut. Twelve changes of speed, arranged for drills from ½ inch to 2½ inches, are provided for. One-half of these speeds are obtainable by the speed box, which provides for six changes of speed, it being possible to make changes while the machine is running. This number of speeds is multi-

plied by two through the back gears. The latter are also designed to be thrown in while the machine is running.

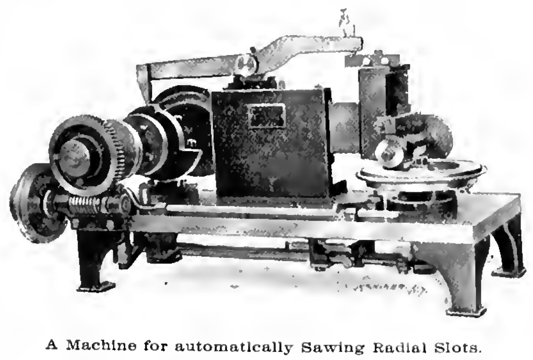
There are four feed changes, the feed change mechanism being located directly on the front of the head. The quick return and approach lever also engages and disengages the feed, so that but one hand needs to be used for these operations. The tapping attachment is placed in the base of the column, behind the back gears, which insures greater power. The starting, stopping, and reversing lever is right under the hand of the operator, as shown in front of the column in the cut. The style of table used insures alignment at all times. It is rigid and stiff, and has a revolving top. The table, as is seen from the cut, is easily removable, and drilling on the base can be performed without much trouble experienced in first removing the table.

The general dimensions of the machine are as follows: Total height of drill, 7 feet 5 inches; diameter of column, 8 inches; Morse taper in spindle, No. 4; maximum distance between the spindle and base, 48 inches; between spindle and table, 23 inches; diameter of table, 22 inches; working surface on base, 22 x 22½ inches; spindle speeds, from 36 to 267 R. P. M.; feeds per revolution of spindle, 0.008, 0.012, 0.016 and 0.020 inch; speed of driving pulley, 360 R. P. M. The floor space required is 22½ x 55 inches, and the total weight of the drill is 2,100 pounds.

AUTOMATIC SLOTTING MACHINE.

The machine shown in the accompanying engraving is a modification of the automatic pinion cutter built by the Standard Manufacturing Co. of Bridgeport, Conn. It is shown engaged in the operation of sawing slots in the base and edge of a ring, which is part of a knitting machine. The mechanism is cam-operated throughout.

In this particular case, the cut taken is a peculiar one. In the figure, the cutter is set in a position to start a cut. It travels toward the outer edge of the ring, then travels down past the edge of the saw, making a perfect right-angle cut in the work. The slide carrying the cutter is forced down by a mechanism which, in the standard pinion cutting machine, is used for withdrawing the cutter on the return stroke during the indexing, and bringing it down again to cutting depth.



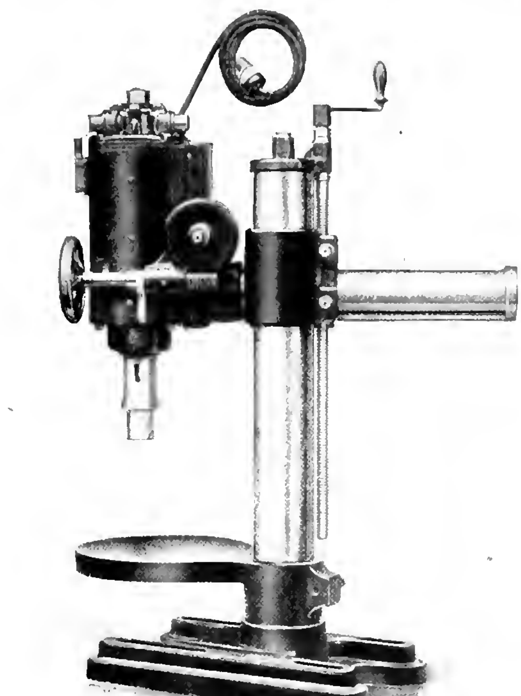
A Machine for automatically Sawing Radial Slots.

The index mechanism is so arranged as to be adjustable to the desired number of cuts, by altering the number of teeth that the ratchet will take. A positive lock is provided, which holds the index disk firmly while the saw is doing its work. Provision is also made for holding this disk while the work is being removed from the table or tightened down upon it. This is done in such a way that no strain is thrown on the indexing mechanism, so that all possibility of throwing the machine out of alignment is avoided. This machine is also sold arranged for slotting screw heads of all sizes and styles, a hopper feed being used in conjunction with it.

PORTABLE ELECTRIC RADIAL DRILL.

In the accompanying cut a new portable tool made by the Hisey-Wolf Machine Co., Cincinnati, O., is illustrated. This tool is termed by its makers the Hisey portable electric Scotch radial drill, of 2-inch capacity. These drills are also made in two smaller sizes of ⅞-inch and 1¼-inch capacity, respectively. These drills are self-contained, and are portable in the full sense of the word, being of a comparatively small size. The range of work that can be done on these machines is, within their capacity, as complete as that of the large size types of stationary radial drills, but on account of their small weight, the machines can be taken to any part of the shop, or outside of the works, without trouble, one man being able to easily handle a machine of this size. These drills are electrically driven, and are made for either direct or alternating current. The motor has two speeds, controlled by a thumb lever at the lower end. The driving power is obtained from an ordinary lamp socket. This permits the drill to be used anywhere within the machine shop.

The 2-inch capacity drill, which is the one illustrated, has a 12-inch feed through the hand-wheel shown at the left, and



A Small Portable Drill of the Radial Type.

is arranged for quick return by hand. It can drill at a radius of 24 inches, at any place in the horizontal plane, and at any angle. The hand-wheel and the worm box are provided with a swivel adjustment so that the tool may be used in corners and where space is limited. The horizontal column, as well as the vertical arm, is made of hollow steel tubing, and the column is fitted with a screw to raise and lower the motor and drill head, as shown. The bracket on the horizontal column is also fitted with a pinion meshing with a rack on the vertical arm, which provides the radial adjustment. These attachments permit the operator to adjust the drill to his work very quickly. The table is adjustable and detachable. As may be judged from the illustration and description, the machine is thus provided with possibilities for quick adjustments in all respects, and will therefore, undoubtedly, be found a very useful tool wherever a small portable drill is required.

POWER HACK-SAW GIVING RELIEF ON THE RETURN STROKE.

The Racine Gas Engine Co. of Racine, Wis., is building a power hack-saw which has mechanism designed to raise the blade of the saw on the return stroke. This operates without interfering with the feeding mechanism. The builders state that it gives surprising results in the way of length of life of the blades, rapidity of cutting, and accuracy of the cut. Fig. 1 shows the general appearance of the machine; the line cut, Fig. 2, will serve to explain the action quite clearly.

A is the guide on which the saw frame travels, while *B* is a weight adjustable on the bar on which it is mounted for the degree of feed desired. The saw frame is reciprocated by a crank in the usual fashion. The crank is mounted directly on the driving pulley shaft, the pulley being large enough in diameter so that no gearing is required. Fastened to guide *A*,

which is pivoted around the driving shaft, is a sector *C*, curved to the arc of a circle with the same center as the guide, and having ratchet teeth on its concave surface. On the driving shaft is a cam *D*, half of the periphery of which has a somewhat greater diameter than the other half. This operates a roll on lever *E* in such a way that the latter is raised at the beginning of the return stroke and lowered at the beginning of the cutting stroke. The outer end of lever *E* carries a dog *F*, engaging the teeth in sector *C*. When this lever with the dog is raised as the cutting stroke is completed, the sector is raised with it, and the saw returns free

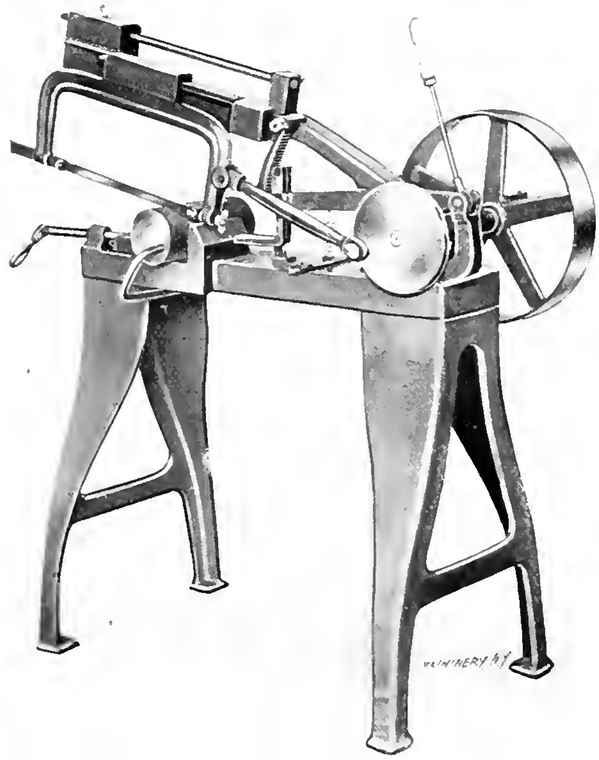


Fig. 1. Racine Automatic Relieving Power Hack-saw.

of the work, not dragging as is the usual case. At the end of the backward stroke, as the saw is about to return, cam *D* allows lever *E* to drop again, and the saw is again lowered in contact with the work. The long bent tail of the dog *F*, when it is lowered, rests on the head of screw *G*, and is by it thrown out of contact with sector *C*, leaving the saw thus entirely free to be acted on by the feeding weight *B*.

Lever *H*, operating a clutch, is connected with the slide in which screw *G* is held in such a way that the latter is

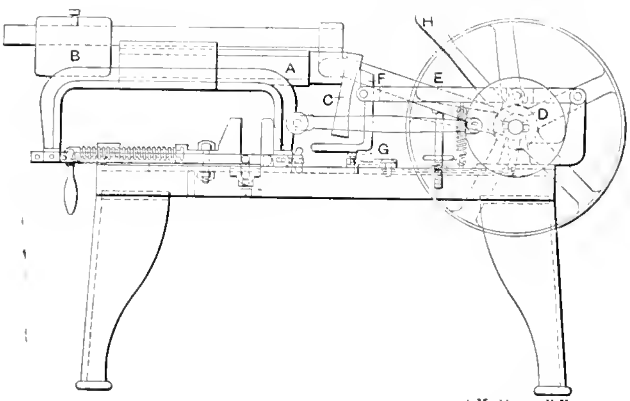


Fig. 2. The Mechanism of the Racine Power Hack-saw.

moved out of contact with the tail of the dog when the machine is stopped. This allows the saw to be raised and held in any position when it is not in operation, making it convenient for inserting work or taking measurements, etc. A stop is provided for depth of cut in cases where it is not desired to cut clear through the piece. The clutch is connected with an automatic stop arrangement which throws out the power connection when the work has been cut through. Provision is made for using either 10-inch or 14-inch blades, depending on the size of the work, thus allowing the full length of the blade to be used in any case.

This machine was the result of the necessities of its builders, who had large quantities of crucible machinery steel to saw. They experienced great difficulty in doing this, owing to the fact that the saw would become so dull before the cut was completed that it would run out of true from ¼ to ½ inch, and sometimes would not go clear through without breaking the blade, thus wasting time and material, besides the extra facing required in the lathe. After the lifting device

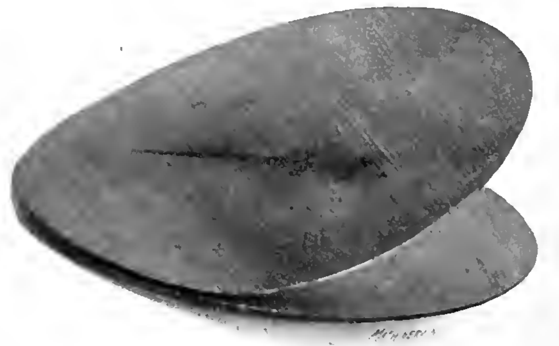


Fig. 3. A Sample of the Fine Work of which the Machine is Capable.

was applied, there was no trouble on the same work in taking six cuts with one blade, these being so nearly square that the stock was cut to within 1/16 inch of finished length. As an example of the excellent work of which the saw is capable, we show in Fig. 3 a reproduction of a photograph of a section of crucible steel in which a cut has been taken separating a piece of only about 0.040 inch thickness, there being a variation of less than 0.010 inch over the whole area of the cut.

SHEPARD ELECTRIC HOIST.

The electric hoist shown in two forms in the two accompanying half-tones has been designed after careful reference to operative requirements of such mechanisms, and it is believed by its builder (the General Pneumatic Tool Co., Montour Falls, N. Y.) to fill these requirements very nearly. Perhaps the appliance can best be described by taking up these requirements in turn, and explaining how the design, in each case, has been made to conform to them.

One of the features of this hoist, plainly in evidence in Fig. 1, is its compactness. This has not been considered as a primary virtue, and nothing in the way of accessibility and strength has been sacrificed to obtain it. It will be seen, however, that the mechanism has been enclosed in an unusually small casing or framework. The ruggedness of construction necessary for a machine to be used largely by unskilled workmen has been carefully looked out for, also, all its load sustaining parts being of unusual strength. With the simple design chosen, this has been found possible without exceeding the dimensions or weight of other hoists of equal rated capacity.

Interchangeability has been carefully provided for. Not only is the hoist built on a plan which makes it possible to replace repair parts without fitting, but parts made for these hoists will interchange with corresponding parts in traveling cranes built by the same makers as well. This plan results in greater economy of manufacture also, and makes it possible to furnish at current prices a much better hoist than would otherwise be possible. The hoists themselves may be considered as interchangeable parts to be applied indiscriminately as simple hoists, or as parts of electric cranes and other apparatus of a similar nature. As all these machines of the same capacity will interchange perfectly, very few spare parts will suffice for a large and varied equipment. This interchangeability extends to the pneumatic form of the hoist as well, which is identical with the electric form in many of the mechanical features of its design, and so may be interchanged with it in any given case.

Careful attention has been given to the matter of accessibility, no other feature of the design having been allowed to interfere with this prime requirement. This has been carried out to the extent that every important group of parts

is accessible without disturbing unrelated mechanism. For instance, the armature can be removed without disturbing any part of the electrical connections except the armature leads, and requiring the removal of no part of the mechanism except the front housing of the motor. The monkey wrench and screw driver are the only tools needed to take the machine apart or reassemble it.

In the design of this tool the severe use to which it is likely to be put, and the lack of skill in the workmen who are expected to use it have required that adjustments be entirely done away with. All wearing surfaces are made to take permanently their proper position, and are designed with sufficient bearing area so that any disturbances due to natural wear will not affect their perfect operation. Any attendant of average ability or less will have no difficulty in removing or replacing parts successfully and safely, since no delicate adjustments are involved.

Constant and thorough lubrication is necessary in any machine of this kind, no matter how well designed and made it may be. Provision is taken in these hoists to insure the access of oil to all running parts, even when proper attention to this important matter is not given by the operator or attendant. Every part of the hoist will be properly oiled when three conspicuous oil reservoirs are filled. The supply of lubricant contained in each of these three reservoirs is sufficient to protect the machine from harm, even if it is not replenished for a long period.

An important improvement consists in providing the motor with a variable speed electric control. It has been usually considered that this is not necessary with series-wound motors of small size, but experience has led the builders to believe that the sudden turning on of full current strength into a

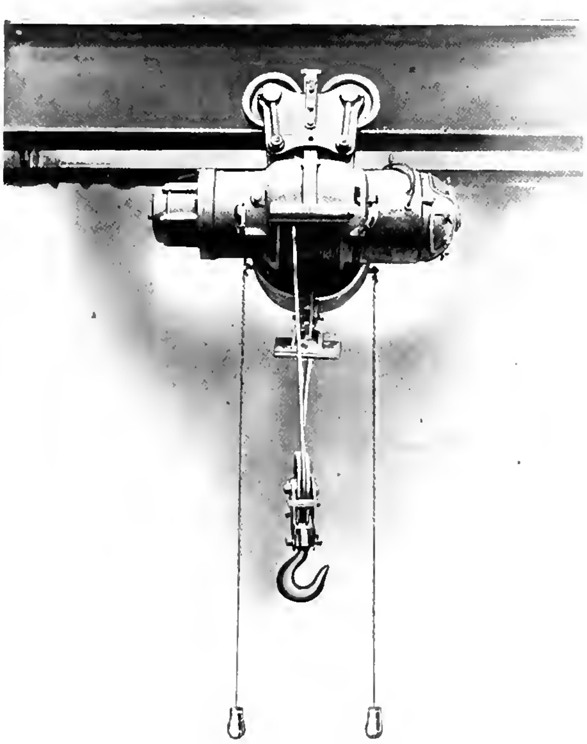


Fig. 1. The Shepard Electric Hoist

hoist motor results in unnecessary strain on the shafts, gears and hoisting rope, and when long continued, results in serious deterioration in the motor as well. On opening the circuit under full voltage and current strength, there is also the serious damage to the controller contacts to reckon with. The controller used with these hoists provides an unusual number of contact steps—14 on the smallest size, and 18 in those of larger capacity. It is proven in practice that this improvement results in a great decrease in the amount of care necessary to maintain the electrical features of the hoist in good condition.

As intimated in the paragraph devoted to the matter of interchangeability, these devices may be applied in a number of different ways, using the proper structure or holding mechanism for the work in hand. In Fig. 1 is shown the simplest form of the hoist, arranged to be supported by a single I-beam, and to be traversed by hand. The controller in this case is mounted on the farther side of the hoisting drum, and is operated from the floor by pull ropes. An automatic stop is provided to prevent over-winding. In Fig. 2

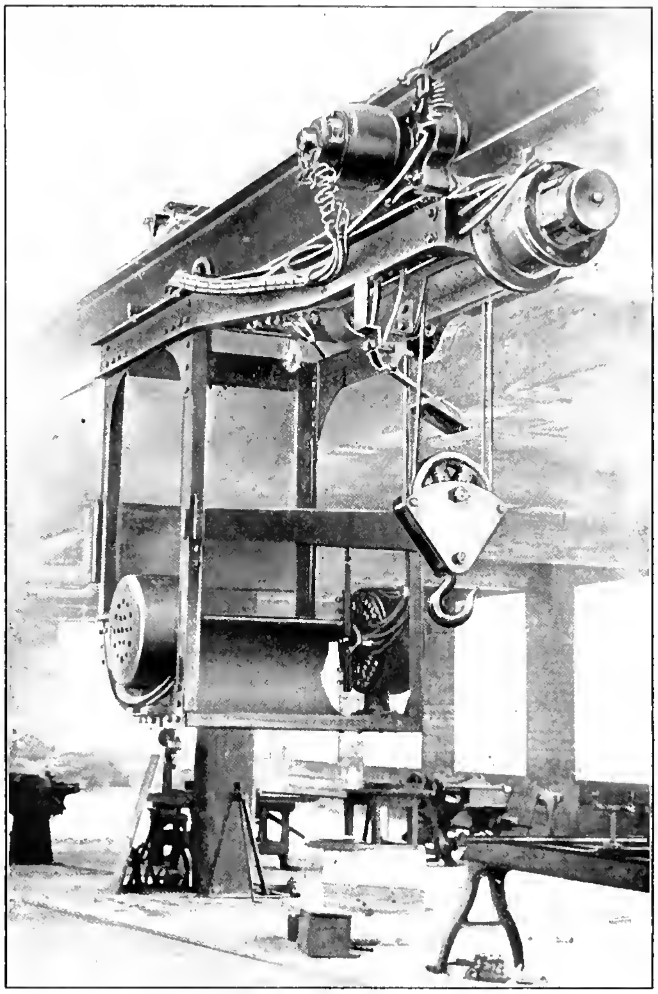
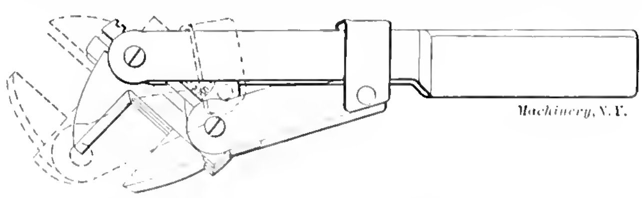


Fig. 2. The Shepard Hoist arranged with Self-traversing Trolley and Operator's Cab.

the device is shown applied to a trolley suspended from an I-beam as before, but with a second motor for power traverse, and a suspended operator's cab carrying the controllers, operated in this case directly by hand levers. The equipment shown in the latter figure is in use in the works of the American La France Fire Engine Co. Of course this hoist may be used in many other ways besides in the two applications shown.

RATCHET MONKEY-WRENCH.

The engraving shows a wrench of new and unusual construction which combines the handiness and quick adjustment of the monkey-wrench with the ability of the ratchet wrench to work in confined quarters. The jaws are adjusted to the size of the nut or screw head by a knurled thumb nut as in



An Adjustable Ratchet Wrench.

the monkey-wrench. As may be seen, the head containing these jaws is pivoted at one end to the handle, and at the other to a link connecting with a stirrup sliding on the handle. It may be used as a monkey-wrench with the jaws in the position shown if there is room for the turning movement re

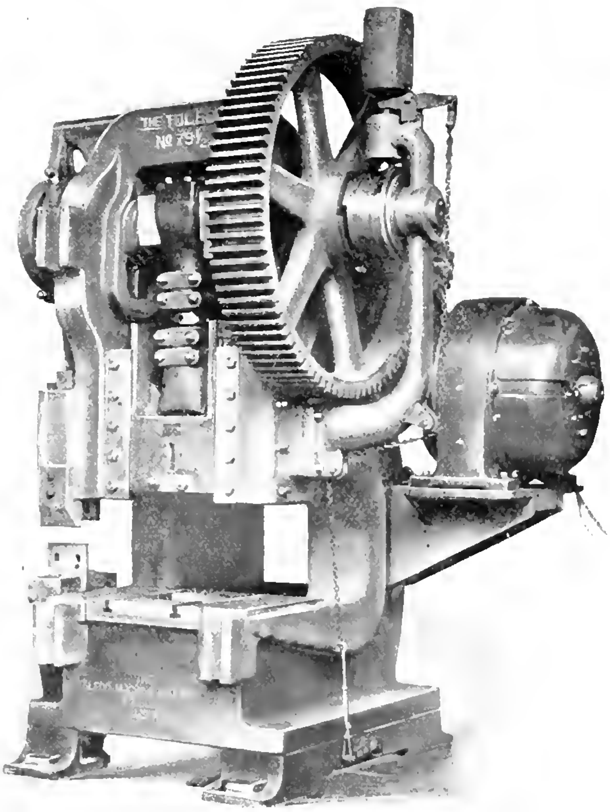
quired. When there is not room for this, the nut or bolt head may still be turned by successive short angular movements of the handle. The stirrup in this case acts as a ratchet, pushing the jaws around farther and farther with each movement. The head of the wrench can also be turned in the same way at any convenient angle, to get it into odd corners where an S-wrench would otherwise be necessary.

This tool is made by the Simplex Mfg. Co., 90 West Street, New York City.

LARGE OPEN-BACK SINGLE PITMAN GAP POWER PRESS.

The machine shown herewith was designed and built by the Toledo Machine & Tool Co. of Toledo, Ohio, for use in one of the United States Navy Yards for trimming hot or cold forgings. It is also intended for heavy blanking and shearing, thus making a tool of considerable range of usefulness.

As shown, the frame is of the over-hanging or gap pattern, with provisions for using the rods at the front for unusually heavy work which does not require the use of the gap. It is powerfully geared, and has an unusually long stroke for the main ram (7 inches), adapting it to the trimming of forgings



Press for Heavy Trimming, Blanking and Shearing.

of irregular or special shapes. An outer or shearing slide is provided on the left-hand housing. This has a stroke of 3 inches, and is capable of shearing, hot, 3-inch square bars.

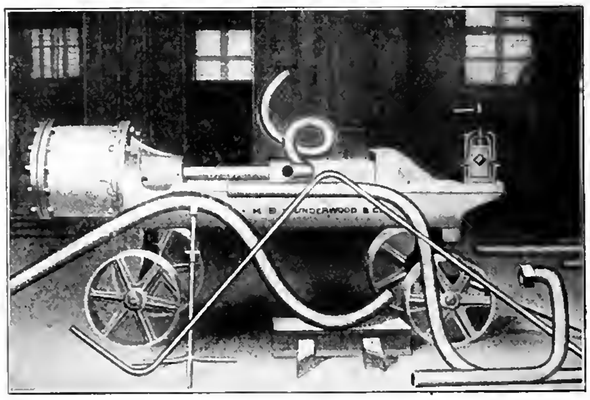
The clutch gear of this machine is 62 inches in diameter by 10 inches face, and the balance wheel, which weighs 1,600 pounds, is 50 inches in diameter. The distance between the uprights is 27 inches, the distance from the bed to the slide is 20 inches, and the area of the bed is 41 inches from right to left, and 28 inches from front to back. The distance from the center of the slide to the back is 16½ inches. The net shipping weight of the machine is 35,000 pounds. This press is the largest of a line of fifteen sizes designed and built by the makers.

RIGHT-ANGLE DRIVE FOR DILL SLOTTER.

The T. C. Dill Machine Co., Kensington, Philadelphia, Pa., has recently built a number of slotters with a drive at right angles to the axis of the base. This arrangement, which is believed to be new in slotter construction, has been found to be of marked advantage in allowing the tool to be placed in the proper relation with the line-shaft and the apparatus for placing and removing the work. This is especially true in the case of shops of the usual construction for heavy work, having a central bay served by a traveling crane, with side bays provided with line shafting, running lengthwise of the shop. Under these conditions, the slotter can be placed with the table projecting out from under the gallery into the space served by the crane, in which case its driving shaft will be parallel with the line-shaft from which it receives its power.

UNDERWOOD PNEUMATIC PIPE BENDING MACHINE.

H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa., have recently added to their list of tools a pneumatic pipe-bending machine, covering the range required in the ordinary work of the locomotive or air brake repair shop. It is

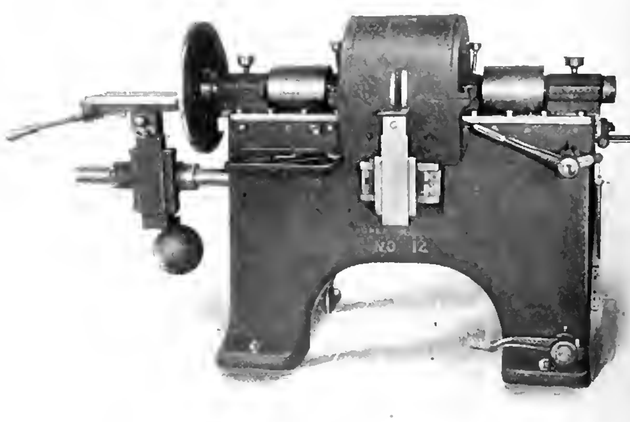


A Pneumatic Machine for Bending Pipe.

pneumatically operated, and will bend pipes to the desired radius without the filling and heating required for hand-operated machines. It will make a right-angle bend in a 2-inch pipe in two minutes, without flattening or injuring the work in any way. It will handle pipe from ½ inch up to 2 inches in diameter, in any standard radius required for locomotive work. Special dies for special radii or shapes are made to order.

COMBINATION SINGLE AND DOUBLE DISK GRINDER.

The machine shown herewith is a combination single and double disk grinder built by the Gardner Machine Co. of Beloit, Wis. It consists of a rigid box frame provided with ways on the top for two spindle heads, of which the one at the right is a sliding head operated by hand or foot lever, while that at the left is adjustable through a range of 8 inches.



Gardner Disk Grinder arranged for Single and Double Surfacing.

The latter head also carries a disk at each end of the spindle, the outer one being adapted for the full range of ordinary disk grinder work. For this work a table of any style desired may be furnished, the one shown being what the makers call their "universal lever feed table," adapted for a large variety of manufacturing operations. The feeds of this table are provided with micrometer stop screws on all movements.

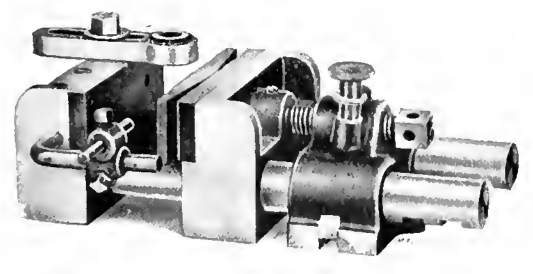
The double head grinder is adapted for machining rough pieces having equal opposite parallel faces, such as washers,

nuts, bolt heads, etc. The wheels are covered by a cast iron hood provided with a sheet steel shield, in which an opening of any desired size may be cut to suit the work being operated on. When an exhauster is used, this hood so encloses the machine that the operation is as dustless as that of turning or milling. As may be seen, the work is supported by a narrow table, adjustable on ways at the front of the machine for height and lateral position. This table projects between the two disks and supports the work when the disks are pressed against it. Micrometer stop screws are provided for limiting the movement of the heads toward each other, so that the work may be finished accurately to size. In work which requires both the hands of the operator for holding it, the feeding pressure is applied by the foot lever shown, a retracting spring being provided for withdrawing the movable head when pressure is removed, while a back stop limits its retracting movement.

The spindles of this machine are very large, and are driven by 8-inch belts. The end thrust is taken on large hardened steel collars bearing on composite babbitt and cast iron thrust surfaces. Double disks of any size up to 20 inches, and an outside disk up to 23 inches in diameter, may be used if desired. Chucks for carrying ring emery wheels are provided by the builder if the purchaser desired to use these on certain classes of work. A full assortment of tools and e.uipment, such as setting up press, cement, wrenches, etc., are provided with the machine.

THE BOWN DRILL PRESS VISE.

The drill press vise, shown in the accompanying cut, has been designed with the object of overcoming the inconvenience of hunting for straps, clamping bolts, nuts, etc., every time a piece of work has to be clamped to the drill press table. A great deal of time is spent unprofitably, because of lack of proper provisions for holding work on the tables of machines; and, although it is difficult to say to what extent the breakage of drills is due to improper means of holding work, it is probable that the expense incurred in this respect cannot be lightly considered. With a drill press vise, such as is shown in the cut, the work can be clamped instantly. As will be seen from the illustration, the vise is also provided with an adjustable strap, containing a drill bushing,



A Drill Press Vise with Locating and Jig Bushing Attachments.

and with adjustable stops, so that interchangeable work can be drilled in the vise accurately. The saving resulting from this use of the vise is apparent, as the expense of drill jigs for many ordinary jobs becomes unnecessary. In cases where a drill jig would not be made, then a great deal of time would have to be spent in laying out each piece of the work for drilling; this also becomes unnecessary for simple duplicate drilling when the vise is used. When work with many holes is to be drilled, a jig plate can be placed between the jaws, and this jig plate, covering the work, can contain any number of holes desired. In order to hold taper or irregular work rigidly, one jaw is made to swivel. Jaws are also made provided with vertical grooves, for holding round pieces in a perpendicular position for centering or drilling. The vise may, of course, also be used on other machines, such as planers, shapers, or milling machines.

The movable jaw is instantly adjusted to any desired opening, by pressing down a knob, which is connected with the tool steel locking bar. By giving the knob a slight turn, the bar is held down until the jaw is moved to the right position. Turning the knob back again, allows the locking bar to spring back into the square notches milled on the lower side of the rods; these notches are plainly shown in the cut. The jaws are made of tool steel and hardened, and the rods are also made of tool steel and ground.

The width of the jaws is 5½ inches, and the full depth to the bottom, 3½ inches. The depth to the rods is 1¾ inch. The regular vise can be opened up to 8 inches between the jaws, but longer rods are made to order so that openings of any width can be obtained. The weight of the vise is 33 pounds. It is made by the Bown Machine Co., Ltd., Battle Creek, Mich.

CORRECTION TO DESCRIPTION OF PLANER CLAMP.

An error was made in our description of the J. H. Williams & Co.'s planer clamp, which was illustrated in the December issue. The clamp is not case-hardened as was stated therein, but is given a special heat treatment which toughens and strengthens the forging, making it better suited to stand the rough usage that such machine tool accessories commonly get.

* * *

Some experiments regarding the strength of cast iron beams have recently been carried out at the Worcester Polytechnic Institute, and the data obtained during these investigations are given in the November issue of the *Journal of the Worcester Polytechnic Institute.* The experiments were carried out by Messrs. E. A. Adams, C. S. Frary, and E. H. Fish, of the Polytechnic Institute. The conclusions arrived at are very interesting, more particularly so as they do not fully agree with the commonly accepted ideas that a much higher stress should be permitted in cast iron beams on the compression side than on the tension side. It will be recollected that in our November issue we published an abstract from a paper on physical characteristics of cast iron, in which this question was referred to in connection with the design of shear or punch frames of the open jaw or gap type, in which it was stated that the breakages on the tension side were often caused by comparatively too little metal being deposited on the compression side. While the report of the tests at the Worcester Polytechnic Institute concludes with the statement that it is difficult to arrive at a definite conclusion of the tests made, it is added that it appears to be correct to design beams on the assumption that the strength of the material is the same in tension as in compression. A design made in this way would seem to be wasteful of material on the compression side, but it is said if the indications from these experiments are correct, then a smaller factor of safety might be used than has previously been the custom. The investigators sum up this conclusion, however, with the statement that what has been found from the present experiments can be taken only as an indication, and that tests on a still wider range of cross sections and sizes would be necessary before they would consider that this statement could be accepted as an actual fact. It will be understood, of course, that, while in designing a beam to carry a load the design would be based on the same strength of material for tension as for compression, that should not be construed to mean that cast iron when subjected simply to stress or simply to compression has got the same strength in both cases. Of course the well-known relation between cast iron's tensile and compressive strength, each considered by itself, which was thoroughly investigated over a century ago, is as true to-day as ever.

* * *

An item in the *Daily Telegraph*, London, mentions that lately about 0.1 ounce of radium was produced at the University laboratory at Vienna. Small as this quantity is, it is claimed to be the greatest yet produced, and to obtain it, ten tons of uranium pitchblende had to be used. The process of obtaining this amount of radium cost $10,000. Important experiments will now be begun at Vienna to ascertain whether the theory of Sir William Ramsay, that radium can be converted into other elements, especially into helium and lithium, be correct or not. It is also mentioned that the Vienna Academy of Science, in recognition of the great services rendered by the English scientist in connection with radium discoveries, will lend him a fraction of this one-tenth of an ounce for the purpose of experiments.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

Though the aggregate of British trade keeps up wonderfully, signs are not wanting that considerable caution will, in many instances, be needed as regards future productive policies. German producers of iron and steel in various forms are not so well engaged as for some time past, and doubt as to the future action of the Continental and American syndicates tends to restrict British trade movements. The high bank rate, largely due to the drain of gold on account of American financial troubles, also considerably hinders current enterprise.

Trade Disputes and Labor Questions.

The threatened railway trouble has been obviated, largely through the tact and administrative ability displayed by Mr. Lloyd George, president of the Board of Trade. The agreement reached holds good for at least six years. Committees of various grades of railway men will confer with the local railway companies' officials with respect to any grievances. If the matter is not settled to the satisfaction of the men, the directors of the companies may be negotiated with. Failing a settlement, the matter is to be placed before a Conciliation Board composed of equal numbers of representatives of the companies and the men, the men's trades union officials being eligible as members of the board; and an arbitrator appointed by the Speaker of the House of Commons or the Master of the Rolls, or both, will give the final decision, which will be binding on both parties. Though deprecated by extreme trade unionists, the settlement arrived at is generally approved as admitting the principle of trades union recognition, with a minimum of interference with the internal discipline of the railways.

Ship Building and Naval Topics.

Shipbuilding returns show a continued decline, both on the northeast coast and on the Clyde, new orders comparing very unfavorably with the corresponding period of last year. The rapid completion and fine trial records of the *Mauretania* are naturally very gratifying to the Northeastern district, its constructional facilities being thus proved second to none. In naval circles current matters of interest include the launch of the *Cyclops*, now being fitted at Portsmouth. The vessel will be the most powerful and completely equipped repair ship afloat. The lifting shears fitted on board will be capable of lifting a torpedo boat completely out of the water. The naval dockyard extensions at Devonport are of an important character. The new crane will lift 160 tons at a radius of 95 feet, 80 tons at 115 feet, and 30 tons at 128 feet, and is understood to be the largest of its class yet installed. Satisfactory progress is being made with the piecing up of the *Suevic*, and it would appear, as a consequence of precautions taken, that the vessel will be more seaworthy than when new.

General Progress of British Industries.

During the last few years British manufacturers have, in the face of international competition, done so well generally, in consequence of adoption of meritorious foreign methods or machinery, that there is some little danger of a return of the self-satisfied condition which preceded the temporary setback experienced in some branches about ten years ago. Mr. Joseph Adamson, president of the Manchester Association of Engineers, in his presidential address, drew attention to the importance of the Manchester district retaining, or regaining, its previous reputation as a center of industrial research and pioneer work. It is only necessary to mention such names as Crompton, Arkwright, Roberts, Nasmyth, Whitworth, Bodmer, Fairbarn, Daniel Adamson, Joule, Dalton, etc., to indicate the type of men who initiated the characteristic productions and influence of Manchester engineering, and the task which awaits their industrial successors. Mr. Adamson was of the opinion that standardization of designs, products, and methods, had gone far enough for a while, and that more attention should be paid to original work than has been the case for some time. Curiously enough, similar advice has recently been proffered to American manufacturers and engineers.

The utilization of what has often been considered waste heat or gases from blast furnaces, etc., is being much more systematically carried out than formerly. The latest proposition, likely to be carried into effect, is to employ the waste heat from coke ovens for the production of electric current, the plant being run by special power companies, who will purchase the gases from the coke oven proprietors and sell the current. In some instances the same procedure will be followed in the case of blast furnace gases.

Touching on South America and neighboring machinery business, it is of interest to note the obtaining by Mirrlees, Watson & Co., of Glasgow, of a large contract for the machinery of a sugar factory at Porto Rico, the order, which amounts to about $350,000, being obtained against considerable international competition.

Automobile Industry.

The outstanding feature at the motor car exhibition at Olympia is the strong position of British makers, who appear to have quite made up the considerable leeway which divided them from their Continental competitors a few years back. The greatest successes of the Continentals have been represented by the cars constructed practically regardless of expense, but in consequence of the bad summer and overproduction, the firms building these cars are not so well placed as the British builders mostly are, who, while offering the expensive styles, have also planned to easily change, if necessary, to the manufacture of moderate, or even comparatively low-priced, cars, and in fact the latter are now being made a leading line by several makers. While special tools for manufacturing the parts of motor-car mechanism have been designed and largely sold, the needs of repairers and small makers are receiving a fair share of attention. As was the case a few years ago in the cycle trade, small makers can often produce a small or medium priced car of a quality to compare favorably with the product of the large concerns, and at a distinctly lower price.

Machine Tools.

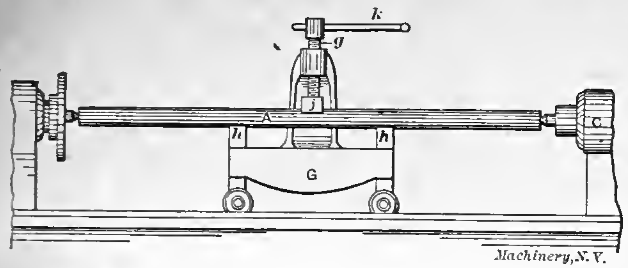
A lathe of 9-inch swing, adapted for repair and amateur workshops, is being built by King & Co., Armley, Leeds. In addition to turning and boring work, it is easily adaptable for many milling jobs. The main variations from ordinary lathe design are in the saddle and tail-stock. The saddle slides on a pair of Vs, cast on the front face of a strong bed, and carries a vertical pocket, the bore of which corresponds to the bore of the tail-stock barrel. Cast onto the under side of the compound slide-rest is a shank which is turned to fit both the saddle pocket and the tail-stock barrel, a nut in the end of the shank being made to engage with the screw in both barrels and saddle pocket. The change from a lathe to a milling machine is easily effected by taking out the spindle from the tail-stock, and then taking the compound rest out of the saddle pocket and putting it into the tail-stock barrel. The top slide of the compound rest consists of a table 8 x 5 inches, provided with two T-slots on which to secure tools and jigs when used as a lathe, and jigs and work when used as a milling machine. The table has a traverse of 10 inches, and a cross traverse of 5 inches. Within the limits of these traverses objects can be milled with practically the same facility as on an ordinary milling machine. Spur wheels up to 10 inches diameter by 1½ inch face can be cut, or greater widths up to 7 inches diameter. Attachments are in preparation for converting the lathe into a shaping and boring machine. Though, as a rule, machine tools of too comprehensive a range are not desirable, a tool as described can be profitably used in many cases. We may add that the machine, as described, is listed at $150 when arranged on a 4-foot bed. At one time the small upright and sensitive drill presses were almost an impregnable line with certain American makers. Though a good many of the best makes from the States are still sold, several makers over here find that they can make them with profit. In fact, one firm—Jones, Pollard & Shipman—almost confine themselves to upright and sensitive drills, and, finding their works accommodation altogether too cramped, are now building a large new works at Leicester, adjoining their old premises. With the additional equipment to be installed, the firm will be placed in an exceptionally good position for profitable manufacture and rapid output. JAMES VOSE.

Manchester, England, Dec. 5, 1907.

PUNCH PUNCH

SHOP OPERATION SHEET NO. 52.

H. K. Griggs. MACHINERY, February, 1908.



To Straighten a Rough Bar for Making a Shaft.

1. Take the rough bar *A* to the centering machine, and drill and ream center holes in each end.

2. Place the shaft straightener *G* on the lathe bed with its supporting wheels between the inside and outside vees.

3. Fasten a lathe dog to one end of the bar *A*, and place the bar between the lathe centers.

4. Start the lathe at a moderate speed, the slowest speed with the gears out being about right, and hold a piece of chalk close to the bar. If the bar runs out of true, the chalk will make a mark on the high side. In this way test the bar at various points until the greatest bend has been located.

NOTE.—When straightening a small bar, it may be rotated by drawing the hand rapidly across it. This will cause the bar to revolve on the centers, and then the chalk may be held against it as described. When rotating a bar in this way, the dog is, of course, not needed.

5. Turn the bar *A* until the chalk marks are up, and then move the straightener *G* to the most pronounced bend in the bar, as indicated by the chalk marks. Bring the pressure-screw *g* directly over this bend, and place the blocks *h* under the bar as shown. Slack up on the lathe centers to avoid springing them. Bring down the pressure-screw block *j* upon the bar *A*, and with the lever *k* turn the screw *g* sufficiently to bend the bar, not only straight, but to produce a slightly reversed curve to compensate for the tendency to spring back. If there is a reverse bend in the bar, the bar running out in opposite directions, first straighten one of the bends. The bar will then run out in one direction only, and this bend can then be straightened.

NOTE.—In case of short bends, the blocks *h* may be placed nearer each other. If very short bends occur near the ends, the center hole may run out of true and should be reamed again. Very large shafts, or those of high carbon steel, having short bends, should be heated before being straightened.

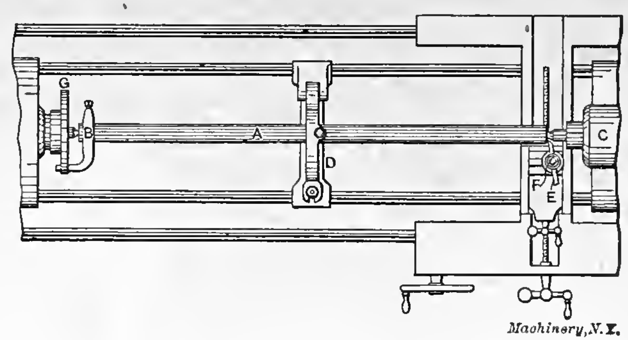
6. Set up the tail-center, and again test the bar with the chalk. If the bar still runs out, again move the straightener to the most pronounced bend and straighten as before. Continue in this manner until the bar is practically straight.

NOTE.—The surface of a shaft is sometimes under a tension due to the rolling process. Because of this it is at times difficult to turn a long shaft and have it perfectly straight when finished, as this tension is removed in turning the shaft, which causes it to spring and run out of true when the center-rest is removed. For this reason it is often necessary to straighten the finished shaft.

PUNCH PUNCH

SHOP OPERATION SHEET NO. 53.

H. K. Griggs. MACHINERY, February, 1908.



To Face the Ends of a Rough Bar for Making a Shaft.

NOTE.—In the regular production of shafting, special appliances are in use by which the standard sizes are rapidly turned out. It is, however, often necessary to make shafts when these facilities are not available. In the present instance the shaft is supposed to be of such a length that a center support is necessary to prevent sagging. It is also assumed that center holes have been drilled and reamed in the ends of the rough bar.

1. Set the tail-stock *C* so that the lathe will take the bar *A* between the centers, and clamp it.

2. Fasten the lathe-dog *B* to one end of the bar *A*, and place the bar between the centers of the lathe, the dog engaging with the slot in the face-plate *G*. Oil the tail-center and set it up in place.

3. True up a spot, which is to be used as a bearing for the center-rest, near the middle of the bar *A*. This spot should not be midway between the ends of the bar, but about six inches nearer the head-stock end. When turning this spot, use a sharp pointed tool, and take light cuts, using a fine feed.

4. Clamp a center-rest *D* to the lathe bed, placing the center-rest so that its jaws are opposite to the spot just turned. Adjust the jaws to the work and oil their inner ends.

NOTE.—If a bar is quite long, it may be impossible to turn a spot near the middle of the bar because of its extreme flexibility; in such a case, a spot is turned on the bar as far from the dead center as possible and the center-rest jaws are adjusted to this spot. Then a second spot is turned farther along the bar, and, if necessary, the operation repeated. When it is not desirable to turn a spot for the center-rest, a "cat head" is sometimes used. This consists of a collar, about six inches long, which has four set-screws in each end. This collar fits loosely over the bar, and it is adjusted by the set-screws until it runs true. The jaws of the center-rest are then adjusted to the cylindrical surface of the cat head between the heads of the set-screws.

5. Place the facing tool *E* in the tool-post *F*, and clamp it.

6. Face the end of the bar *A*, feeding from the center out, by hand.

7. Take the bar out of the lathe, turn it end for end, and change the dog to the opposite end. Then face the second end as described in steps 5 and 6.

PUNCH PUNCH

SHOP OPERATION SHEET NO. 54.

H. K. Griggs. MACHINERY, February, 1908.

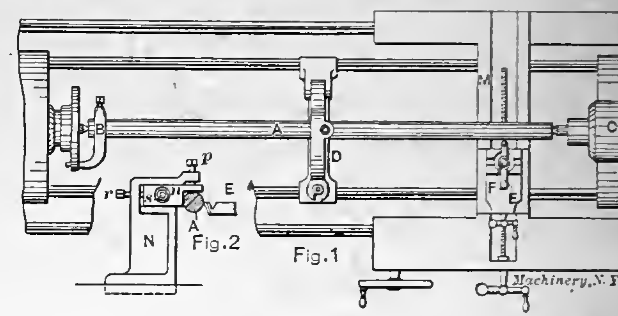


Fig. 2 Fig. 1

To Rough Turn and Finish a Shaft from the Rough Bar.

NOTE.—The bar *A* is supposed to have been center-drilled and reamed; to have been straightened; to have had the ends faced and a spot turned near the middle for a center-rest bearing.

1. Adjust the jaws of the center-rest *D* to the turned spot on the bar *A*. Care should be taken to have the jaws bear evenly on the bar to avoid springing it, and when the jaws are adjusted, the bar should rotate easily. Oil the inner ends of the jaws.

2. In the tool-post *F*, clamp a diamond point roughing tool *E* and turn 3 or 4 inches of the end of the bar to within 1/32 inch of the finish diameter.

3. Upon the rear of the carriage *M*, fix the follow-rest *N* (Fig. 2) with its jaw *n* in close contact with the turned portion. Adjust the jaw *n* by the set-screws *p* and *r*, and clamp it by the bolt *s*. This follow-rest steadies the bar when it is being turned, and the roughing cut may now be continued until the carriage is prevented from going farther by the center-rest *D*.

4. Turn the bar *A* end for end, and change the dog *B* to the opposite end. Rough turn this half of the bar as described in steps 2 and 3.

NOTE.—When rough turning a shaft, it will become more or less heated which will cause elongation. Because of this it is necessary to slacken the tail-center at times, especially when turning long shafts, to avoid springing them.

5. After taking the roughing cut, unscrew the center-rest jaws, speed up the lathe and see if the rough-turned shaft runs true. If it does not run true, again turn a spot for the center-rest jaws.

6. Again adjust the jaws of the center-rest to the work, and replace the roughing tool *E* with a finishing tool having a straight cutting edge and slightly rounded corners. Set the tool to the exact finish diameter, and take the finishing cuts in the manner described for the roughing cuts in steps 3 and 4. When taking this cut the tool should be lubricated with soda water, or some soapy mixture. A lubricant of this kind can also be used to advantage when taking the roughing cuts.

NOTE.—Regular shafting lathes are sometimes arranged so that a shaft can be driven from either end. This is desirable when turning a long shaft, as otherwise the torsional stress at the beginning of the cut would be considerable.

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

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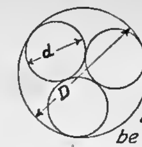
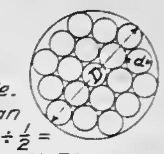
TABLE OF INSCRIBED TANGENT CIRCLES.



Approximate Formulas:

$N = 0.907\left(\frac{D}{d} - 0.94\right)^2 + 3.7. \qquad R = 0.94 + \sqrt{\frac{N-3.7}{0.907}}.$



N = Number of inscribed circles.
R = Diameter of large circle ÷ diameter of small circle.
Example:- How many wires $\frac{1}{2}$ inch in diameter can be placed inside a 5 inch pipe? The value of R is $5 \div \frac{1}{2} =$ 10, and looking for this number in table, find by interpolation N = 76.

N	R	N	R	N	R	N	R	N	R
2	2.00	34	6.76	130	12.80	290	18.75	600	26.65
3	2.15	35	6.86	135	13.06	295	18.90	610	26.86
4	2.41	36	7.00	140	13.26	300	19.05	620	27.07
5	2.70	37	7.00	145	13.49	310	19.35	630	27.28
6	3.00	38	7.08	150	13.72	320	19.65	640	27.49
7	3.00	39	7.18	155	13.95	330	19.94	650	27.70
8	3.31	40	7.31	160	14.17	340	20.23	660	27.9'
9	3.61	41	7.39	165	14.39	350	20.52	670	28.12
10	3.80	42	7.43	170	14.60	360	20.81	680	28.33
11	3.92	43	7.61	175	14.81	370	21.09	690	28.54
12	4.05	44	7.70	180	15.01	380	21.36	700	28.75
13	4.23	45	7.72	185	15.20	390	21.63	720	29.14
14	4.41	46	7.81	190	15.39	400	21.90	740	29.52
15	4.55	47	7.92	195	15.57	410	22.17	760	29.90
16	4.70	48	8.00	200	15.75	420	22.44	780	30.28
17	4.86	49	8.03	205	15.93	430	22.70	800	30.65
18	5.00	50	8.13	210	16.11	440	22.96	820	31.02
19	5.00	55	8.21	215	16.29	450	23.21	840	31.39
20	5.18	60	8.94	220	16.46	460	23.47	860	31.75
21	5.31	65	9.25	225	16.63	470	23.72	880	32.11
22	5.49	70	9.61	230	16.80	480	23.97	900	32.46
23	5.61	75	9.93	235	16.97	490	24.21	920	32.80
24	5.72	80	10.20	240	17.14	500	24.45	940	33.14
25	5.81	85	10.46	245	17.30	510	24.68	960	33.48
26	5.92	90	10.73	250	17.46	520	24.91	980	33.82
27	6.00	95	11.15	255	17.63	530	25.13	1000	34.15
28	6.13	100	11.34	260	17.79	540	25.35	1100	35.75
29	6.23	105	11.60	265	17.95	550	25.57	1200	37.30
30	6.40	110	11.85	270	18.11	560	25.79	1300	38.80
31	6.44	115	12.10	275	18.27	570	26.01	1400	40.20
32	6.55	120	12.34	280	18.43	580	26.23	1500	41.60
33	6.70	125	12.57	285	18.59	590	26.44	1600	42.95

Contributed by E. H. Lockwood.

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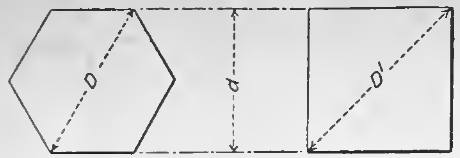
SQUARE AND HEXAGON NUT DIAMETERS.

$D = 1.154694\,d$



$D' = 1.4142136\,d$

d	D	D'	d	D	D'	d	D	D'
$\frac{1}{4}$	0.2886	0.3535	$1\frac{1}{4}$	1.4434	1.7677	$2\frac{5}{16}$	2.6702	3.2703
$\frac{9}{32}$	0.3247	0.3977	$1\frac{9}{32}$	1.4794	1.8119	$2\frac{3}{8}$	2.7424	3.3587
$\frac{5}{16}$	0.3608	0.4419	$1\frac{5}{16}$	1.5155	1.8561	$2\frac{7}{16}$	2.8145	3.4471
$\frac{11}{32}$	0.3968	0.4861	$1\frac{11}{32}$	1.5516	1.9003	$2\frac{1}{2}$	2.8867	3.5355
$\frac{3}{8}$	0.4329	0.5303	$1\frac{3}{8}$	1.5877	1.9445	$2\frac{9}{16}$	2.9589	3.6239
$\frac{13}{32}$	0.4690	0.5745	$1\frac{13}{32}$	1.6238	1.9887	$2\frac{5}{8}$	3.0311	3.7123
$\frac{7}{16}$	0.5051	0.6187	$1\frac{7}{16}$	1.6598	2.0329	$2\frac{11}{16}$	3.1032	3.8007
$\frac{15}{32}$	0.5412	0.6629	$1\frac{15}{32}$	1.6959	2.0771	$2\frac{3}{4}$	3.1754	3.8891
$\frac{1}{2}$	0.5773	0.7071	$1\frac{1}{2}$	1.7320	2.1213	$2\frac{13}{16}$	3.2476	3.9794
$\frac{17}{32}$	0.6133	0.7513	$1\frac{17}{32}$	1.7681	2.1655	$2\frac{7}{8}$	3.3197	4.0658
$\frac{9}{16}$	0.6494	0.7955	$1\frac{9}{16}$	1.8042	2.2097	$2\frac{15}{16}$	3.3919	4.1542
$\frac{19}{32}$	0.6855	0.8397	$1\frac{19}{32}$	1.8403	2.2539	3	3.4641	4.2426
$\frac{5}{8}$	0.7216	0.8839	$1\frac{5}{8}$	1.8764	2.2981	$3\frac{1}{16}$	3.5362	4.3310
$\frac{21}{32}$	0.7576	0.9281	$1\frac{21}{32}$	1.9124	2.3423	$3\frac{1}{8}$	3.6084	4.4194
$\frac{11}{16}$	0.7937	0.9723	$1\frac{11}{16}$	1.9485	2.3865	$3\frac{3}{16}$	3.6806	4.5078
$\frac{23}{32}$	0.8298	1.0164	$1\frac{23}{32}$	1.9846	2.4306	$3\frac{1}{4}$	3.7527	4.5962
$\frac{3}{4}$	0.8659	1.0606	$1\frac{3}{4}$	2.0207	2.4708	$3\frac{5}{16}$	3.8249	4.6846
$\frac{25}{32}$	0.9020	1.1048	$1\frac{25}{32}$	2.0568	2.5190	$3\frac{3}{8}$	3.8971	4.7729
$\frac{13}{16}$	0.9380	1.1490	$1\frac{13}{16}$	2.0929	2.5632	$3\frac{7}{16}$	3.9692	4.8613
$\frac{27}{32}$	0.9741	1.1932	$1\frac{27}{32}$	2.1289	2.6074	$3\frac{1}{2}$	4.0414	4.9497
$\frac{7}{8}$	1.0102	1.2374	$1\frac{7}{8}$	2.1650	2.6516	$3\frac{9}{16}$	4.1136	5.0381
$\frac{29}{32}$	1.0463	1.2816	$1\frac{29}{32}$	2.2011	2.6958	$3\frac{5}{8}$	4.1857	5.1265
$\frac{15}{16}$	1.0824	1.3258	$1\frac{15}{16}$	2.2372	2.7400	$3\frac{11}{16}$	4.2579	5.2149
$\frac{31}{32}$	1.1184	1.3700	$1\frac{31}{32}$	2.2733	2.7842	$3\frac{3}{4}$	4.3301	5.3033
1	1.1547	1.4142	2	2.3094	2.8284	$3\frac{13}{16}$	4.4023	5.3917
$1\frac{1}{32}$	1.1907	1.4584	$2\frac{1}{32}$	2.3453	2.8726	$3\frac{7}{8}$	4.4744	5.4801
$1\frac{1}{16}$	1.2268	1.5026	$2\frac{1}{16}$	2.3815	2.9168	$3\frac{15}{16}$	4.5466	5.5684
$1\frac{3}{32}$	1.2629	1.5468	$2\frac{3}{32}$	2.4176	2.9610	4	4.6188	5.6568
$1\frac{1}{8}$	1.2990	1.5910	$2\frac{1}{8}$	2.4537	3.0052	$4\frac{1}{8}$	4.7631	5.8336
$1\frac{5}{32}$	1.3351	1.6352	$2\frac{5}{32}$	2.4898	3.0494	$4\frac{1}{4}$	4.9047	6.0104
$1\frac{3}{16}$	1.3712	1.6793	$2\frac{3}{16}$	2.5259	3.0936	$4\frac{3}{8}$	5.0518	6.1872
$1\frac{7}{32}$	1.4073	1.7235	$2\frac{1}{4}$	2.5981	3.1820	$4\frac{1}{2}$	5.1961	6.3639

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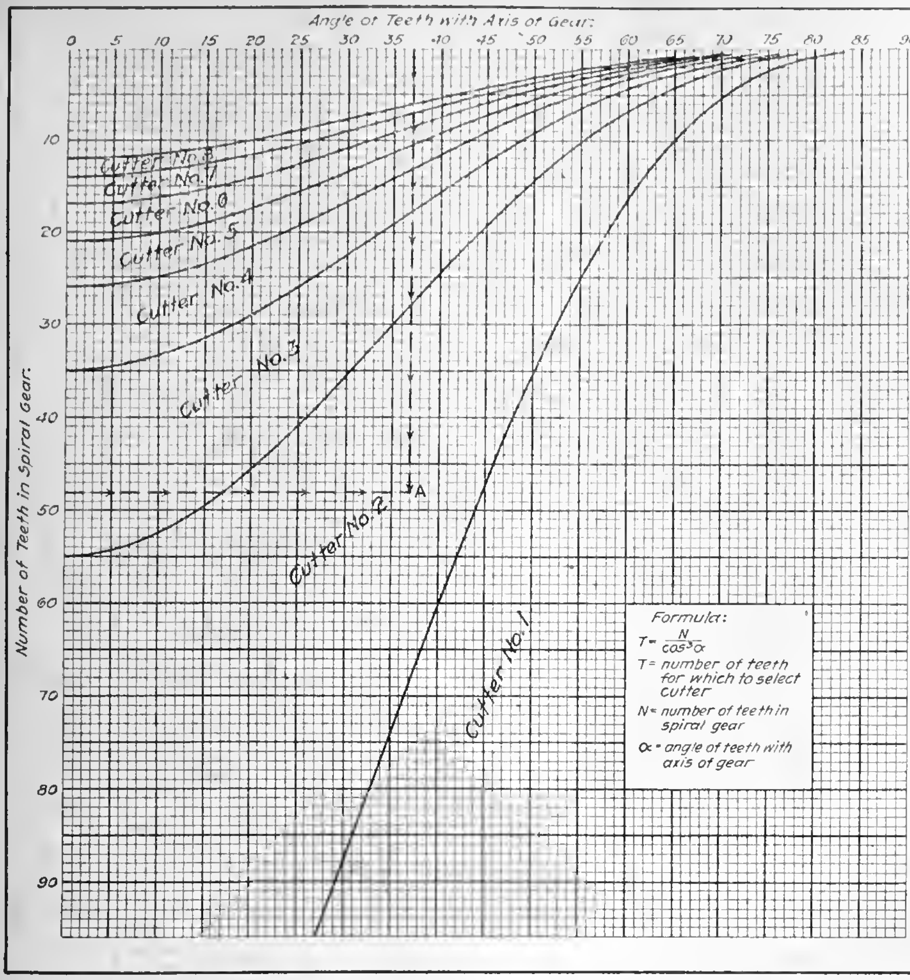
DIAGRAM FOR FINDING SPIRAL GEAR CUTTER NUMBERS.



The cutter used in milling spiral gears is a standard spur gear cutter; the only difference being that the number of the cutter used to cut a spiral gear is not necessarily the same as that used to cut a spur gear of the same number of teeth. The angle of the teeth of a spiral gear with its axis affects the tooth form, and therefore, the number of the cutter.

The selection of the cutter is fixed by the formula given in the lower right-hand corner of the diagram. The delimiting curves thereon were plotted by the formula, the area between the curves being the field of intersection of the combinations of angles and numbers of teeth covered by each designated cutter number.

For example, suppose the angle of the teeth of a gear is 37 degrees with its axis, and the number of teeth is 48. The point A, at which the horizontal line (representing the tooth number), and the vertical line (representing the angle) intersect, falls within the area marked "Cutter No. 2" Therefore, a No. 2 cutter is required to cut a 48-tooth spiral gear having the teeth at an angle of 37 degrees with its axis.

Con ributed by Elmar G. Eberhardt.

CREASE HERE

SOLUTION OF OBLIQUE ANGLE TRIANGLES.

Parts Given	Parts to be found. $a=$	$b=$	$c=$	$\angle A$	$\angle B$	$\angle C$
$a-b-c$				$\frac{b^2+c^2-a^2}{2bc}=\cos A$	$\frac{a^2+c^2-b^2}{2ac}=\cos B$	$\frac{a^2+b^2-c^2}{2ab}=\cos C$
$b-c-\angle A$	$\sqrt{b^2+c^2-2bc\cos A}$				$\frac{b\sin A}{c-b\cos A}=\tan B$	$\frac{c\sin A}{b-c\cos A}=\tan C$
$a-c-\angle B$		$\sqrt{a^2+c^2-2ac\cos B}$		$\frac{a\sin B}{c-a\cos B}=\tan A$		$\frac{c\sin B}{a-c\cos B}=\tan C$
$a-b-\angle C$			$\sqrt{a^2+b^2-2ab\cos C}$	$\frac{a\sin C}{b-a\cos C}=\tan A$	$\frac{b\sin C}{a-b\cos C}=\tan B$	
$a-b-\angle A$			$\frac{a\sin C}{\sin A}$		$\frac{b\sin A}{a}=\sin B$	$180°-(A+B)$
$a-b-\angle B$			$\frac{b\sin C}{\sin B}$	$\frac{a\sin B}{b}=\sin A$		$180°-(A+B)$
$a-c-\angle A$		$\frac{a\sin B}{\sin A}$			$180°-(A+C)$	$\frac{c\sin A}{a}=\sin C$
$a-c-\angle C$		$\frac{c\sin B}{\sin C}$		$\frac{a\sin C}{c}=\sin A$	$180°-(A+C)$	
$b-c-\angle B$	$\frac{b\sin A}{\sin B}$			$180°-(B+C)$		$\frac{c\sin B}{b}=\sin C$
$b-c-\angle C$	$\frac{c\sin A}{\sin C}$			$180°-(B+C)$	$\frac{b\sin C}{c}=\sin B$	
$a-\angle A-\angle B$		$\frac{a\sin B}{\sin A}$	$\frac{a\sin C}{\sin A}$			$180°-(A+B)$
$a-\angle A-\angle C$		$\frac{a\sin B}{\sin A}$	$\frac{a\sin C}{\sin A}$		$180°-(A+C)$	
$a-\angle B-\angle C$		$\frac{a\sin B}{\sin A}$	$\frac{a\sin C}{\sin A}$	$180°-(B+C)$		
$b-\angle A-\angle B$	$\frac{b\sin A}{\sin B}$		$\frac{b\sin C}{\sin B}$			$180°-(A+B)$
$b-\angle A-\angle C$	$\frac{b\sin A}{\sin B}$		$\frac{b\sin C}{\sin B}$		$180°-(A+C)$	
$b-\angle B-\angle C$	$\frac{b\sin A}{\sin B}$		$\frac{b\sin C}{\sin B}$	$180°-(B+C)$		
$c-\angle A-\angle B$	$\frac{c\sin A}{\sin C}$	$\frac{c\sin B}{\sin C}$				$180°-(A+B)$
$c-\angle A-\angle C$	$\frac{c\sin A}{\sin C}$	$\frac{c\sin B}{\sin C}$			$180°-(A+C)$	
$c-\angle B-\angle C$	$\frac{c\sin A}{\sin C}$	$\frac{c\sin B}{\sin C}$		$180°-(B+C)$		

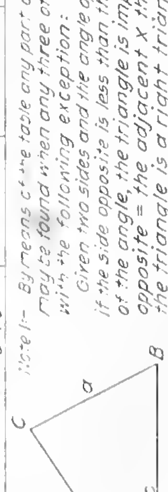


Fig. 1

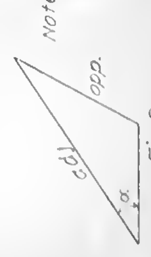


Fig. 2.

Note 1:— By means of the table any part of an oblique triangle may be found when any three other parts are given, with the following exception:

Given two sides and the angle opposite one of them; then, if the side opposite is less than the adjacent × the sine of the angle, the triangle is impossible; or if the side opposite = the adjacent × the sine of the angle, the triangle is a right triangle; or if the side opposite is less than the adjacent but does not come under the above, the triangle is capable of two solutions and can be drawn as in Fig. 2 as well as in Fig. 1.

Note 2:— In some cases two steps are necessary to solve, as for example, having given sides a and b and angle A, to find c: The formula reads $c=\frac{a\sin C}{\sin A}$ but angle C must first be derived from $C=180°-(A+B)$, and the same applies to other angles in certain cases as is apparent above.

MACHINERY.

February, 1908.

MONEY AND MONEY-MAKING MACHINERY.

CLAUDE E. HOLGATE.*

C. E. Holgate.

IT has been said that one of the most important functions of the government is the creation of money and its distribution. Money itself is the most important instrument of civilization in contributing to human comfort and enjoyment. With pieces of paper bearing the seal of the Treasury of the United States, the holder can procure for his use any article of necessity or luxury produced in the world. Without this contrivance called money, he would be compelled to live within very narrow limitations, and his conveniences and comforts would be but little better than those of a savage. It is not the province of this paper to discuss the money question, nor to volunteer individual opinions as to the prospective future policy of the United States with reference to its money, but it is proper to say that the tendency of modern thought and civilization is to regard the issue of all kinds of money as distinctly a national function, to be exercised only by that sovereign power whose mandates and prerogatives constitute the supreme law of the land. Therefore, a word or two in these times of financial stringency, concerning the machinery and the manner of producing our national currency, may prove of interest.

Fig. 1. Bureau of Engraving and Printing, where the Paper Money is made—and afterwards destroyed.

In a general way, most every one knows that our so-called paper money is made at the Bureau of Engraving and Printing, at Washington, but it is safe to say that very few outside of those directly connected with the industry, know that practically all of the important machines used in bank-note engraving, not only in the United States, but all over the civilized world, are supplied by less than half a dozen concerns in Newark, N. J.

The office of the Bureau of Engraving and Printing is to design, engrave, and print all the obligations of the government of the United States, including the interest-bearing bonds, the treasury notes, the national bank-notes, and the gold and silver certificates; also to design, engrave and print the customs and internal revenue stamps, postage stamps, and checks and drafts used in the different departments of the government.

Until recent years, the postage stamps were printed by private bank-note companies, who were the lowest bidders in competition with the Bureau of Engraving and Printing. The Secretary of the Treasury selects the subjects which appear on the face of the government money and securities. The portraits only of departed citizens who have won distinction are used. Living subjects are not reproduced in the design. The designs are made under the supervision of the Chief of the Engravers' Division of the Bureau, and all are subject to the approval of the Secretary of the Treasury.

The designs on the government money are engraved on steel dies. The complete design for the engraving having been selected, a corps of engravers begins work on the different parts of the design. One engraver may work upon the portrait, one upon the lettering, and others upon the ornate work. The engraving of an entire design is never entrusted to a single person, and the whole design is never made upon a single plate, but in sections. When the engraving on the different sections is completed, the dies are hardened and tempered. Sectional rolls, of soft steel, are then passed over the hardened dies by pressure, and the design is transferred in relief to the roll. Each sectional roll bears a part of the complete design. The whole design is then transferred to one piece of steel called the bed-piece, from which a complete roll is made. The finished roll is then tempered and hardened, and four notes are transferred to each plate. This plate is also hardened, and is then ready for the printer. When the complete roll and the printing plates are worn out, recurrence is had to the original rolls, and when these rolls are unfit for further use, the original dies are brought into requisition for the production of new rolls and plates. Rolls and plates are hardened by the cyanide of potash process.

The paper money of the United States, when it is new and fresh from the press, is the finest in the world, and its production is the most expensive. The paper used is made by the Crane Mills, at Dalton, Mass., expressly for the Bureau of Engraving and Printing, and directly under its supervision. It is composed of fine linen and silk, and a collection of silk fibers run lengthwise through the sheets. The process of its manufacture is known only to the manufacturers and the officers of the Bureau. Heavy penalties are imposed merely for the act of having the unprinted paper in possession. The commercial bank-note companies have the government's sanction to use a security paper, also made by the Crane Mills, in which planchettes or small pieces of silken fiber are interwoven in the texture of the paper during manufacture, but they are not permitted to use the kind employed by the government in the making of money.

All of the engraving on the plates used is hand work, with the exception of the fine scroll or lace work, which is done by a triumph of mechanical ingenuity known as the geometric lathe, and a cycloid ruling machine for the straight work. Most of the engraving on the back of the different denominations of paper money is the work of the geometric lathe. As these machines cost over $5,000, and as it requires an expert mathematician to operate them, it will readily be seen that the work of the counterfeiter is much embarrassed by its operation.

* Address: 464 Washington St., Newark, N. J.

Origin of the Geometric Lathe.

The first geometric lathe was invented by Charles W. Dickinson, who died in 1900, and whose business is now carried on by his son, C. W. Dickinson, Jr., at Belleville, a suburb of Newark. Mr. Dickinson, the senior, was employed as a watch-case maker, and became interested in fine machinery. "Engine turned" watch cases began to be the style, and he made his first lathe for the purpose of decorating a watch case. This was a success, and a jeweler asked him to make a machine to cut a die which could be used to decorate an oval silver salver. The salver was thirty-four inches long, and the pattern was to follow its general form in one continuous figure or set of interlaced lines. This necessitated new motions being added to the machine, the one he then had being arranged for circles only. Mr. Dickinson made the machine and it was a great success. Later a man wanted a machine to make the curved combinations on bank-notes. A thousand dollars was deposited as a guarantee, and the machine was made. Notice was sent to the individual ordering it when it was completed. Nothing was heard from him, however, and the lathe was sold to someone else. Three years afterward this man was one of a gang arrested for counterfeiting. This gave Mr. Dickinson an idea of one great use for his lathe, and the present geometric lathe, to which improvements have been added from time to time, is the result. The first one was used upon bank-note plates in 1862. Mr. Dickinson went to Washington to run the lathe he had built for the government, and stayed there a year and a half, cutting new combinations for the currency then in use, until he had succeeded in instructing someone in the intricacies of running the lathe. The geometric lathe complete is one of the finest pieces of machinery in existence. It is constructed of a number of superimposed flat plates, accurately hand scraped to surface-plates, which are actuated by cams and gearing, and these are as near perfection as it is possible for human endeavor to get them. It requires four men, about five months, to build one of these lathes, and as infinitesimal accuracy is required in laying out the work and fitting the various movements together, only the most skilled mechanics, who have had years of experience in building this class of

Fig 2. Thomas J. Sullivan, Chief of the Bureau of Engraving and Printing.

Fig. 3. Cutting Bills Apart by Machine.

Fig. 4. A Million Dollars in Paper Money ready to be destroyed.

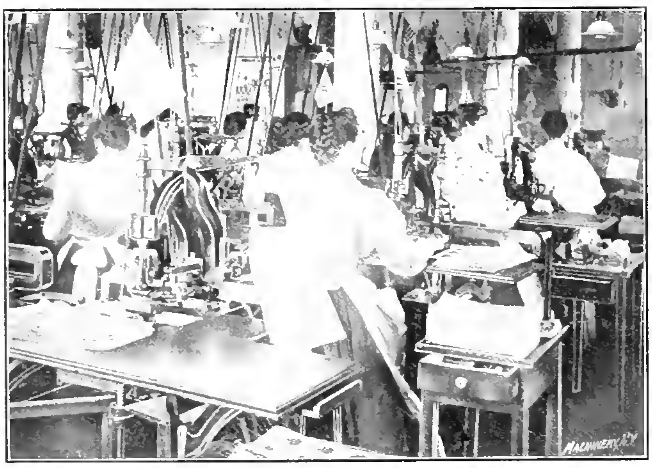


Fig. 5. Numbering Bills at the Bureau of Engraving and Printing

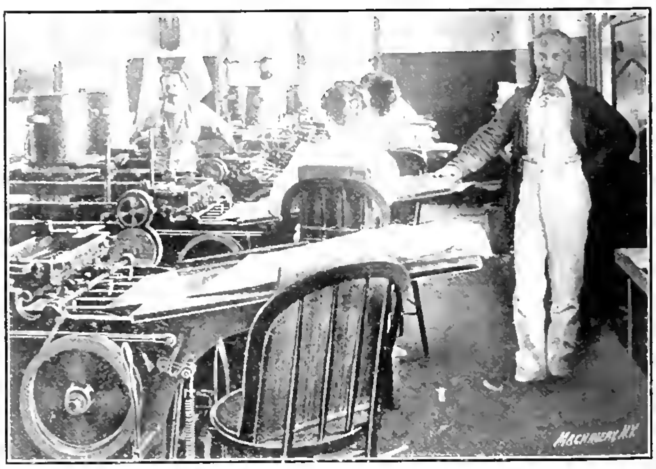


Fig 6. Machines for Gumming Postage Stamps.

machinery, are employed in the work. The accuracy required will be appreciated when it is known that this machine will produce lines so close together that they can only be counted with the aid of a microscope. In the finer engraving, it is possible to work within a twelfth of one-thousandth of an inch. The lathe produces an almost endless combination of geometric figures, by means of combinations of gears, cams and eccentrics. Over twenty million different patterns have already been counted off, and the end is not yet reached. In fact, with his latest improved lathe, Fig. 7, Mr. Dickinson claims to be able to get almost any movement desired.

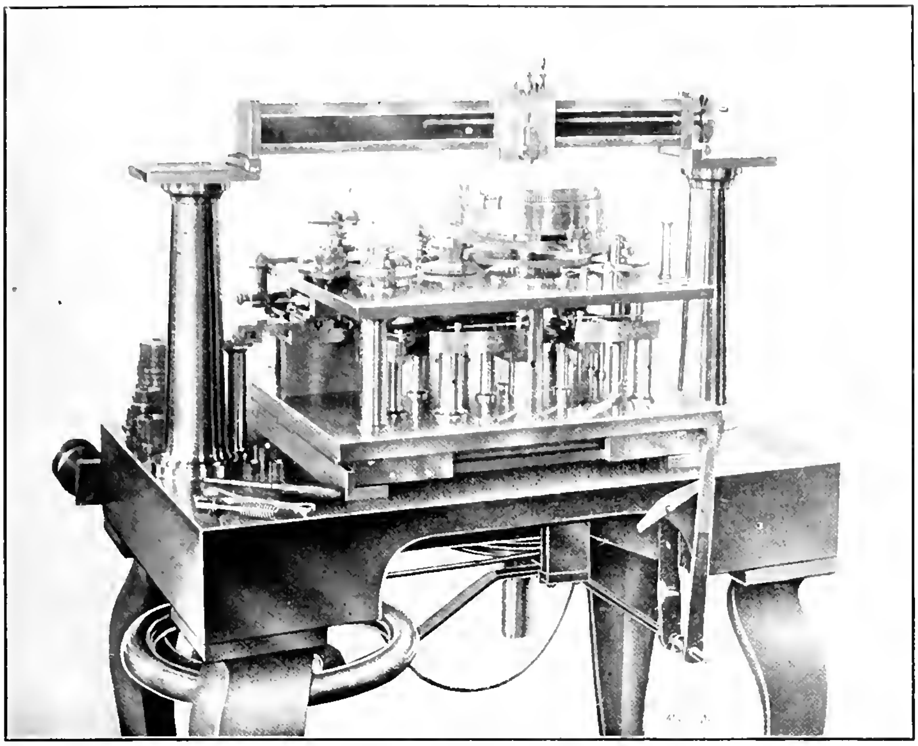


Fig. 7. Improved Dickinson Geometric Lathe.

At the corner of a treasury note, the figure denoting its denomination rests upon an ornate design in the shape of a heart, trefoil, a hexagon, an oval or some other design composed of wave lines finer than hairs. Down in the corners you will find the words "five," "two," or the letter "V" or figure "2" printed upon the same little lacy figure made up of the finest lines. Turn the bill over and you will find the lacy figures repeated in groups or borders, almost entirely covering the back. Look at the little green band around a box of cigars or a bag of tobacco, and somewhere upon it appears similar combinations of circles and wave lines. Every treasury note, every revenue stamp, postage stamp, bank bill or bond carries these fine lined creations, and each of a different combination so as to make it difficult to counterfeit. In fact the design in each corner of the face of every bill is different, thus multiplying the difficulty. The die to be engraved is clamped to the top platen or chuck of the lathe. The hardened steel cutting tool—sometimes pointed with a diamond—is fastened in a stationary position on the cross-beam shown at the top of the lathe. The working of the lathe is like fairy fingers. There is no noise only a slow movement or series of movements of the platen holding the die. The die follows the directions necessary to produce the pattern. Each pattern is calculated mathematically from the degree of a circle. Sometimes it will take two months to make a shell or die of the most intricate patterns. Ordinarily it takes four or five days to complete one of the small designs in the corner of a bill. Not only is the distance from each line measured, but the depth to which the tool is to go. The cutting tool is adjustable vertically, and after a given series of movements is completed, the tool is adjusted and a deeper cut taken. The average number of cuts on each movement is about twenty. Having had one row or thread of the figure cut upon it, a shadow of change in the adjustment of the lathe is made, and now the movement may perhaps be from the center to the rim of the design, in and out, over and over again. There are only about twenty of these lathes in existence, and they are owned by the United States and foreign governments, or by the bank-note companies, and it is safe to say that they are the product of either the Dickinson shops, or those of the W. H. Chapman Co., which are also located at Newark. It is unnecessary to add that the U. S. Secret Service keeps a close watch on where new lathes go, as well as the plates that are turned out on them.

While the operator of the geometric lathe has been turning out his lacy designs, the hand engravers have been busy with the portrait work and lettering, and when all the separate dies are completed they are then ready for the transferrer, whose methods of operation are described in the fore part of this article.

The Transfer Press.

The transfer press, which is used for transferring the separate designs from the dies to the soft steel rolls, and thence back to the flat plates as a completed design, is an important machine in this work. It not only is an aid to the government in its policy of having each part of a treasury note engraved by a separate person, but on bonds and other work of this character, it effects a wonderful saving in time, as it enables several engravers to work on various parts of a design at one time; these are then assembled by means of the transfer press into a complete design. It would take a great many months to complete a design if the original engraving were all done on one plate, and each engraver would be required to wait for the other to finish before he could start on his part of the work.

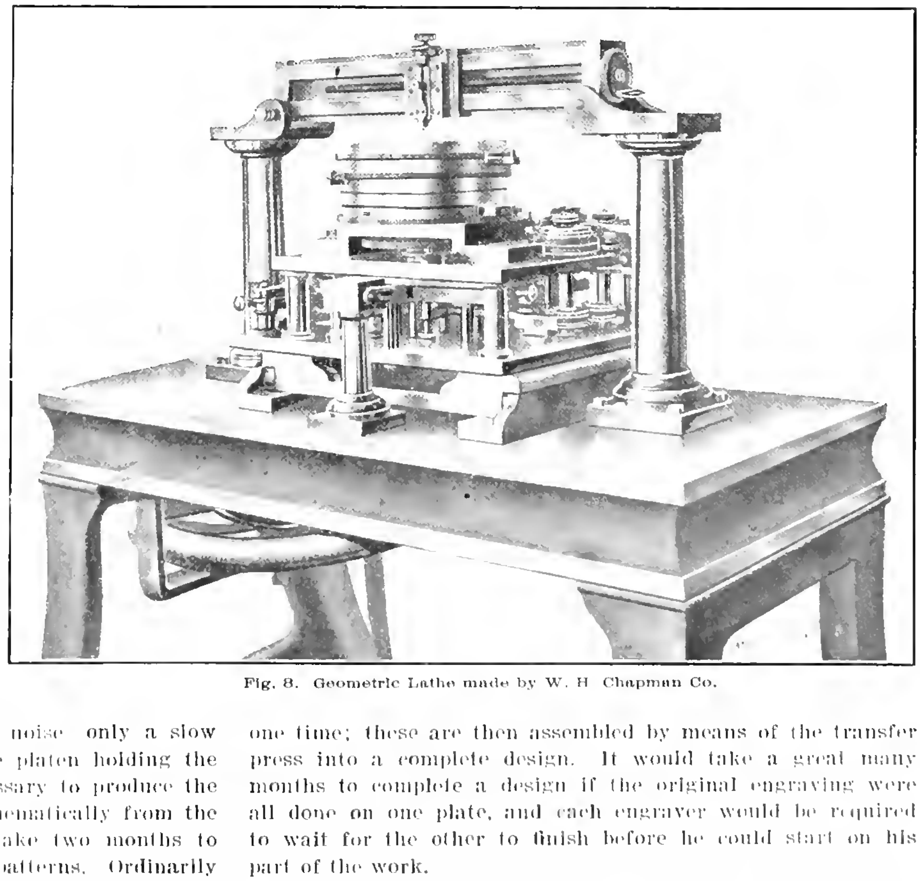


Fig. 8. Geometric Lathe made by W. H. Chapman Co.

The transfer press is designed on the compound lever prin-

ciple, as will be noted on referring to the illustration. The engraved die, and the roll which is to receive the impression, are set square with each other by means of a very delicate and accurate gage seen at the front end of the large beam at the top of machine. Then the foot-lever which extends under the bed of the press is depressed and the operator, or transferrer as he is called, racks the die back and forth across the surface of the roll through the medium of the large hand-wheel on the side of the press. The shaft on which this hand-wheel is keyed, carries a spur pinion on its inner end which meshes with a rack in the bed of the press. With this style of press and its system of compound levers, great pressure can be produced, the ratio between the end of the foot-lever, where the

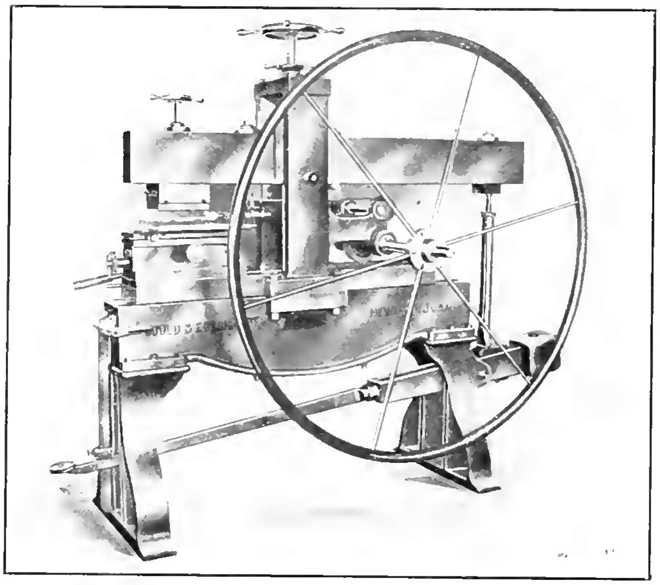


Fig. 9. Gould & Eberhardt's Improved Transfer Press.

initial pressure is applied, and the end of the beam where the roll is placed being about thirty-five to one.

At one time the government manufactured its own presses. Castings were made under the directions of the Bureau, and put together by machinists in their employ. This policy, however, was abandoned several years ago, and the government now purchases new presses when needed. Some of the first transfer presses were made by Poole & Hunt, of Baltimore, but in later years nearly all of the presses used by the bureau and the bank-note companies have been manufactured by either W. H. Chapman Co., or Gould & Eberhardt, of Newark. The latter concern has made a number of valuable improvements in the press, some of which have been patented. The original design of the press has been made more stable in construction, and more convenient for the operator, and their type of transfer press is used by the government in issuing its specifications for new machines.

The Printing Presses.

Two styles of presses are commonly employed by the plate printers for their flat work, one known as the D-roller hand press, and the other as the steam power plate press. A new press, however, has recently been designed, by which it is possible to bend up the engraved plates in circular form and print from them on this press very much like the ordinary cylinder presses. While the commercial bank-note companies find occasion to use a great many of the steam presses for their bond work, lithographing, etc., and while the government also uses them for some of its work, for the finer work, the government prefers the hand press, of which there are several hundred in use. It was long contended by expert engravers and printers that the fine effects attained by hand work could not be obtained by the steam presses, however ingenious.

This contention, however, has been disputed, and a test by inspection, was made several years ago, of work done on the two styles of presses. As a result of this, the government still continues to use the power presses. The law governing the printing of the United States money requires that it be done "in the highest state of the art," and it is safe to say that hand-operated presses will still continue to be an important factor in turning out the higher grades of work.

The steam presses are used almost exclusively at the Bureau for printing the backs of treasury and bank-notes, and for revenue and postage stamps. The first printing of any money is on the back. The printing of the face of the note (which is done on the hand presses) then follows. Then follows the numbering consecutively by automatic numbering machines. The final process is the imprint at the treasury of the seal of the Treasury Department, which makes the money valid. The signatures of the Treasurer and Register of the Treasury are printed in fac-simile, and not signed as many suppose. The national bank-notes, however, are signed in ink by the president and cashier of each bank.

The special paper used comes from the Treasury Department dry. It is then counted and prepared in the damping room for the presses. Women in the damping room receive so much paper each morning, count the sheets and give receipts for them. Layers of sheets are laid between layers of wet cloths, twenty sheets to a cloth, and then subjected to a strong pressure. When the sheets are turned over to the printer, his woman assistant counts them and certifies to the number, which certificate is witnessed by the printer, who thus in turn becomes responsible. Lock-boxes, attached to each press, register automatically every sheet printed. During the process of printing, before the plate is inked, it is warmed over a gas stove which is attached to the press. The plate is then inked thoroughly, so that the ink fills all of the engraved depressions. The surplus of ink is next rubbed off with a cloth, and it is finally rubbed off with the hand and polished with a whiting substance. The assistant lays on the sheet, and the final impression is made. This seems a slow process, and yet each hand printer and his assistant average from 800 to 1,000 impressions a day, each sheet containing four bills.

The functions of the steam power plate press are practically the same as those of the hand press, with the exception that the different operations are nearly all performed automatically by the press itself. The steam press consists of a large, square table, with four "planks" on which the engraved plates are carried. Sometimes only one plate is used at a time, and at

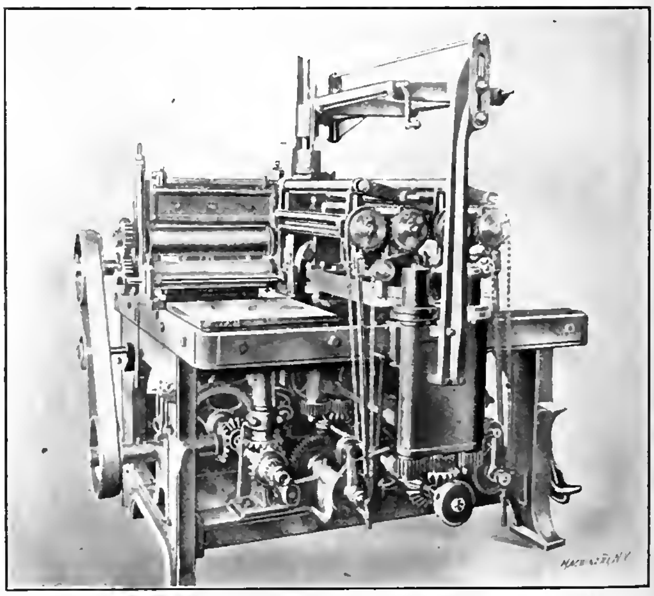


Fig. 10. Gould & Eberhardt's Steam Power Plate Printing Press.

others any number up to the capacity of the press, which is four plates. These plates are automatically and continuously carried around each side of the press by means of an endless chain, bringing them successively under the inking and printing rolls. One man and three women assistants are required to operate it. After the plate is inked by the machine, an automatic wiper removes the surplus ink, leaving but very little hand polishing to be done. One of the assistants then lays the sheet on the plate, which passes under the printing roll, after which the sheet is removed by another assistant, and the plate continues on to complete another cycle. The speed with which the plate is carried around the press varies with the work to be done, and can be regulated to suit. The number of impressions, however, average from eight to ten a

minute. After printing, the sheets are put in lock-boxes, and are taken by messengers in lots of 200 to the Examining Division, where they are counted and certified. If the count is correct, they are put in perforated racks and wheeled into the drying room where they are dried by artificial heat.

Just before the last stage of the work, and after printing, the sheets are placed between heavy sheets of cardboard, and subjected to hydraulic pressure. The pressure is 5,000 pounds to the square inch on money, checks and postage stamps, and 4,500 pounds on the revenue stamps. The next step is to take the sheets to the numbering room, where they are trimmed and numbered. Finally they are put up in packages of 1,000 sheets and placed in the receiving vault of the Bureau, where they are kept until transferred to the Treasury Department. Each sheet has been counted more than fifty times, and it takes about one month to complete the printing.

* * *

HIGH-PRESSURE TURBO-COMPRESSORS.

ALFRED GRADENWITZ.*

Centrifugal ventilators, until a short time ago, were used for compressing air only in the case of pressures inferior to 1 m. (40 inches) water. The introduction of steam turbines and high-speed electric motors reaching very high speeds of rotation, however, made possible the use of turbo-compressors even in the case of rather considerable pressures. The first successful turbo-compressors of this kind were designed

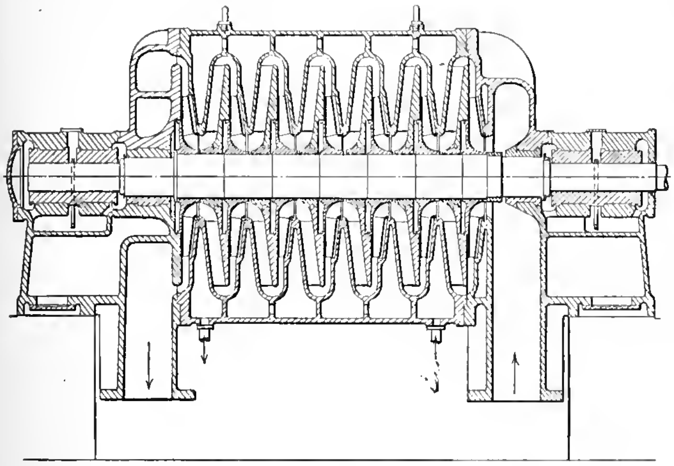


Fig. 1. Longitudinal Section of Rateau Turbo-compressor, showing Cooling Chambers.

by Prof. A. Rateau of Paris, and are exactly analogous to the centrifugal pumps constructed by the same engineer.

In Fig. 1 is shown a longitudinal section of a multiple-rim compressor unit cooled by water injected between the various cells. The rotating rims are made of steel. Especially remarkable is the construction of the diffusers, the cross-sections of which are U-shaped channels surrounding the partitions. Fixed vanes are placed in the section of the channel, conveying the fluid toward the center, and sometimes also in the centrifugal section. These U-shaped diffusers are largely the cause for the high efficiency of this type of centrifugal apparatus. In order to avoid any leakage, the outside bearing is made entirely enclosed.

The cooling of the air to be compressed is a very important question in the case of pressures of compression exceeding, say, twice the initial pressure. Whereas, in the first compressors constructed by Prof. Rateau, a system of cooling analogous to surface condensing plants between each two successive compressor units was employed, a less expensive solution has been suggested by M. René Armengaud, *viz.*, simply to cool the compressor housing. This arrangement is represented in Fig. 1.

In the compressors recently constructed, a further advance has been made in this connection, fresh water being introduced into the partitions (which to this effect are hollowed out) and even into the diffuser vanes. The cooling surface is thus augmented considerably, and the heating of the air is reduced in proportion, so as to bring the working of the machine even closer to an isothermal cycle than that of reciprocating compressors.

From the numerous efficiency tests made by Prof. Rateau on turbo-compressors of recent construction, it is inferred that very high pressures can be obtained with efficiencies approaching 60 per cent, which is a figure quite comparable to those applying in the case of good reciprocating compressors. When cooling the compression by a water circulation round the compressor housings, even higher figures can be obtained, the working cycle coming very close to that of isothermal compression, though at a temperature far superior to that of the sucked-in air. The efficiency in this case reaches figures as high as 63 per cent.

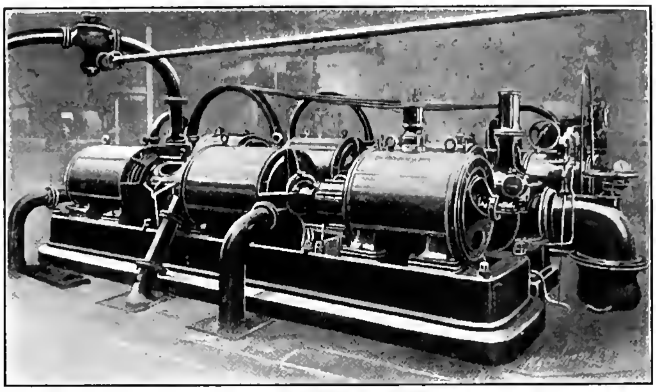


Fig. 2. Rateau Turbo-compressor for the Bethune Mines.

While the efficiency of turbo-compressors and reciprocating compressors thus is about equivalent, the former type of compressor possesses a number of advantages over the latter. The dimensions of the new type of compressor are obviously far smaller than those of ordinary compressors. A very striking instance is quoted by Rateau, *viz.*: the turbo-ventilator of Commentra, which takes up a total area of 75 square feet, whereas the blowing machine for which it was substituted took up an area more than twenty times greater, or 1,760 square feet. The centrifugal apparatus also is of far smaller weight, and as its vibrations are quite immaterial, it obviously requires far less substantial foundations.

A further advantage is the extraordinary simplicity of construction and relative cheapness of centrifugal compressors. Again, there are no working expenses worth speaking of, due to the consumption of lubricating oil, the only parts subject to friction being the bearings of the shaft. As no oil enters the interior of the apparatus the compressed

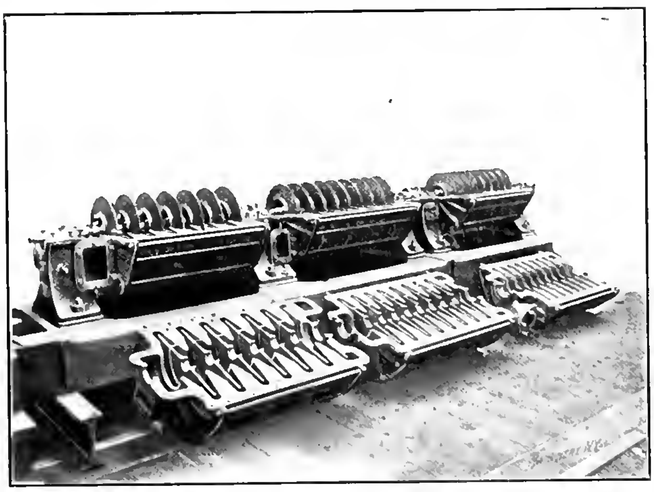


Fig. 3. Rateau Turbo-compressor built by Brown, Boveri & Co., to be driven by Gas Turbine.

gas does not contain any, which in some cases may be important.

The perfect regularity of the air current yielded by turbo-compressors is another good point as compared with the pulsations produced by reciprocating compressors which necessitate the installation of compensating reservoirs.

The output of a centrifugal compressor is obviously regulated readily within wide limits, by slightly varying the speed, or by opening and closing a gate in the suction or compression conduits, whereas, in the case of reciprocating compressors, a similar result could be obtained only by controlling the speed of the motor.

* Address: Berlin W. 50, 3 Regensburgerstrasse, Germany.

No accident need be feared in case one of the conduits becomes obstructed, as the compressor continues to turn freely with the consumption of energy reduced in proportion. The safety valves, which are quite indispensable in the case of reciprocating compressors, are, therefore, superfluous. In spite of the elasticity of output, the turbo-compressor allows a constant output as well as a constant pressure to be insured. The regularity of the motor is, in fact, controlled without difficulty by a special apparatus which acts on it in the case of any variation of the output or pressure. The regulators constructed to this effect by Rateau are of remarkable simplicity and are absolutely reliable in operation.

The possibility of coupling turbo-compressors directly to electric motors or to steam turbines without any intermediary gearing, is another advantage of centrifugal compressors, resulting in a diminution of friction losses. The

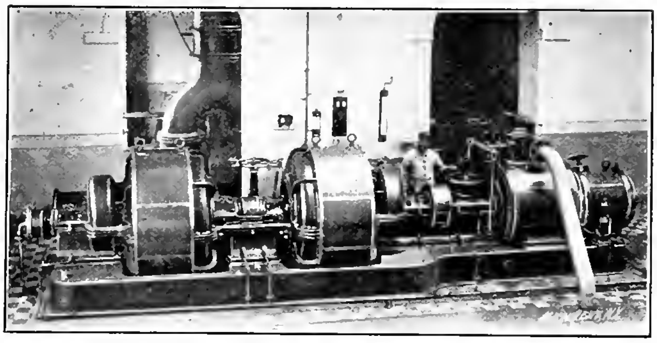


Fig. 4. Rateau Turbo-compressor at the Chasse Blast Furnaces.

exhaust steam from other engines, operating low-pressure steam turbines of the Rateau system, can thus be utilized for the production of compressed air, by combining a steam accumulator with a turbo-compressor driven by low-pressure steam. Compressed air can, for instance, be produced in mining plants and in metallurgical works exclusively by the aid of the exhaust steam from the winding engines or rolling mills, respectively. A striking instance of this economical scheme is found in the Béthune mines, and will be described in the following, and many other plants of the same kind are in course of construction. In this special field the old type of compressor will obviously be quite unable to compete with the newcomer, which may be called an ideal machine for a satisfactory utilization of exhaust steam. On the other hand, it should be borne in mind that turbo-compressors would be less satisfactory in the case of small outputs and low speeds of rotation. A few typical instances of plants constructed by Prof. Rateau and his licensees will be described in the following.

The turbo-compressor installed at the Béthune mines, which has just been referred to, serves to compress air to 6 and even to 7 atmospheres (88 to 103 pounds per square inch) by utilizing the exhaust steam from the winding engine. This machine (Fig. 2), which has been in regular operation since May, 1906, is made up of four multi-cellular units, traversed by the air, in series. These units are arranged in groups of two each on two parallel shafts, each of which is actuated by a low-pressure turbine. A high-pressure turbine fitted to one of the shafts does not do any work under normal conditions, and is used only as reserve in the case of interruption in the supply of exhaust steam, when an automatic apparatus will open the entrance conduit of the boiler steam to the high-pressure turbine, the exhaust of which is conveyed toward the low-pressure turbine. Another automatic apparatus is intended for uniformly distributing the charge between the two shafts. Between each two consecutive compressor units are inserted cooling devices, traversed by the cold water which is supplied by a small centrifugal pump mounted on the same shaft.

This plant, at a speed of 5,000 turns per minute, has been found to yield 32 cubic feet of air per second, the pressure of compression being 100 pounds per square inch above the atmospheric pressure. This is the highest figure so far obtained with centrifugal compressors.

The efficiency of the first three compressor units is especially remarkable, being as high as 70 per cent, while in the case of future applications it is hoped to raise the efficiency of the last unit to the same figure.

A compressor of even greater size, Fig. 3, has been constructed in 1906 by Brown, Boveri & Co. This is intended for operation by the aid of an Armengaud petrol turbine, and consists of three units mounted on the same shaft, the cooling of the air being effected during compression by a water circulation surrounding the compressor units. This compressor has been designed for drawing in 39 cubic feet of air per second in order to compress this to an absolute pressure of 71 pounds per square inch at a speed of 4,000 revolutions per minute.

Another turbo-compressor, Fig. 4, which was constructed by Sautter Harlé & Co., has been in operation at the Chasse blast furnaces since the month of March, 1907. This is calculated for yielding 255 cubic feet per second (this volume being reduced to atmospheric pressure) at a pressure of 11¾ inches mercury. The same plant is capable, in the case of any irregularity in the working of the blast furnace, of yielding 141 cubic feet per second at a pressure of 23½ inches mercury. To this effect the compressor has been divided into two identical units, which can be coupled up either in quantity or in series. The speed of rotation is 3,000 revolutions per minute. This machine is provided with an apparatus for recording its output, so as to ensure a perfect regularity.

As regards the numerous turbo-compressors in course of construction, the centrifugal blowers constructed by the Gutehoffnungshütte should be mentioned in the first place. These are intended for being operated by electric motors of up to 2,000 H. P. Brown, Boveri & Co., on the other hand, have received orders for about 10 turbo-compressors, one of which (of 1,500 H. P.) will be used for the compression of air to 120 pounds per square inch absolute. Some of the compressors planned for the blowing-in of Bessemer converters will have a capacity of even more than 4,000 H. P.

* * *

POWER TRANSMISSION BY FRICTION DRIVE.*

A friction drive, as the term is employed in the following, consists of a fibrous or somewhat yielding driving wheel, working in rolling contact with a metallic driven wheel. The drive may consist of a pair of plain, cylindrical wheels mounted on parallel shafts, or of a pair of beveled wheels, mounted on shafts at right angles. In the following, the results of tests with such drives are summarized.

Wheels Tested.

Wheels of the following materials have been tested in the experiments referred to: Straw fiber; straw fiber with belt dressing; leather fiber; leather; leather-faced iron; sulphite fiber; and tarred fiber.

The straw fiber wheels were worked out of blocks, built up of square sheets of straw-board, laid upon one another, with a suitable cementing material between them, and compacted under heavy hydraulic pressure. In the finished wheel the sheets appear as disks, the edges of which form the face of the wheel. The wheel of straw fiber, with belt dressing, was similar to the one described, excepting that the individual sheets of straw-board were treated with belt dressing before being converted into a block.

The leather fiber wheel was made of cemented layers of board, consisting of ground sole leather cuttings, imported flax, and a small percentage of wood pulp. The leather wheel was composed of layers or disks of sole leather. The leather-faced iron wheel consisted of an iron pulley, having a leather strip cemented to its face. After less than 300 revolutions, the bond holding the leather face failed, and the leather separated itself from the metal of the pulley. The wheel proved incapable of transmitting power, and no tests were recorded. The wheel of sulphite fiber was made up of sheets of board, composed of wood pulp. The tarred fiber wheel was made up of board, composed principally of tarred rope stock, imported French flax, and a small percentage of ground sole leather cuttings.

* Abstract of paper by W. F. M. Goss, read before the American Society of Mechanical Engineers, December meeting, 1907.

Each of the wheels was tested in combination with driven wheels of iron, aluminum, and type metal. All the wheels tested, both driving and driven, were 16 inches diameter, the face of the driving wheels being 1¾ inch, while that of the driven was ½ inch. The purpose of the experiments was to secure information for formulating rules regarding the power which may be transmitted by friction between fibrous and metallic wheels. To accomplish this, it was necessary to determine for each combination the coefficient of friction under varying conditions, and the maximum pressures of contact which could be withstood by the fibrous wheels.

Results of Tests.

The results of the experiments involving the straw fiber driver and the iron driven wheel, show that although the ranging from 100 to 400 pounds, the coefficient of friction is practically constant, when the rato of slip is constant. With a type metal driven wheel, the coefficient was 0.310.

Wheels of straw fiber, treated with belt dressing, and of iron, worked together with a pressure of 150 pounds per inch width of wheel and with a slip of 2 per cent with a coefficient of friction of 0.12, the friction remaining practically constant up to a pressure of 400 pounds per inch width of wheel.

The coefficient for 150 pounds pressure per inch width of wheel between leather fiber and iron, and a slip of 2 per cent equals 0.515. The same material with aluminum shows a friction coefficient of 0.495, and with type metal, 0.305.

The coefficient of friction between an iron wheel and one of tarred fiber, with a slip of 2 per cent, and a pressure of 150 pounds per inch width of wheel, equals 0.220, and for a

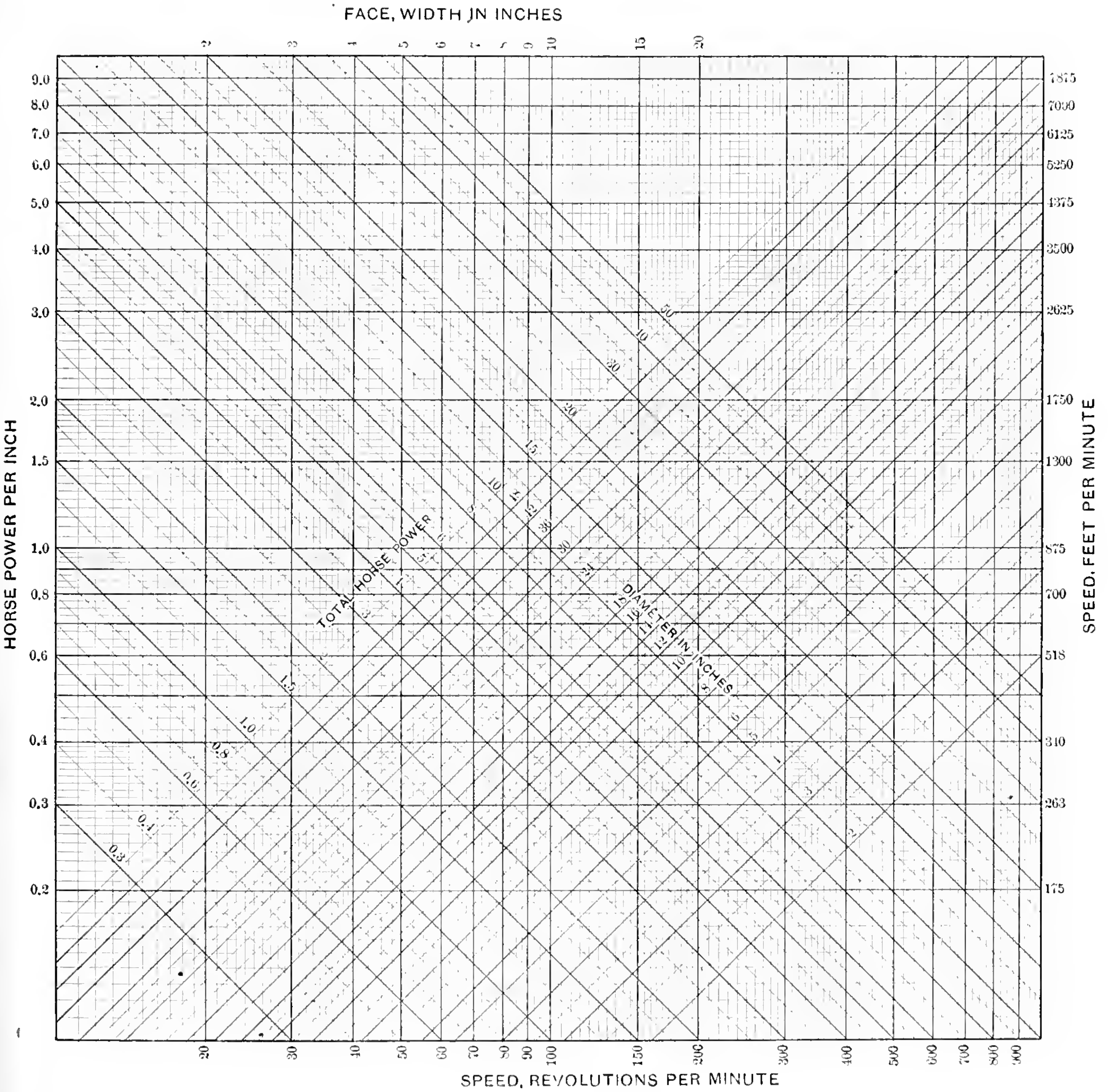


Chart for Determining the Horse-power Transmitted by Straw-fiber Friction Wheels working against Iron Wheels.

values of the coefficient of friction for 400 pounds pressure per inch width of wheel were slightly lower than those for 150 pounds pressure, the results were sufficiently similar to establish the fact that the law governing the change in the coefficient of friction, with slip, is independent of the pressure of contact. With a 2 per cent slippage the coefficient of friction for the pressures mentioned varied between 0.410 and 0.425.

Experiments with the straw fiber driver and aluminum-driven wheel show that the coefficient of friction with a working pressure of 150 pounds per inch width of wheel, and a slippage of 2 per cent is 0.455, and that for all pressures pressure of 400 pounds per inch, 0.250. Aluminum and tarred fiber show a coefficient of friction of 0.305 for a pressure of 150 pounds, and a coefficient of 0.295 with a pressure of 400 pounds per inch width of wheel. With type metal the coefficients for 150 and 400 pounds are 0.275 and 0.270, respectively.

The coefficient of friction between leather and iron with a slip of 2 per cent and a pressure of 150 pounds per inch width of wheel equals 0.225, and for a pressure of 400 pounds, 0.215. A leather driver may be successfully operated up to a pressure of 750 pounds per inch width of wheel. With aluminum, the coefficient of friction proved to be 0.260 and 0.295 for 150 and

300 pounds pressure, respectively. Running with type metal, the leather showed a coefficient of friction of 0.410, with a pressure of 150 pounds per inch width of wheel.

Sulphite fiber proved to have a coefficient of friction of 0.550 for a pressure of 150 pounds, and was successfully operated up to a pressure of 700 pounds per inch width of face. The coefficient of friction for this material running with aluminum was 0.410, with a pressure of 150 pounds; and when running with type metal, the coefficient of friction was 0.515 for the same pressure.

Tests were also undertaken to demonstrate the maximum pressure per inch width of face, which each wheel could stand. These experiments showed that hardly any of the wheels would decrease in diameter under a pressure of 200 pounds per inch width of face, but when the load was increased, a decrease in diameter followed. For straw fiber wheels and a pressure of 750 pounds, the decrease in diameter was 1/8 inch. Leather fiber proved to stand pressures to a far greater extent. A pressure of 800 pounds per inch width of face compressed the diameter of the wheel less than 1/16 inch, and it took 1,100 pounds pressure to compress it as much as 1/8 inch. Tarred fiber wheels decreased in diameter more than 1/8 inch when the pressure reached 800 pounds, and the leather wheels, when the pressure reached 550 pounds. Sulphite fiber decreased nearly 1/16 inch in diameter with a pressure of 400 pounds, and more than 1/8 inch with a pressure of 600 pounds.

General Conclusions.

The relative value of the metal drive wheels is not the same when operated in combination with different fibrous driving wheels. Driving wheels which are more dense, work more effectively with an iron follower than with either aluminum or type metal followers, but the softer and less dense driving wheels work better with aluminum and type metal than with iron.

The relative value of the different fibrous wheels, when employed as drivers of a friction drive, show that the addition of belt dressing to the composition of the straw fiber wheel is fatal to its frictional qualities. The highest frictional qualities are possessed by the sulphite fiber wheel, but, on the other hand, it is the weakest of all the wheels tested. The leather fiber and tarred fiber wheels are the strongest, and the former possesses also frictional qualities of a superior order. The plain straw fiber, which in a commercial sense is the most available of all materials, possesses frictional qualities which are far superior to leather, and strength which is second only to the leather fiber and the tarred fiber.

As safe working pressures of contact, the following figures may be given:

Material.	Pounds per inch of Width of Face.
Straw fiber	150
Leather fiber	240
Tarred fiber	240
Sulphite fiber	140
Leather	150

For *working values* of the coefficient of friction, the following figures may be considered correct:

Type of Drive.	Coefficient of Friction Working Value.
Straw fiber and iron	0.255
Straw fiber and aluminum	0.273
Straw fiber and type metal	0.186
Leather fiber and iron	0.309
Leather fiber and aluminum	0.297
Leather fiber and type metal	0.183
Tarred fiber and iron	0.150
Tarred fiber and aluminum	0.183
Tarred fiber and type metal	0.165
Sulphite fiber and iron	0.330
Sulphite fiber and aluminum	0.318
Sulphite fiber and type metal	0.309
Leather and iron	0.135
Leather and aluminum	0.216
Leather and type metal	0.246

Horse-power Transmitted.

Having now determined the safe working pressure of contact, and a representative value for the coefficient of friction, it is possible to formulate equations expressing the horse-power which may be transmitted by each combination of wheels tested. In these equations let

d = diameter of friction wheel in inches,
W = width of face of friction wheel in inches,
N = number of revolutions of friction wheel per minute,
H.P. = number of horse-power transmitted.

The formula would then be:

$$\text{H.P.} = k\,d\,W\,N$$

in which equation k is a coefficient which for the various materials is as follows:

Type of Friction Drive.	Coefficient.
Straw fiber and iron	0.00030
Straw fiber and aluminum	0.00033
Straw fiber and type metal	0.00022
Leather fiber and iron	0.00059
Leather fiber and aluminum	0.00057
Leather fiber and type metal	0.00035
Tarred fiber and iron	0.00029
Tarred fiber and aluminum	0.00035
Tarred fiber and type metal	0.00031
Sulphite fiber and iron	0.00037
Sulphite fiber and aluminum	0.00035
Sulphite fiber and type metal	0.00034
Leather and iron	0.00016
Leather and aluminum	0.00026
Leather and type metal	0.00029

A convenient means for finding the horse-power transmitted is supplied in the chart shown. This chart, in fact, gives a diagram for determining the value of *any one* of the variable factors in the formula H. P. = $0.0003\,d\,W\,N$ for the straw fiber friction wheel working in combination with an iron follower, the remaining factors being known or assumed. To transform values thus found to corresponding ones for the other possible combinations of wheels, it is only necessary to multiply by the proper factor chosen from the table of multipliers given above. The use of the chart may be illustrated as follows:

TABLE OF MULTIPLIERS FOR FINDING HORSE-POWER OF FRICTION DRIVES.

Type of Friction Drive.	Multiplier.
Straw fiber with iron	1
Straw fiber and aluminum	1.10
Straw fiber and type metal	0.73
Leather fiber and iron	1.97
Leather fiber and aluminum	1.90
Leather fiber and type metal	1.17
Tarred fiber and iron	0.97
Tarred fiber and aluminum	1.17
Tarred fiber and type metal	1.03
Sulphite fiber and iron	1.23
Sulphite fiber and aluminum	1.17
Sulphite fiber and type metal	1.13
Leather and iron	0.53
Leather and aluminum	0.87
Leather and type metal	0.97

a. To find surface speed, locate the intersection of the vertical line representing the given speed in revolutions per minute with the diagonal one representing the given diameter. The horizontal line passing through this point will give the surface speed in feet per minute on the vertical scale to the right of the diagram.

b. To find the horse-power for a given wheel, locate the intersection of the vertical line representing the given speed in revolutions per minute with the diagonal line representing the given diameter. Follow the horizontal line passing through this point to the right or left until the intersection between it and the vertical line representing the given width, as shown on the scale at the top of the diagram, is reached. The diagonal line passing through this point marked "Total horse-power" will represent the required horse-power.

c To find the face width of a given wheel, necessary to transmit a given horse-power, the speed being known, locate the intersection of the vertical line representing the given speed in revolutions per minute with the diagonal line representing the given diameter. Follow the horizontal line passing through this point to the right or left until the intersection between it and the diagonal line representing the required horse-power is reached. The vertical line passing through this point will give the width of face in inches on the scale at the top of the diagram.

* * *

It is stated that, at the present time, there are in the United States 700 steam turbines in use, representing 1,500,000 horse-power.

GEAR-CUTTING MACHINERY.—2.

RALPH E. FLANDERS.*

This installment continues the description of the formed milling cutter type of machine for cutting spur gears, the automatic gear-cutter of orthodox design being under consideration.

Another well-known tool in this field is that shown in Fig. 24. It is built by Gould & Eberhardt, Newark, N. J. In this machine, as in the Flather machine, the column is double and

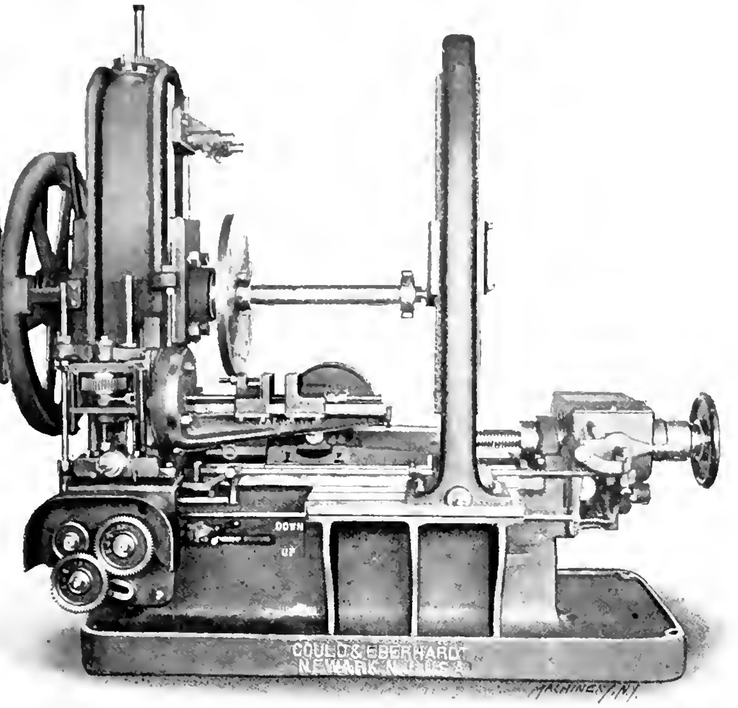


Fig. 24. Gould & Eberhardt Spur Gear Machine, with Special Automatic Rim Clamping Device Attached.

the work carrying head passes through it. This machine is of larger capacity than any of the others shown so far, and in common with most large capacity machines, is provided with a mechanism for raising and lowering the work spindle head by power. Another point of interest in this machine is the automatic clamping feature with which it is provided, used for firmly holding the rim of the blank being cut while the cut is in progress. This is in addition to the usual positive back stop against which the blank rests. This clamp consists of a pair of jaws, carried by slides on the adjustable arm shown at the front of the machine. This arm is set to bring the jaws in position to clasp the rim of the gear being cut. The jaws are operated by a screw connected with the mechanism of the machine in such a way as to hold the work firmly while the cut is in progress, releasing it while the indexing takes place, and again clamping it for a new cut. It is especially useful for comparatively slender work.

The general features of this line of machines can be best seen by referring to Fig. 25, which shows another member of this line, specially constructed for the severe service of cutting steel motor gears. The cutter and feed screw are in line with each other, so that a direct central thrust is imparted to the slide. The machine is driven through a single pulley, from which the movement is transmitted through gearing and keyed shafts to the different parts of the machine. This insures a large and constant area of belt contact at all speeds. The cutter spindle is driven by worm and worm-wheel through change gearing. The index wheel is of the split rim type with hobbed teeth, the final finishing of which is done with the dividing wheel in position on the machine. Means are provided for compensating for all wear and lost motion which may take place in this mechanism. A slight tension is constantly maintained between the stop cam and the worm in the direction of rotation, which prevents all danger from back lash and rebound. The rigid construction of the outer support of the work arbor will be noticed. Its base is mounted on a bracket cast on the side of the main frame. In removing a finished gear from the machine, it can be moved back out of the way without disturbing the height adjustment of the outboard bearing.

An automatic gear-cutter of continental design and manufacture is shown in Fig. 26. This tool is built by Ludwig Loewe & Co., of Berlin, Germany. Its most striking feature, so far as appearance is concerned, is the provision made for supporting the outer end of the work arbor. Two uprights are used, one at the front and the other at the rear of the bed, supporting a bearing for the work arbor. This bearing is counterweighted, so as to be easily adjustable for vertical position. The uprights can be moved back when it is desired to insert the work, by operating the hand-wheel shown at the base of the front one. The spindle of this machine is driven by a worm-gear. It has a dividing wheel of large diameter for the range of work it is intended for, it having a diameter of 57 inches, and being made in two parts, by the method which generates each wheel anew, rather than making it a copy of a previously made master wheel. Eight changes of feed are provided, varying from .010 to 0.42 inch per revolution of the cutter. This machine is also built in two smaller sizes; the size shown will cut gears up to 78 inches in diameter.

The machine shown in Fig. 27 is built by J. Parkinson & Son, Shipley, England. This machine cuts gears up to 48 inches in diameter by 10 inches face. The cutter spindle is driven by a worm and worm-gear, and has four changes of speed obtained by a sliding quick change gear arrangement, instead of by the usual removable gears. The dividing mechanism is driven by friction, and has a device which starts and stops it gradually to avoid shock. The gradual starting and stopping is done by the interposition of a pair of elliptical gears which gradually increase the rapidity of the indexing movement when it is started, and retard it in the same way as it is being completed. Provision is made also for preventing the feeding of the cutter into the work if a wrong division takes place. By means of suitably arranged connections, provision is made for multiple indexing, which is often resorted to, to avoid local heating. In cutting a gear having 47 teeth, for instance, every fourth tooth may be cut continuously, until the gear is completed. In this way, the heat due to cutting

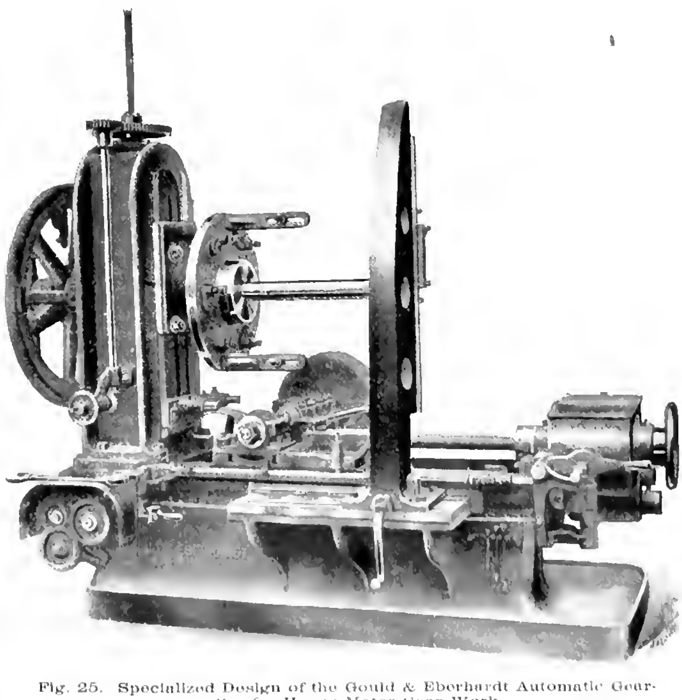


Fig. 25. Specialized Design of the Gould & Eberhardt Automatic Gear-cutter for Heavy Motor Gear Work.

* Associate Editor of MACHINERY.

is distributed more uniformly around the rim, avoiding the distortion due to local heating, which is liable to occur when teeth are cut in regular order. This multiple indexing is obtained without requiring the change gears to be specially calculated for it.

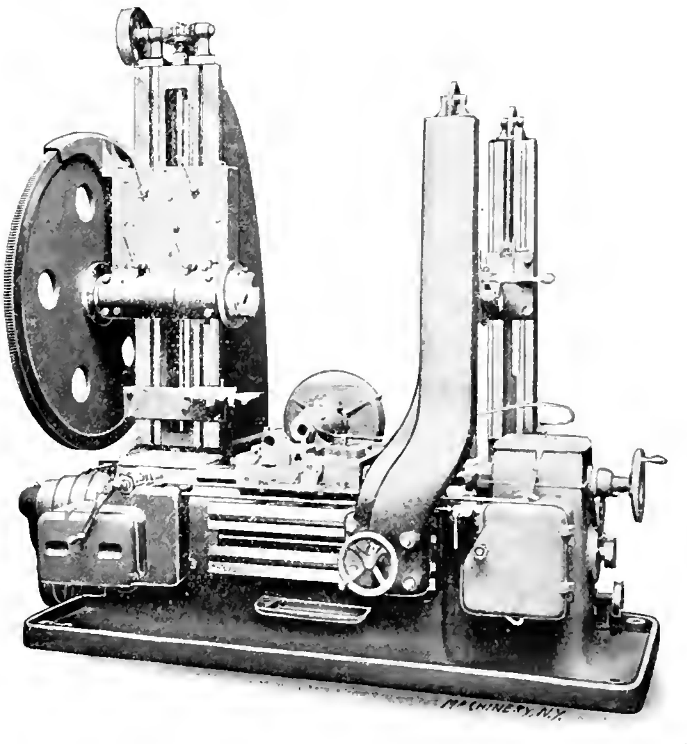


Fig. 26. The Largest Size of the Line built by Ludwig Loewe & Co.

A gear-cutter made by J. E. Reinecker, of Chemnitz-Gablenz, Germany, is shown in Fig. 28. The index wheel of this machine is of large diameter, about 7/10 of that of the largest gear that can be cut. The mechanism controlling the movements of the machine is so arranged that the forward feed does not commence until the indexing has been completed, the cutter slide being retained in its rearward position until that

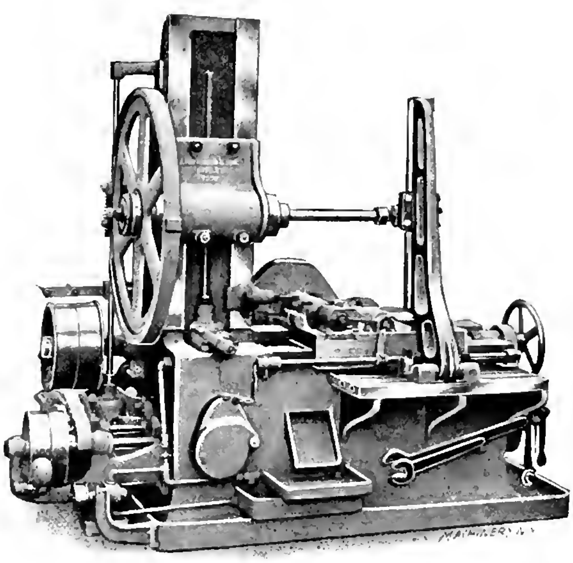


Fig. 27. An Example of English Design, built by J. Parkinson & Son.

time, thus avoiding the possibility of damage to the machine or work from failure of the mechanism to operate properly. An unusual feature of the machine, seen in the view shown, is the spindle drive gearing. The spindle is driven by a worm. This is not of the ordinary type, with a hole through its center, splined to be driven by the longitudinal driving shaft on which it slides as the table is fed forward or back; instead, a long worm is used, fixed longitudinally, and threaded for a sufficient length to accommodate the worm-wheel throughout the full travel of the slide. It will also be observed that the outboard support for the work arbor is hinged to facilitate the insertion and removal of the work.

A gear-cutter built by Messrs. G. Wilkinson & Son, of Keighley, England, is shown in Fig. 29. This is essentially the same in principle as the previous machines described, but it has an entirely different appearance, due to the fact that the bed is set on legs, instead of extending down to a solid bearing on the floor. The controlling mechanism is also somewhat differently arranged, although the movements required are the same. It will be seen that it is intended for comparatively small work. It takes wheels up to 18 inches in diameter and 6 diametral pitch. The cutter spindle is driven by a spur gear of large diameter.

Conventional Type of Automatic Formed Cutter Machine for Heavy Work.

The machines we have just been describing are representative of the standard form of automatic machine for small and

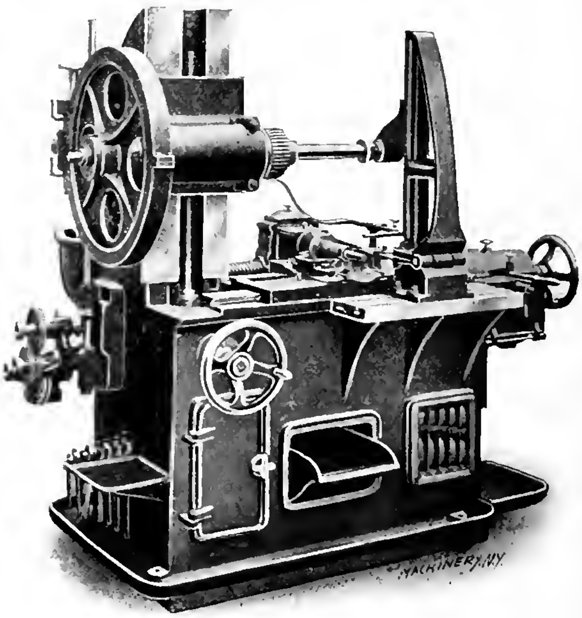


Fig. 28. The Reinecker Automatic Spur Gear Cutting Machine.

medium work. Considerations of ease of handling the work and convenience in arranging the mechanism, have evolved a somewhat different form of machine for the largest and heaviest work. The change made may best be described by saying that the previous type of machine is laid down on the back of its column, with the bed extending vertically upward into

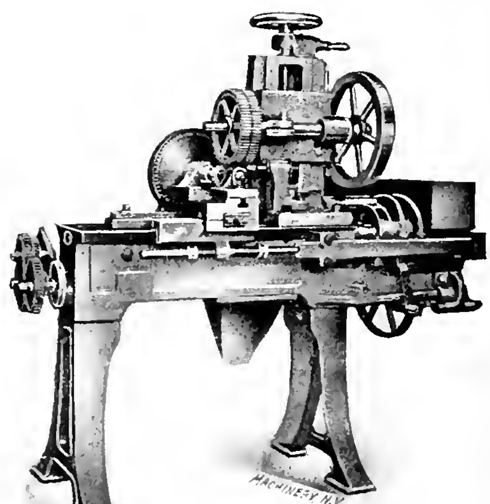


Fig. 29. The Wilkinson Automatic Machine for Small Gears.

the air. In other words, the change is simply a change of base. The bed becomes the column, and the column becomes the bed. This explanation will be easily understood by comparing the machines shown in Figs. 33 to 36 with those in Figs. 21 to 28. The principal advantage due to the change

of base in this machine is the better support given to heavy work, the weight of which is carried directly by the bearing of the slide on the bed, instead of being taken by the elevating screw in the column, as in the design previously discussed.

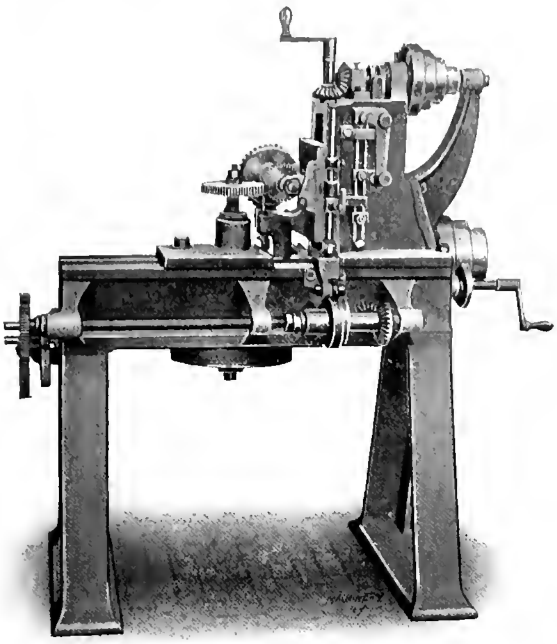


Fig. 30. A Small Armstrong Whitworth Automatic Machine.

Although it was stated that this design was especially adapted for heavy work, the first three machines here shown of this kind are comparatively small. That shown in Fig. 30 is built by Sir W. G. Armstrong Whitworth & Co., Manchester, England. The machine is very simple in design and ruggedly

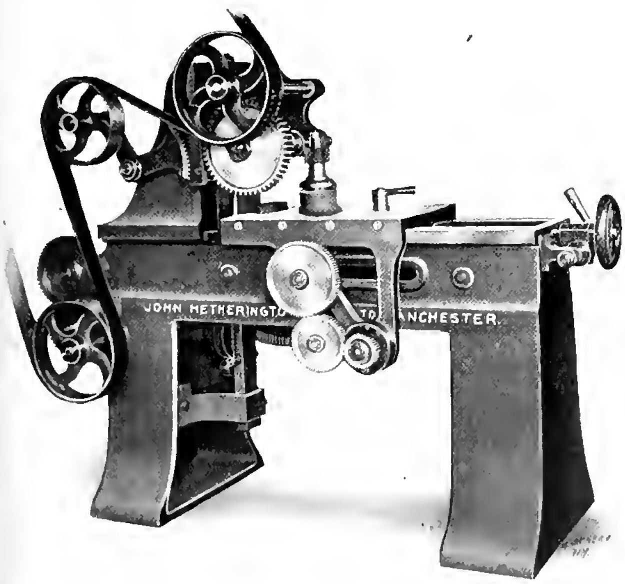


Fig. 31. A Simple Machine with Cam-operated Feed, built by John Hetherington & Sons.

built. The slow downward feed and quick return is obtained by epicyclic gearing in the feed cone at the top of the column. The clutches controlling this mechanism are operated by stops on the side of the column operated by the slide. The indexing mechanism is of the frictional type set by change gears for the required number of cuts.

The gear-cutting machine shown in Fig. 31 is built by John Hetherington & Sons, Ltd., of Manchester, England. A number of interesting points are evident from the cut. For instance, as may be seen, the vertical feed of the cutter slide on the face of the column is effected by a cam under the base, at the end of the horizontal bearing in the rear leg. This cam, and the roller and slide which it operates, are plainly visible beneath the machine. The slide is counterweighted to keep the roll always pressed up against the cam. Another ingenious detail of the mechanism is the belt tightener provided, which compensates for the change in position of the cutter slide. The belt is passed over an idler fastened to one end of a bell crank, whose other arm has teeth engaging a rack on the cutter slide. As the slide descends, requiring more belt, the idler moves toward the right, furnishing the required amount. The same belt drives both the spindle mechanism and the feed mechanism. The index worm and wheel are beneath the table. A quick withdrawing motion operated by an eccentric lever is provided for bringing the spindle back from the cutter when it is desired to remove or replace work on the arbor; this can be operated without disturbing the setting for depth of cut. This machine will cut gears up to 30 inches in diameter, 4 inches face and 4 diametral pitch. The proper change gears for varying the feed and indexing are furnished with the machine.

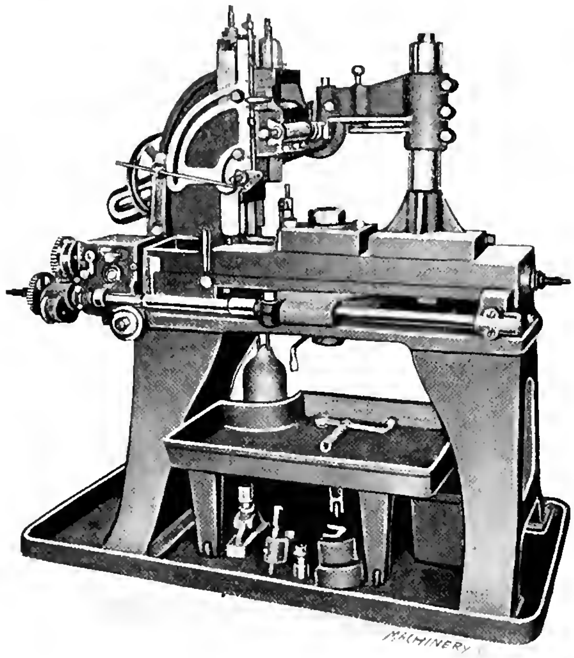


Fig 32. The Whiton Automatic Gear-cutter.

An American machine of the same structural type, built by D. E. Whiton Machine Co., New London, Conn., is shown in Fig. 32. It is fully automatic, and one of the features of its mechanism is a provision for making the starting of each movement dependent on the successful completion of the previous one. That is to say, the mechanism is so arranged that

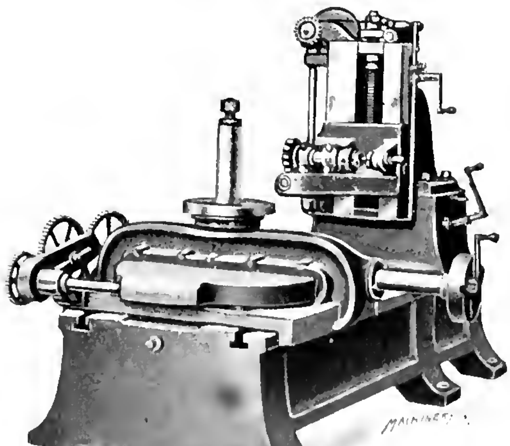


Fig. 33. Heavy Armstrong Whitworth Gear-cutting Machine.

the reverse feed is locked until the forward feed has been completed, the indexing is locked until the reverse has been properly indexed. There are no frictional devices, and but one stop adjustment—that for length of stroke, which also releases the indexing device. Unlike other machines of this type to be described, this one is arranged for cutting bevel

gears as well, the cutter slide being mounted on an adjustable sector which may be set to the cutting angle of the bevel gear which is to be milled.*

The first of the heavier machines here shown in Fig. 33 is another built by Sir W. G. Armstrong Whitworth & Co., of Manchester, England. In this machine the index wheel is carried above the bed, while a second bearing for the work spindle is provided by the arm which springs from the work slide on either side, and spans the index wheel. This brings the top of the base rather low, so the column is carried on an upward extension of the bed, giving the whole structure a distinctive appearance. The change gears for indexing are mounted on the slide, and carried with it when adjustment is made for diameter. In this machine the indexing is either automatic or hand, as may be thought best. There is less gain in automatic indexing in very heavy work than in the medium size, since the time of feeding is proportionately longer, while the large machine should have at least as much attention as is required for indexing. The cutter head of this machine can be set on an angle if desired, for gashing worm-wheels. The cutter spindle is supported at the outer end by a bearing and is driven by a coarse lead worm-gear. The machine is adapted to the cutting of wheels from 12 to 96 inches in diameter, up to 14 inches face.

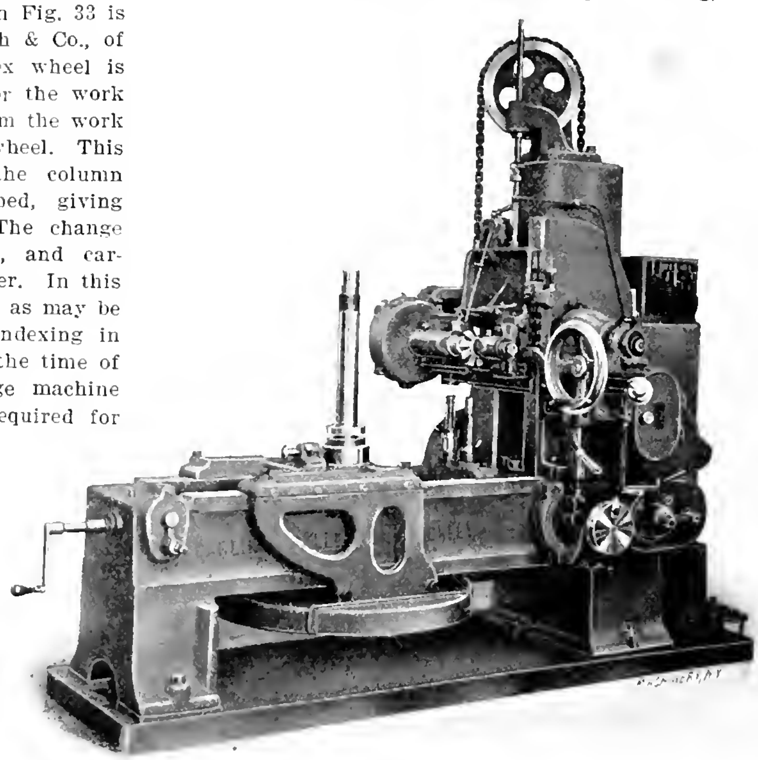


Fig. 35. The Darling & Sellers 4-foot Automatic Spur Gear Cutting Machine.

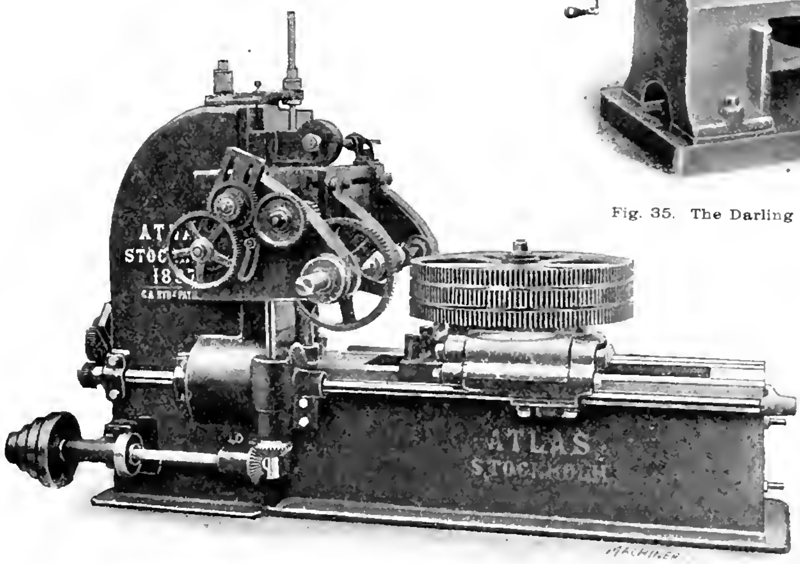


Fig. 34. An Example of Swedish Design—The Atlas Machine, as arranged for Cutting Spur Gears.

The machine shown in Fig. 34, built by Nya Aktiebolaget Atlas, Stockholm, Sweden, is shown cutting a stack of large spur gears. It is in reality, however, a universal machine, being adapted to making spiral and worm-gears as well as spur gears, so that it has mechanism in addition to that needed for cutting spur gears only, as may be seen from the cut. The heavy cross rail and the change gearing mounted on it are part of the mechanism required for hobbing worm-wheels. Its action as a spur gear machine is automatic and similar to that of the machines previously described. Like the Armstrong machine in Fig. 33, it has the index wheel above the bed. The machine will cut gears up to about 8 feet in diameter. Other applications of this tool will be described later.

The machine shown in Fig. 35, built by Darling & Sellers, Keighley, England, has the index wheel carried below the bed with the work spindle passing up through it. It will also be noted that the work carriage encircles the bed, having bearings on its sides, as well as being gibbed at top and bottom. The cutter spindle is driven by spiral gearing, and the head is counterbalanced. The spindle is hardened and carried in a long taper bearing, which is carefully ground to fit. The endwise adjustment for centering the cutter is effected by moving the main spindle bearing bodily to the left or right. A permanent gage is attached to the cutter slide which can be instantly lowered to test the centering of the cutter. A novel feature of this gear-cutting machine is the way in which the quick return of the cutter slide is effected by the excess weight of the counterbalance, which returns the slide immediately to its upper position when the feed is released, stopping against an air cushion. The feed change is accomplished by

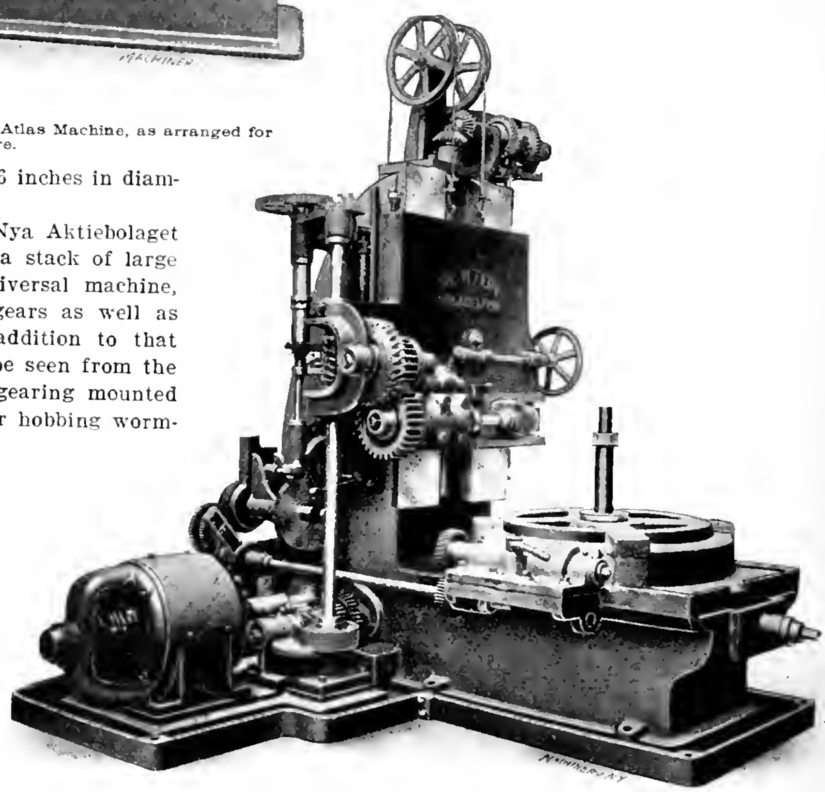


Fig. 36. A Newton Machine, especially designed for the Cutting of Heavy Motor Gears and Pinions.

* See article entitled "A New Automatic Gear Cutter" in the January, 1898, issue of MACHINERY.

change gearing. The indexing device is of the friction type, but so interlocked with the feeding mechanism as to prevent the feeding of the cutter before the indexing has been completed. A larger size of this machine is provided with a clamping arrangement which firmly holds the rim of the work while the cut is being taken. This works automatically; a friction drive acting through a screw presses it down onto the work, while a positive clutch raises it again. The machine shown in the cut has a feed of 16 inches and will swing a 4-foot gear. The whole design of the machine is unusually interesting and attractive.

In Fig. 36 is shown an automatic gear-cutting machine built by the Newton Machine Tool Works, Philadelphia, Pa. This is intended especially for the cutting of heavy gears made of high carbon steel, such as are used in motor gears for electric cars, locomotives, etc., with the expectation of cutting two or three teeth at once. The massive proportions of the machine give evidence of the duty for which it is intended. It is provided with a mechanism which renders it impossible to engage the downward feed until the dividing has been successfully completed for the next tooth. The machine shown is directly motor-driven, the spindle being connected to the motor through a train of spur, spiral, and worm-gearing. The indexing worm-wheel is mounted above the slide, as may be seen.

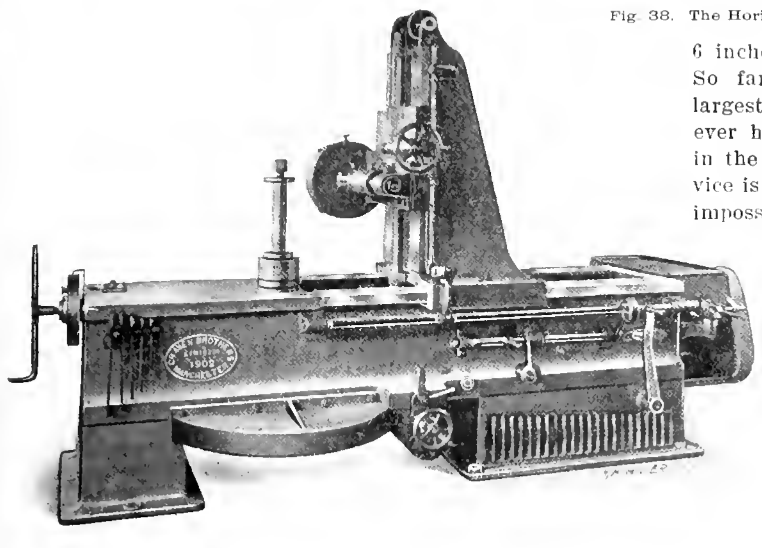


Fig. 37. The Craven Automatic Gear-cutting Machine.

Machines for Heavy Work with Column Adjustable for Diameter.

A common modification of this type of machine consists in making the column carrying the cutter slide adjustable on the bed to suit the diameter of the work, instead of adjusting the work spindle. A machine thus arranged, built by the Newton Machine Tool Works, has been illustrated in these columns.* It is not automatic, however, since it requires that the indexing be done by hand.

An automatic machine of this type is shown in Fig. 37. This tool is built by Craven Bros., Ltd., Manchester, England. The spindle head is counterbalanced, and is provided with four feeds which may be changed by the quick change mechanism seen at the front of the machine. The cutter spindle is driven by a quick feed worm and gun-metal worm-wheel. The outer end is supported in an adjustable bearing. The dividing mechanism can be operated either by hand or power. The design is a neat one and shows evidence of careful planning.

The adjustable column machine shown in Fig. 38 is built by Gould & Eberhardt, of Newark, N. J. This is the 15 foot size of a line of three, of which the largest will cut, entirely automatically, gears up to 20 feet in diameter, 36 inches face and 6 inches circular pitch in cast iron, or 4½ inches in steel.* So far as the writer knows, this latter machine is the largest entirely automatic spur gear cutting machine that has ever been built. There are a number of interesting features in the design and construction of this machine. A safety device is incorporated in the indexing mechanism which makes it impossible for the cutter to feed downward before the indexing has been successfully completed. An auxiliary cutter spindle (shown in place in the machine) is provided for finer pitch, small diameter cutters. When the heaviest work is being done, this small spindle and the boxes which support it are removed. The column has rapid power adjustment on the bed with fine hand adjustment for the final setting. This line of machines has been largely used in cutting cast iron and steel gears which had formerly been made with

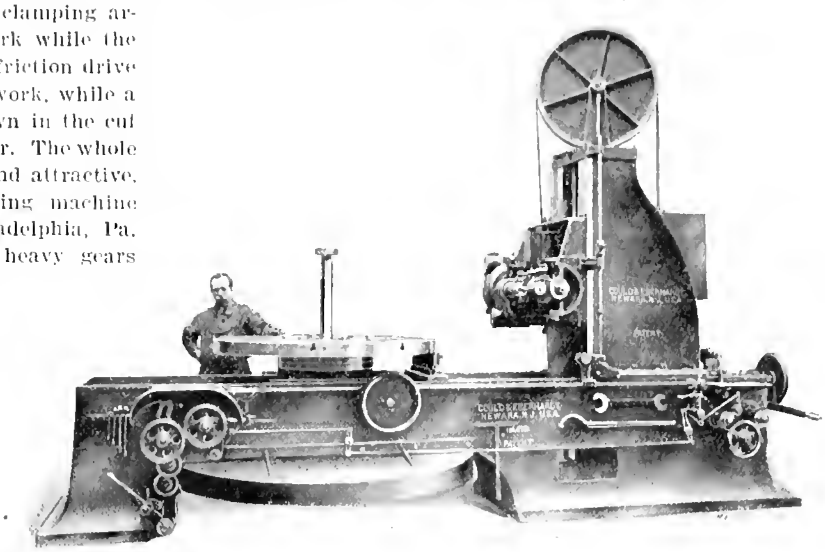


Fig. 38. The Horizontal Type of Gear-cutter, as built by Gould & Eberhardt.

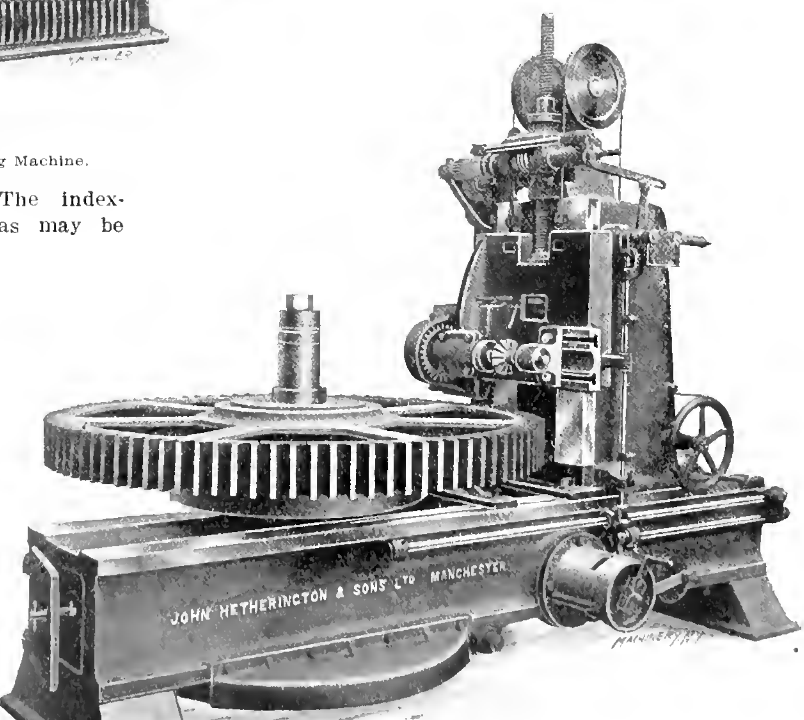


Fig. 39. The Hetherington Automatic Gear-cutting Machine.

* See article entitled "American Gear Cutting Machinery" in the June, 1898, issue of MACHINERY.

* Described in "New Tools of the Month" section of MACHINERY, February, 1901.

cast teeth, giving very much better gears at an expense not much greater than was required with those with cast teeth.

In Fig. 39 is shown a machine of the adjustable column type built by John Hetherington & Sons, Ltd., of Manchester, England. This is a large capacity machine being fitted for cutting gears up to 8 feet in diameter, 16 inches face and 1 diametral pitch. The dividing mechanism may be operated

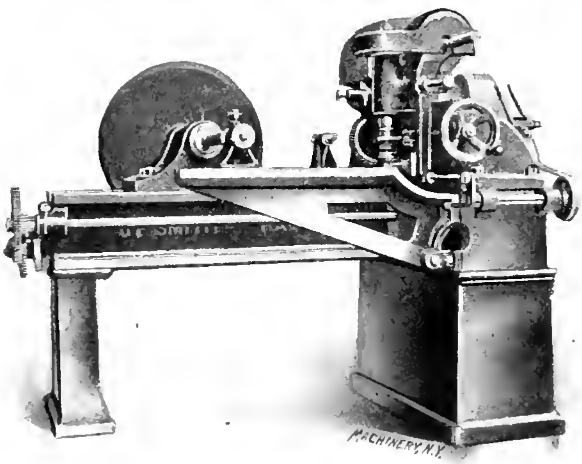


Fig. 40. An Example of Machine with L-shaped Bed, as made by G. F. Smith, Ltd.

either automatically or by hand. In the former case it is effected by means of a ratchet mechanism operated by a crank which starts the movement gradually and stops it in the same way without shock and without danger of over-running. The spindle is driven by worm and spur gears from a 3-step cone pulley for a wide belt of high velocity. The worm-gear is gun metal, and the worm of steel.

Spur Gear Cutting Machines, with L-shaped Bed.

As the machines we have been describing for heavy work were evolved from the orthodox gear-cutter by the expedient of laying that machine on its back and transforming the base into the column and *vice versa*, so a third type, occasionally met with, has resulted from laying the orthodox machine on its side, producing a bed having an L-shape. The Pratt & Whitney gear-cutting machine was an example of this. This is familiar to most mechanics engaged in gear-cutting, as there are many of them in use in various shops in this country for cutting spur gears and hobbing worm-wheels. The builders have discontinued making the machine, however, so we do not show it here.*

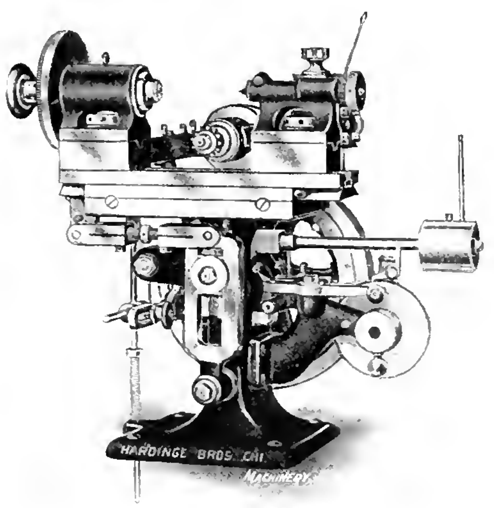


Fig. 41 The Hardinge Automatic Precision Gear-cutter.

Fig. 40 is an example of this type. Here is shown an automatic gear-cutter built by G. F. Smith, Ltd., of Halifax, England. As may be seen, one branch of the L furnishes ways on which the horizontal work spindle is adjusted to set the machine for the proper diameter of work. The other portion of the bed furnishes ways for the slide carrying the vertical cutter spindle. This cutter spindle is driven by spiral and worm-gearing from a counter-shaft cone. The indexing worm on the dividing wheel shaft is adjustable in the center to take up wear. All changes of feed and indexing are by positive gearing. An outboard support for the work spindle is plainly shown in the cut attached to the outer end of the cutter portion of the bed.

Another example of this type of machine, though arranged with adjustments permitting the cutting of bevel gears, is that built by Messrs. G. Wilkinson & Son, Keighley, England; it will be shown in a succeeding installment of this article.

Precision Machines using the Formed Cutter.

The machines we have described are suited for the cutting of gears ranging from those used in machinery of ordinary size, up to the largest and heaviest built. There has been a development along somewhat different lines, in machines for cutting teeth in minute pinions and gear blanks, such as are used in watches, fine instruments, etc. Some of these small machines cost as much as, or more than, larger ones for ordinary work. This is due in part perhaps to their complexity, but more to the accurate fitting necessary. An amount of looseness which would be just sufficient to provide oil space in the spindle of a large automatic gear-cutting machine, would give so loose a fit to the spindle of one of these minute mechanisms as to make it totally unfit for the work it has to do. Where the thickness of the teeth of the gear being cut is a matter of a few thousandths only, the required accuracy in the fitting of the spindle, slides, etc., must be expressed in tens of thousandths or even hundreds of thousandths of an

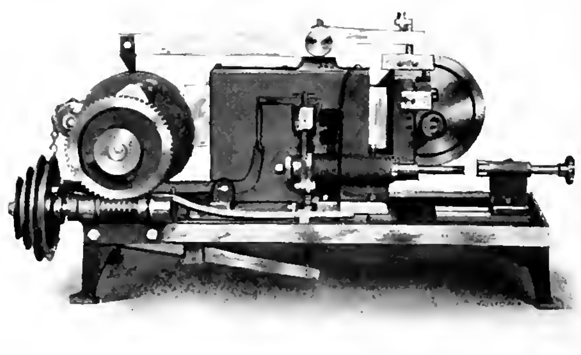


Fig. 42. The Standard Mfg. Co.'s Automatic Precision Gear-cutter.

inch. Even though a high degree of accuracy in fitting is obtained in these machines, it is still found necessary in some cases to take two or three and sometimes more cuts through each tooth space, in order to make sure that the desired outline is obtained. In one of the machines shown, provision has been made for this.

In Fig. 41 is shown a precision gear-cutting machine built by Hardinge Bros., 1036 Lincoln Ave., Chicago, Ill., it will be seen to follow somewhat in its mechanism the Slate, and Sloan & Chace machines, shown in Figs. 18 and 19, being derived in form from the ordinary or column type for milling machines, though greatly reduced in size. In adjusting for diameter, however, the cutter spindle is moved up or down by swinging about its fulcrum, the arm on which it is carried; the table or slide carrying the work head-stock and foot-stock is not adjustable vertically for this purpose. The feeding and indexing movements are effected by a cam shaft driven by the large wheel shown at the back of the machine. The feeding is governed by the slotted link mechanism at the front, connected by the adjustable reach rod shown with the bracket extending downward from the work table, beneath the dividing head. Index plates are used instead of the index worm-wheel common in larger machines. Separate disks are used for locating the spindle and locking it in position after the indexing, the disk for the latter purpose being covered to prevent accidental injury. An arrangement is provided by which the cutter is lowered from the cut on the backward movement to prevent injuring the finished tooth space, and to allow the indexing to take place without loss of time. The ratchet wheel shown below the machine at the right is indexed

* See article entitled "American Gear-Cutting Machinery" in the June, 1898, issue of MACHINERY.

a step for each tooth cut in the work, and may be set to lower the cutter out of the work and stop the feeding mechanism when all the teeth have been cut. The cutter spindle still runs, however, and the indexing still proceeds, so that the working parts are constantly kept at the working temperature.

In Fig. 42 is shown a precision gear-cutter made by the Standard Mfg. Co., of Bridgeport, Conn.* This machine

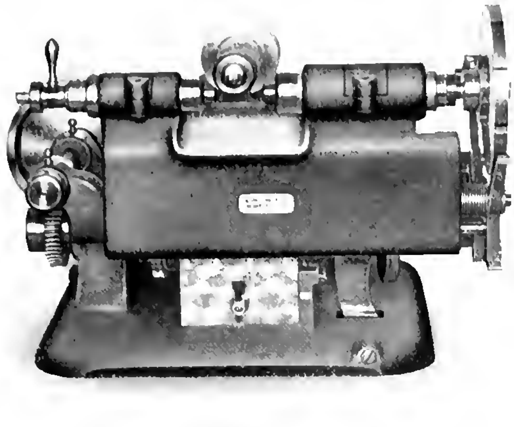


Fig. 43. The Sloan & Chace Automatic Precision Pinion-cutter, arranged for taking Three Cuts through Each Tooth.

has the indexing and feeding mechanisms operated by a cam shaft driven by the worm and worm-wheel shown at the left of the machine. It will cut gears up to 4 inches in diameter in stacks 2 inches long. As in the previous machine, the cutter is raised out of the work while the blank is being indexed and the feed is being returned to commence the next stroke. Two speeds are provided for the cutter spindle, and nine feeds. The cutter works ninety per cent of the time, the indexing and returning movements being very rapid. Both the work and cutter spindles have tapered bearings which can be compensated for wear.

The machine shown in Fig. 43, built by the Sloan & Chace Mfg. Co., Newark, N. J.,† is built on the same general plan as the previous machines so far as concerns the use of dial plates for indexing, and cams for performing the various movements. This machine, however, can be arranged to carry three cutters on the spindle, if desired. The first cutter is used for roughing, the work being indexed clear around for that purpose. The cutter spindle is then shifted endwise to bring the second cutter central with the work, when the operation is continued as before. The spindle is then shifted a

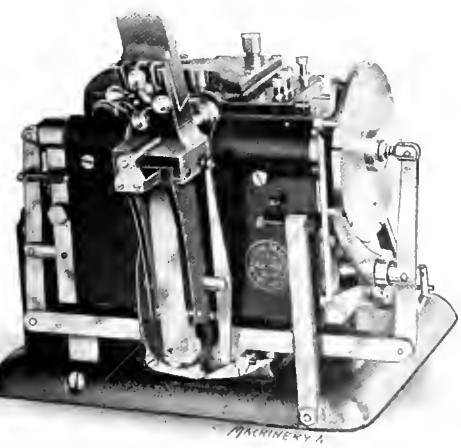


Fig. 44. The Waltham Automatic Pinion-cutter, with Magazine and Self-feeding Mechanism

second time to bring the third or finishing cutter into position for operation, whereupon the work is completed. This little machine is ingeniously arranged to allow all three of the settings, the roughing, secondary and finishing, to be separately adjusted for centering the cutter and depth of cut. All the movements are entirely automatic. The machine is essentially a pinion-cutter rather than a gear-cutter, as it is best adapted for gears having comparatively few teeth.

The automatic pinion-cutter shown in Fig. 44 is made by the Waltham Machine Works of Waltham, Mass. In this machine the automatic principle has been developed to a high degree, in that the machine feeds itself and takes out the work as well, after it is completed. The long slide seen extending upward from in front of the cutter is a magazine in which pinion blanks are placed. This magazine is brought in line with spindles of the head- and foot-stock, which (by the action of the cams by which they are controlled) grasp the shanks of the blank and hold it firmly in position to be cut. The cutting and indexing then proceed as in previous machines. When the indexing has been completed, the hold of the chucks on the work is released, and the work ejected. This operation is continuous as long as the cutter stays sharp and the magazine is kept full.

The Formed Tool Principle applied to the Grinding or Abrasion Process.

The only representative of this process, so far as we know, is the machine shown in Fig. 45. This tool, built by Upton & Gilman, Lowell, Mass.,* is intended primarily for smoothing up teeth of cast gears, so perhaps it does not really belong in the category of gear-cutting machines; as the only representative of its class, however, we have included it. The grinding wheel is formed to the shape of the tooth space of the gear to be finished. The gear is mounted on the vertical

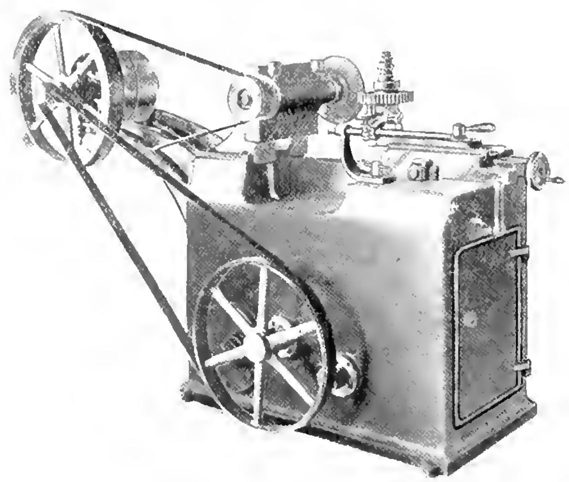


Fig. 45. The Upton & Gilman Machine for Finishing the Teeth of Cast Gears by grinding with a Formed Wheel.

spindle shown. When the machine is in operation the emery wheel is brought down through the tooth space, cleaning it out, and is then withdrawn. The work is indexed, and the operation is repeated. Owing to the fact that the shape of the space and the shape of the wheel are the same, the latter tends to preserve its form, being used merely to remove irregularities in otherwise perfectly shaped surfaces.

The Templet Principle applied to Cutting the Teeth of Spur Gears.

The templet principle is practically limited, in the cutting of spur gears at least, to the shaping or planing process. It has been used principally for large gears having teeth of very coarse pitch, too large to be formed by a formed tool or cutter covering the whole outline. It has the advantage over the formed cutter process of being comparatively simple in operation and adapted to special work at a minimum of expense, it being considerably cheaper to make a templet than to make a formed and relieved cutter of the same size.

Fig. 46 shows a templet spur gear planing machine built by the Gleason Works, Rochester, N. Y. In this tool the work spindle is horizontal, a pit being provided for gears of large diameter. The capacity of the machine is very great, it being adapted to cutting teeth in blanks up to 20 feet in diameter. The cutting tool is mounted in a traveling head at the right side of the machine. This traveling head is driven by a screw controlled by open and crossed belts and shifting mechanism similar to that used for a planer. The scale of

* See "New Machinery and Tools" section of MACHINERY, May, 1907.
† See article entitled "Making Small Relieved Gear Cutters in the Sloan & Chace Shops," January 1907, issues of MACHINERY.

* Described in "New Machinery and Tools" section of MACHINERY, January, 1907.

the engraving is too small to show the templet mechanism clearly, but it is identical in principle with that illustrated in Fig. 2, in the first installment of this article. For varying the diameter adjustment to suit the blank being operated on, the head-stock carrying the work spindle is moved toward or away from the tool slide. The machine shown is motor driven.

Another remarkable example of templet machine for spur gears is shown in Fig. 47. In this case the tool is a modified slotter instead of being a modified Richards planer as in Fig. 46. The column part of this tool is, in fact, practically the portable slotter built by its makers, the Newton Machine

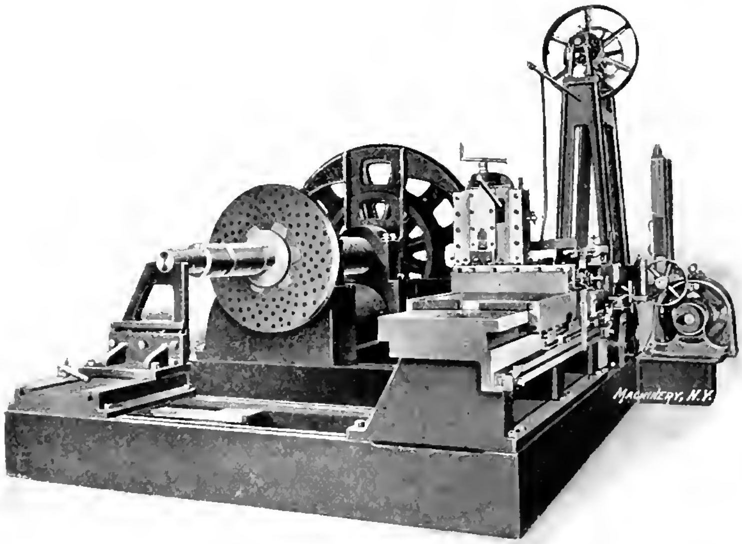


Fig. 46. The Gleason Templet Spur Gear Planer.

Tool Works, Philadelphia, Pa.* It is mounted on a long base plate and may be set at any desired position thereon to agree with the diameter of the gear being cut. The work is supported on a rotating table which is indexed by a worm and worm-wheel operated through change gears by a separate electric motor provided for that purpose. The head may be moved back far enough to swing the work 40 feet in diameter. The templets for shaping the tooth outline are mounted in brackets on the tool head on either side of the tool-post of the portable shaper. The tool-post is pressed toward the right- or left-hand former by a spring, as may be required, and as it is fed outward by the feeding mechanism provided, it is thus shifted sidewise in such a fashion as to reproduce the outline of the templet on the teeth of the gear.

The next installment will describe the various machines and methods used for cutting spur gears by the molding generating process.

* * *

NOTES ON CASE-HARDENING.

The following notes on case-hardening are from papers presented before the International Railway Master Blacksmiths' Association.

The method of case-hardening practiced at the shops of the Cincinnati, New Orleans & Texas Pacific Railroad, at Ludlow, Kentucky, was described by Mr. George Masser. The case-hardening compound used at the Ludlow shops is made by mixing 100 pounds prussiate of potash, and 50 pounds bichromate of potash, with one barrel of salt. The potash is pulverized before it is mixed with the salt. The pieces to be hardened are packed in a cast iron box of suitable size, in such a way that each piece will be covered with a sufficient quantity of potash when it is dissolved. The edges of the box lid are luted with fire clay, to make the box as air-tight as possible. The box is then placed in a furnace, where it is allowed to remain eight or ten hours, the length of time depending somewhat upon the sizes of the pieces being hardened. The pieces are cooled in a cooling tub, which is 6 feet long, 26 inches deep, and 28 inches wide. On the inside of this tub there is a screen which is made of heavy wire netting, such as is used in the front end of a locomotive. This screen is about 4 inches from the bottom of the tub, so that the cold water can circulate freely around the pieces being cooled. It is supported by angle-irons which are fastened to the sides of the tub. The screen has a bail at each end, to facilitate handling. The pieces when taken from the cooling tub, should be clean and white; if they are spotted it is an indication that the furnace was not kept at a uniform temperature.

In a paper presented by Mr. J. J. Ryan, some additional information was given on the subject of case-hardening. He has attained good results with a compound consisting of a mixture of carbonated bone black and salt. The pieces are packed in a cast iron box, which has a close fitting lid which can be bolted into place. All the joints of the box are sealed with clay, so

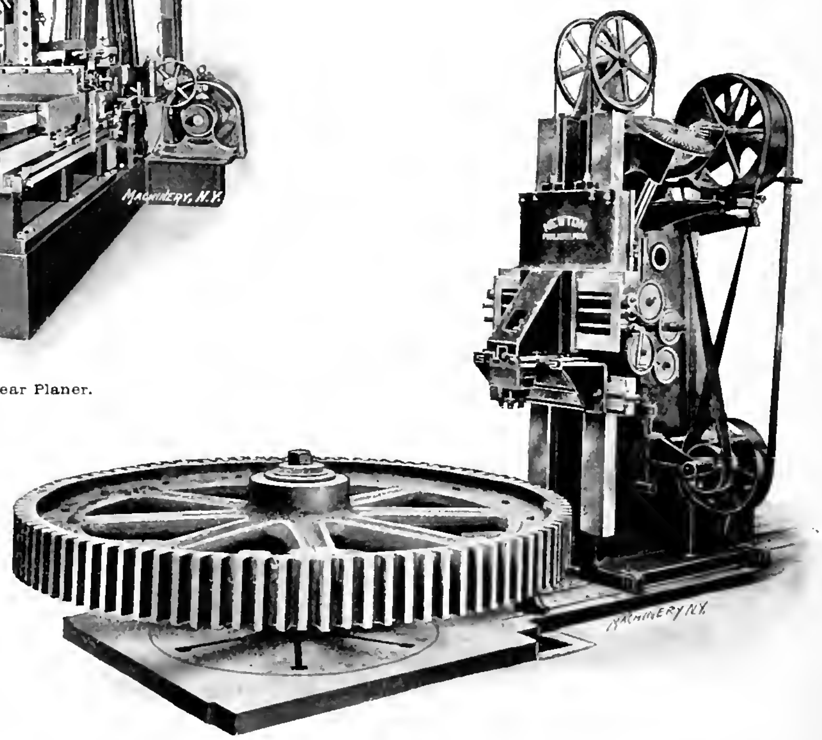


Fig. 47. The Newton Portable Slotter, arranged with Templet Mechanism and Indexing Base for Cutting Spur Gears.

that it will be practically air-tight. The box is kept in a furnace from twelve to fourteen hours, and a special effort is made to keep the furnace at an even temperature during that time, as any great fluctuation in the temperature has a tendency to make the material brittle. A temperature of 1,350 degrees F. is considered maximum. The cooling tub is provided with a water inlet at the bottom, and an overflow at the top, so that the water will be kept cool. All pieces such as links and quadrants should be let down into the water edgewise, to avoid springing them.

Mr. R. A. Mould, master blacksmith at the Omaha shops of the Union Pacific Railroad, made some comments on the subject which will be found of value and interest. Mr. Mould believes that the first thing to be considered in connection with case-hardening, is hardness; and the second, the condition of the material after the process of heating and cooling has taken place. The best results are not always obtained by hardening the pieces to the greatest possible depth. If a depth of 1/16 inch is sufficient to meet all requirements, nothing is gained by hardening to a greater depth. The length of time that it is necessary to keep the work in the furnace will depend upon the class of the work, and upon the depth required for the hardened part. The furnace should be so constructed that a uniform temperature can be maintained, and Mr. Mould believes that an underfeed oil furnace will give the best results, as the degree of heat can be more easily regulated.

* See article entitled "Spur Gear Planer" in the November, 1902, issue of MACHINERY.

THE MANUFACTURE OF SMALL STEAM TURBINES.

K. G. SMITH.*

K. G. Smith †

Owing to the widespread interest in the steam turbine at the present time, the writer believes that a short article describing some of the constructive features of small sized turbines would be of interest to shopmen in general.

The Kerr steam turbine, in the manufacture of which the writer has been engaged for some time, is of the multi-stage nozzle-and-bucket type made in three sizes, ranging from 5 to 300 horse-power. The division into stages is made by cast iron partitions known as diaphragms into which are riveted the steam nozzles. The horse-power of any size of turbine is determined under a given set of conditions by the number and size of these nozzles. For this reason a turbine may be quickly changed to meet different or unexpected conditions. For example, in one turbine installation it was suddenly found necessary, after all plans were made, to run the unit non-condensing instead of condensing as originally intended, owing to the non-arrival of the condenser and the necessity of getting the plant started. A set of non-condensing nozzles was at once designed, and they were made and placed in the turbine in ten hours. The plant was then operated successfully and economically on a non-condensing basis.

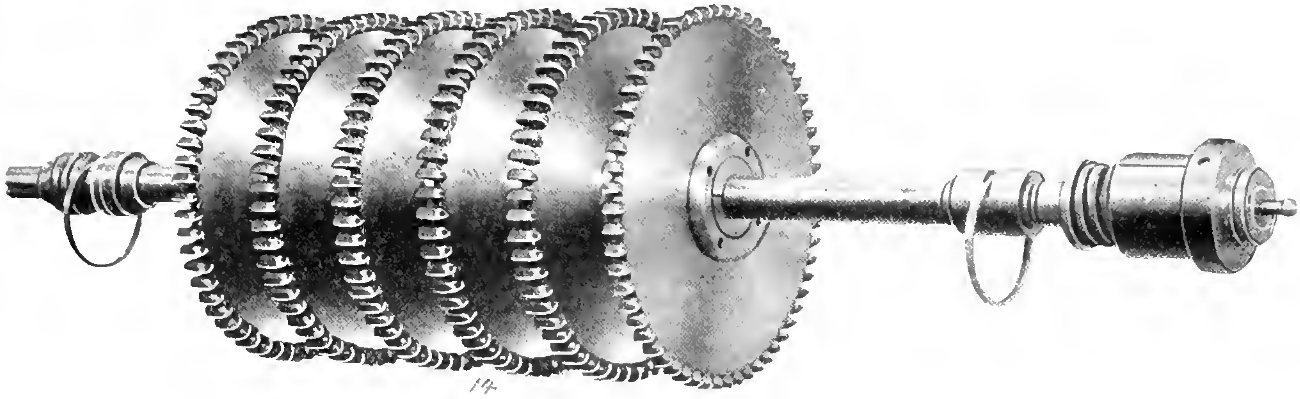


Fig. 1. Assembled Rotor of Kerr Steam Turbine.

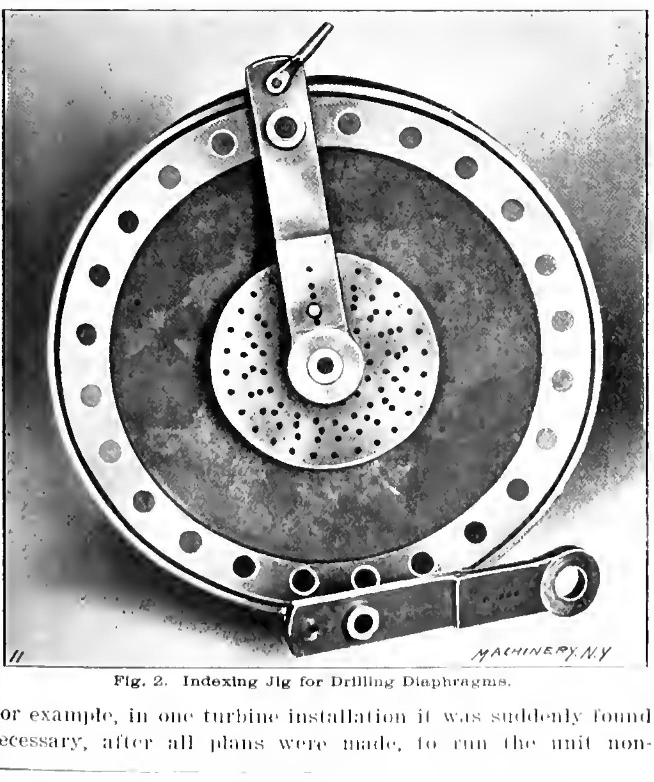


Fig. 2. Indexing Jig for Drilling Diaphragms.

Such flexibility of design necessarily entails careful thought on the part of the machine shop force to avoid an overwhelming number of jigs and special tools. Diaphragms, as shown in Fig. 1, are kept in stock ready for drilling at any time.

The jig shown in Fig. 2 will drill any required number of holes, and by changing the movable arm the drilling radius or size of hole may be varied. Two index plates like the one shown cover all the numbers of holes called for on all sizes of turbines.

To set the nozzles at the proper angle and give clearance on the buckets, a templet, Fig. 3, with a thin clearance shim is used. Once set against the templet, they are beaded in like boiler tubes with a special beading tool and pneumatic hammer. Before being set in the diaphragms, all nozzles must of course be reamed to the proper size and taper. This is done by special reamers held in the spindle of a high-speed sensitive drill, thus giving them a good clean finish on the interior surface. On the testing block all stage pressures are taken, and from the calculated pressures the accuracy of the reaming can be checked. Any marked variation from the proper pressure must be corrected. Such mistakes, however, seldom occur.

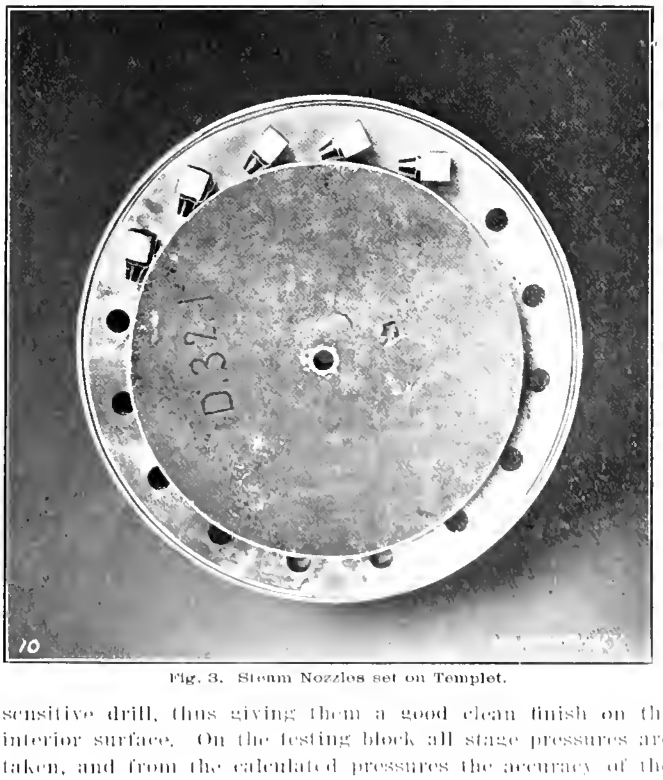


Fig. 3. Steam Nozzles set on Templet.

The most important parts of a turbine, so far as its running qualities are concerned, are the bearings and rotor. The

* Shop superintendent Kerr Steam Turbine Co., Wellsville, N. Y.

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bucket wheels, which form the main part of the rotor, Fig. 1, are of flange steel into which are set drop-forged steel buckets. The wheels are first dove-tailed in a slotting machine of special design operating like a gear cutter. The buckets are then riveted in under a heavy pneumatic riveter. So firmly are they fastened that the bucket itself will be destroyed before it can be pulled from the disk. By the use of properly formed dies the buckets are accurately aligned while being riveted.

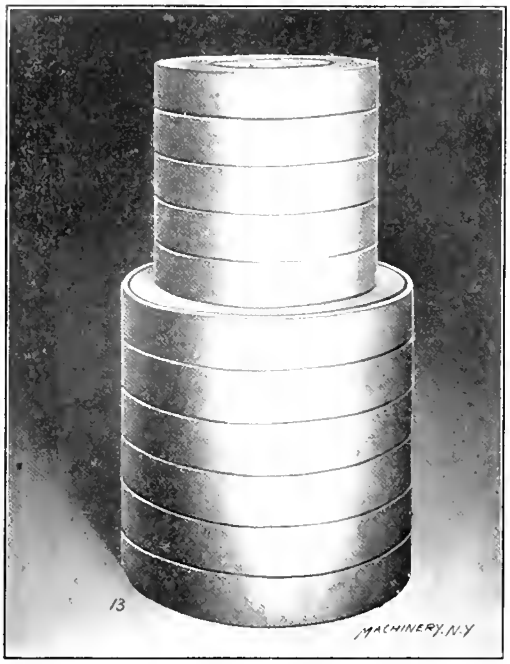


Fig. 4. Stock Diaphragms for Kerr Steam Turbines.

As is any high-speed machine, the balancing of the rotating parts is of paramount importance. For thin steel disks, like the bucket wheels, a static balance is sufficient when carefully and accurately made on a hardened mandrel rolling on hardened knife-edges. See Fig. 5. Each disk is balanced separately on its own hub, and any slight inaccuracies in individual disks tend to counterbalance each other when the whole rotor is revolving.

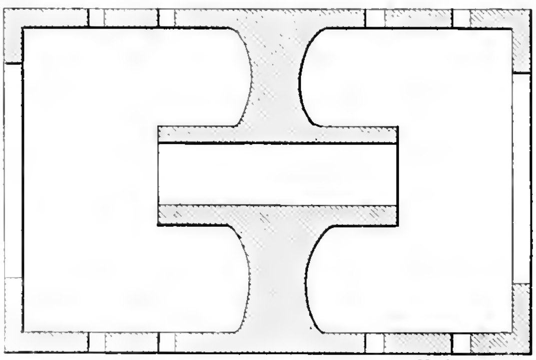


Fig. 6. Hollow Brake Pulley.

For shafts, nickel steel is used as giving the most satisfactory results. It stands heat best and is freest from internal strains. The shafts are first roughed out, and then all drilling and keywaying is done before the final cut is taken, thus insuring an absolutely true running shaft. With shaft sizes of $1\frac{1}{2}$ to $2\frac{1}{4}$ inches, the critical speeds are comparatively low, but as the turbines are never run at these speeds, the slight jar occurring when the critical speed is passed has no effect whatever.

The bearings are of bronze fitted with a special ring oiling device. For any bearing running at high speed the lubrication must be perfect; otherwise vibration will occur even if the bearing does not heat seriously. This is frequently the cause of intermittent spells of vibration in turbines and other high-speed machinery. Oil grooves large enough and numerous enough to carry a good supply of oil must be provided with the edges well chamfered, and care must be taken that the oil actually enters and circulates through the bearing so as to keep a continuous film surrounding the shaft. A well lubricated turbine bearing will last indefinitely, because, being direct connected, there is no belt pull and the bearing pressure is always light.

The testing of small turbines quickly developed a number of problems. When connected with fans, blowers, or pumps, at the shop, the unit, of course, can be tested as a whole, but for testing turbines alone a special form of Prony brake had to be devised.

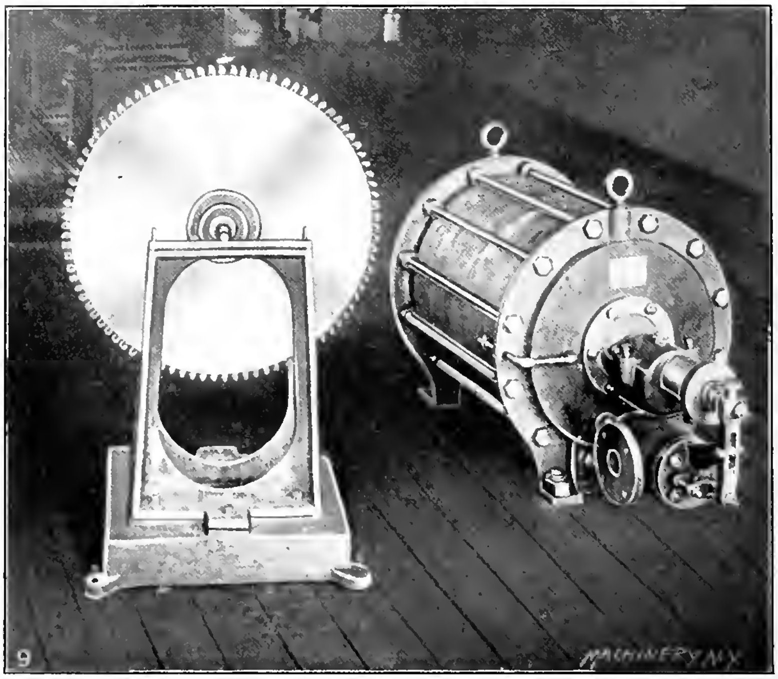


Fig. 5. Balancing Disk on Knife-edge Bearing Ways.

For high speeds and high powers the ordinary form of brake cannot be used as it heats too rapidly, causing jarring and gripping of the brake pulley. The special form of hollow pulley shown in Fig. 6 has been found to give satisfactory results at speeds of 2,400 to 3,600 R.P.M., and for 10 to 300 horse-power. Water is delivered to the interior of the hollow pulley, and is thrown out through holes in the circumference by centrifugal force. The ordinary form of smooth, solid, externally lubricated pulley will carry as high as 40 to 50 horse-power at speeds up to 3,600 R.P.M. fairly well. In using a new brake for the first time it is a good plan to run it at a high speed, for a few seconds, with no water whatever. This burns off any high spots, and puts a glaze on the surface of the wood, causing it to bear smoothly on the pulley and to wear well.

One thing I would say in conclusion as to the manufacture of turbines and high-speed machinery in general. Faulty balance, faulty alignment, imperfect bearings and other faults of construction are evident as soon as the machine goes up to speed the first time. In other words, turbines will not run for a while and slowly develop troubles the germ of which was present at the beginning. Anything apt to cause trouble

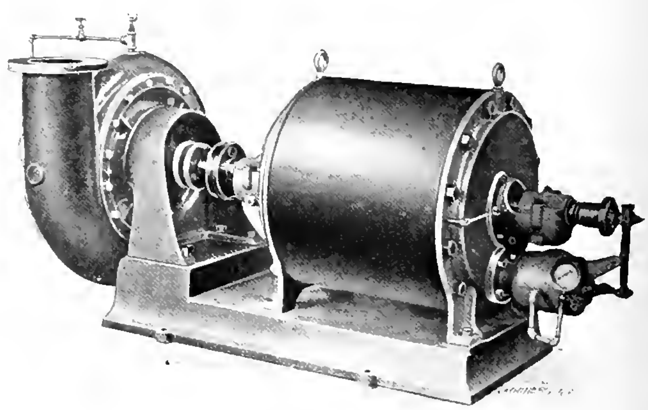


Fig. 7. Assembled Kerr Steam Turbine Unit.

will appear at once on the testing floor, where it can be remedied. A good turbine, once installed, is a thoroughly reliable and durable machine. In one foundry installation with which I am familiar, the turbine runs a fan for one hour and thirty minutes each day during the heat, requiring only the opening and closing of the throttle, and a pint of oil once a month.

* * *

BARR'S RULES FOR POWERING MACHINE TOOLS.

The following simple empirical rules compiled some time ago from the averages of many tests and observations by Mr. J. A. Barr, of the Westinghouse Electric & Mfg. Co., will be found useful in equipping machine tools with individual electric motors. The power ratings indicated for the conditions named agree, generally, with the average of shop requirements.

Lathes.—Engine lathes using one cutting tool of water-hardened steel at about 20 feet per minute:

H. P. $= 0.15\ S - 1$.

For heavy engine lathes such as forge lathes:

H. P. $= 0.234\ S - 2$.

In both engine and forge lathes $S =$ swing of lathe, in inches.

Example: Find the power required to drive a forge lathe of 48-inch swing. Then $(0.234 \times 48) - 2 = 9.23$ H. P.

Boring Mills.—For the operation of standard boring mills, using one cutting tool of water-hardened steel at approximately 20 feet per minute, the following formula will be found to represent good practice for heavy work:

H. P. $= 0.25\ S - 4$, wherein $S =$ swing of mill, in inches.

Milling Machines.—For normal milling machines, using water-hardened steel cutters running at about 20 feet per minute, the following formula will be found useful:

H. P. $= 0.3\ W$, wherein $W =$ distance between housings, in inches.

Drill Presses.—For normal drill presses, using water-hardened steel drills, running at a peripheral cutting speed of approximately 20 feet per minute the following formulas apply:

H. P. $= 0.06\ S$.

For heavy radial drill presses:

H. P. $= 0.1\ S$,

wherein $S =$ swing, in inches.

Slotters.—Normal crank slotters, using water-hardened steels at cutting speeds of from 15 to 26 feet per minute, require:

Stroke.	Horse-power
10 inches.	5
18 "	7
30 "	10

Shapers.—Shapers using water-hardened tool steels at cutting speeds of from 15 to 20 feet per minute have the following power requirements:

Stroke.	Horse-power.	Stroke.	Horse-power.
16 inches.	3	24 inches.	5
18 inches.	3½	36 inches.	6½

Planers.—For normal planers using water-hardened steel at cutting speeds of from 15 to 20 feet per minute, the power is approximately as follows:

H. P. $= 3\ W$.

where $W =$ width between housings, in feet.

For heavy forge planers:

H. P. $= 4.92\ W$.

By normal planer is meant a planer in which the length of the bed in feet is approximately two-tenths the width between the housings in inches. For example, a 48-inch planer would have a length of platen of approximately 9.6, or 10 feet.

The above formulas are for planers having a ratio of cutting to return speeds of approximately 1 to 3, and cover planers with two tools in operation. If more than two tools are used, or if the ratio between the forward and return speeds is more than 1 to 3, the horse-power given by above formula should be increased. It should be noted that where the length of bed is greater than that mentioned above the horse-power should be increased.

THE TRIBULATIONS OF AN INVENTOR.

JOHN.

A long, long time ago, when the Teddy bears roamed wild in the cities, and the rushing red devil wagons tore up and down throughout the land, there was a noted country on our planet called Yewessay. In this country, besides the high financiers, railroad presidents, and captains of industry, there was a very large number of common, ordinary people like ourselves, though one could never have guessed it from the newspapers. Among these common, ordinary people there lived quite a number of peculiar people, who mostly belonged to either one of two classes. The brains of these people were abnormally developed, or, perhaps, abnormally undeveloped; their temperament was such that they could not let well enough alone. In one class the abnormity appeared as de-structiveness. These were called lunatics. When a lunatic saw something which did not suit him, he immediately smashed it, or tried to. In the other class, the abnormity appears as con-structiveness. These were termed inventors. When an inventor saw something which did not suit him, he immediately invented something better, or tried to.

The lunatics were treated kindly and provided with food, shelter, and raiment by the government, but, though the inventors were often, yea, generally, without money, and all other modern conveniences, the government never even appointed a commission to investigate them, let alone doing anything substantial.

The great aim of every inventor, at that time, was to obtain a patent. A patent was really merely a document setting forth that, whereas the inventor had petitioned the Commissioner of Patents for a patent for an alleged new and useful improvement, and had complied with the various requirements of the law in such cases made and provided, and etc., etc., that the inventor, his heirs, or assigns should have the exclusive right to make, use, and vend the said invention throughout the land of Yewessay and the territories thereof for the term of seventeen years.

These patents were held in great reverence and awe by the poor inventors, and were believed (at least by those who never had obtained one) to be of great value—a sort of Midas' touch by which everything could be turned into gold. As a matter of fact, the patents were generally worth very little, and had it not been for the active advertising campaign carried on by certain interested parties, the inventors would soon have realized the true state of things, and the number of patents applied for each year would have been less by a great many thousand. There was a great host of patent attorneys who grew fat on the fees they obtained from the inventors for preparing their applications for patents, and the country was flooded with little books published by these men telling of how inventor Jones had made a million out of his patent everlasting steel-pointed lead pencil, how inventor Smith had made three millions on his patent airless pneumatic tire, and of how sixteen billion dollars had been offered for a cheap substitute for water, and twenty-three cents for a new car coupler.

After reading a few hundred of these little works of art (and craft), the inventor usually began to long for some of the golden dollars dangled so temptingly before his eyes, and, as it is the easiest thing in the world for an inventor to invent, the fees were soon in the hands of the attorneys, which you must admit is quite the proper place for them to be, seeing that they went to so much trouble to secure them. It seems a peculiar oversight, as we look at it now, that none of the little books drew attention to the fact that, while about fifty thousand patents were granted every year, about forty thousand did not profit the inventor at all, and, of the remaining ten thousand, but a very small proportion realized any substantial sum. Perhaps the publication of this information might have discouraged some of the inventors, and as that is the last thing any of the attorneys ever wanted to do, may be the information was accidently omitted for that reason.

Well, this little fairy story is about an inventor that lived in those good old times, in the remarkable land of Yewessay. This inventor, like most others of his kind, was poor, but he had a great idea. Every inventor in those days had a great

idea. This was the principal symptom of the malady, and, though it really did no good to treat the patient, as the malady was practically incurable, it was, then, considered good practice, since hydrotherapy had become the fashion, to use the cold water treatment. Liberal quantities of H_2O, temperature $32\frac{1}{2}$ degrees F., were applied to the great idea whenever convenient, and the wet blanket pack was frequently used. No one was ever permanently benefited by this method, though the treatment was a source of much discomfort to the patient.

But to resume, the great idea of this inventor was a method of making water run up hill. This idea was the result of much study, and much burning of the midnight gas (to the great disgust of the landlady). It was evident to all that if the inventor's claims proved true, he had indeed made a great and valuable invention, but, strange to relate, though all the friends of the inventor congratulated him on the making of such an excellent invention, not one of them would invest one single shekel to help build an experimental machine. The inventor was thus forced to go among strangers seeking the mighty dollar to develop his idea.

Many were the men he visited, and many were the opinions he received, also much experience, but no money, and the inventor was almost discouraged. At last he fell into the hands of the brokers. These, after hearing the inventor's description of his wonderful invention, said: "We must have expert advise upon this."

And many were the experts they visited, and many were the opinions they received (all different), and much advice how not to do it, but no money, and the inventor came to the conclusion that he knew more about his own invention than any of the wise experts could tell him. So also thought the brokers. Then said the brokers, "We must have the patent records searched."

And many were the attorneys they visited, and many were the flattering opinions they received, and many were the searches the attorneys made, but not one anticipating patent did they find, nor any device even remotely related to the invention.

Then said the brokers: "This is very much of a speculation, a gambler's chance; we must have a large commission for telling our friends that this is a sure, get-rick-quick, 520 per cent a year, and no-chance-of-loss investment. You must assign 66 2/3 per cent of your invention to us, and we will then find you the $713.30 you require to build your machine." (This is an exceedingly compact, abridged, and expurgated edition. A verbatim report was recorded on 33 miles of steel wire by the telegraphone, and may be found in exhibit K331,107 court records.)

The inventor was then kept busy for a long time signing assignments, sealing seals, transferring transfers, and performing other little acts necessary in the premises, not otherwise more particularly mentioned or described.

Having secured the money, the inventor then started to build his machine. In a few months it was completed, but alas! when tried it would not only not make the water run up hill, but it would not keep it from running down (and the wise experts looked very wise and smiled behind their hands). The poor inventor scarcely knew what to do. He was sure the principles were all right, but—there was the machine. For forty days and forty nights he labored over it, and at last, by changing one little thing here, and another little thing there, he managed to fix the machine so that it would at least keep the water from running down hill, and that was quite an achievement, you must admit (but the wise experts looked very wise and smiled behind their hands).

About this time the inventor had spent all of the $713.30 supplied by the brokers, and $23 besides, and what he owed made a bit beside that, and he had only one shirt and no credit, so you see he was, technically speaking, pretty hard up. At last the inventor went to the brokers again, and after talking and talking and talking (he was a good talker) again and again, he obtained $479.17 more. This was the exact amount required to finish the invention. The inventor knew that this was the right amount because he had carefully figured it out.

Well, to shorten this long story, after many moons of tedious, heart-breaking work the machine was made to run successfully, the water ran up hill (the wise experts stopped looking very wise and looked foolish instead), and the inventor bought himself a new suit of real store clothes (on credit).

During the time the invention was being perfected, the inventor, who, by the way, was a deacon in the Methodist Church, had learned a new language, which was then extensively used in intimate conversation with unruly and obstreperous, animate or inanimate objects. It was generally written, at least in print, in dots and dashes, much after the fashion of the Morse code, thus, "Oh ——— ——— the ——. ——— — — to — —— —— what in ——— is the next thing to go wrong?" To the ordinary man this will, of course, be unintelligible, but here and there throughout the land, there will be found men who have passed through the deep seas of mechanical trouble, and of necessity learned the language, and also a few individuals to whom is given the power to speak this language in moments of supreme exaltation. These will understand the writing.

The machine having proved successful, it was necessary that a patent should be obtained. Now, the preparing of a patent application was supposed to be a most abstruse and difficult art, only to be discovered after many years of apprenticeship and much study (afterward the inventor changed his mind about this), so certain skilled attorneys were employed to make out the application and prepare drawings of the machine.

Now that the inventor was really going to have a patent of his own, he began to read up a little on the subject. He found that the exclusive right to make, use, and sell his own invention, for a limited time, was given him only in exchange for a full and complete description, so that others might work the invention when the patent expired, that the patent cost the government nothing, that there was no guarantee went with the patent, and that a patent was not generally considered of any great value until it had been confirmed by the courts.

The application was soon prepared, duplicated, triplicated, sworn, witnessed, signed, sealed and delivered, bound hand and foot to the Philistines, or rather, to the patent office, and,

"There it lay, there it lay,
'Til it began to rot."

After the aging process was sufficiently completed, the office took action, the application was rejected, the device claimed having been shown in patents to—

T. Edinghouse: 1719—Improved silent phonograph.

G. Westingson: 1760—Donble duplex hair breaker.

B. Brown: 1492—Machine for removing tails from Teddy bears.

The inventor was dumbfounded. The patents to these men showed nothing remotely connected with his inventions, but, ah! there was a slight similarity in the pictures. That must be the reason. A long letter was written to the examiners, carefully pointing out that the devices were entirely different, and that it was hoped that the patent would soon be allowed.

After another long interval (so long that the inventor had to have his hair cut three times, and you know how long inventors wear their hair when times are hard) another action came; the first references were dropped; application rejected on patents to—

Charles Parsconi: 1711—Improved steam windmill.

G. Marsons: 1769—New barb-wireless telephonograph.

The inventor was dumbfounded again, for this time there was no similarity even in the pictures. Perhaps the examiner was confused by the mention of water in all of the specifications.

The attorneys wrote another long letter, carefully explaining that the inventions cited had no bearing on the case, and then the inventor started in to set out some century plant cuttings so that he might raise a little money selling blossoms, and so keep body and soul together while the patent office was getting ready to issue the patent.

The patent office in those days published a paper each week, and in it, besides a list of patents granted, etc., was given a statement of how many weeks, months, years, or centuries, each department was behind in its work. The inventor used to make great calculations from this report. The action would be due, say, Friday, the 13th; allow three days in the

mail, that would be Monday, say Wednesday for sure; and then the poor old Inventor would hang around the post office, day after day, week after week, month after month, waiting for that action. By and by it would come, another damned, discouraging, heart-breaking rejection on some trivial point of resemblance to some ancient unworkable device that happened to present itself to some incompetent examiner.

And in those days there was famine in the land.

After some more valuable time had been lost, the patent office suddenly discovered that the application covered too much ground—it must be divided. A few months more lost, more fees, more signing, more sealing, more waiting, more damning.

But the Inventor found that the office had only been playing with the case so far, now it was getting down to real business; the next citations made it necessary to cut off some of the less important claims. The attorneys amended the application to avoid conflict with the references, and advised the office that the case was now in condition for allowance. But was it? Guess again.

Some more months delay, some more references, 'nother letter, some more months, more references. It reminded one of the Kansas farmer story, "More hogs, more land, more corn, more hogs, etc.," but in this case it was more references, and the inventor was getting poorer all the time.

The inventor gradually found out a good many things about the patent office. He found that the space occupied by the office was entirely too small for the work to be done, that there were not enough examiners, and that not all those in the office were competent to fill their positions. But the most surprising fact, in view of the state of things in the office, was that it had a surplus of several million dollars which it had collected from the inventors of the country and for which it had given them no return. The inventor thought that the government of his great and glorious country would at least have made some effort to give the inventors a square deal and a quick deal, when they put up all the money, but he was only one of those idealists who believe that the government is of the people, for the people, and by the people.

About the time the inventor's youngest great-grandchild was getting married, the patent office allowed the claims then standing, and, after extracting another fee from the inventor, issued the patent. Fortunately, there was still left to the inventor, after the continual hacking and chopping of the patent office, some really good claims that would protect the invention from those who would try to copy it, else the fate of the inventor had been sad indeed.

How the inventor got along with his patent after he got it, is, as my esteemed contemporary says, another story.

* * *

CORRECTING PERSPECTIVE IN SHOP PHOTOGRAPHY.*

S. S. NEW.†

As stated by Mr. Dow, in his article on Shop Photography, in the December issue of MACHINERY, a long focus lens should be used wherever possible when photographing machinery, a wide angle lens being sure to produce distortion. There are cases, however, where, owing to the lack of space or great breadth of the subject photographed, it is imperative that a wide angle lens be used. When this is necessary, it is often possible to correct the distortion, particularly when the subject consists of several parts.

A case of this kind is illustrated by the accompanying cuts, representing a gas-engine-driven Crocker-Wheeler alternator with direct connected exciter. Owing to the small space available at the time the photograph was taken, it was necessary to use a wide angle lens to include the entire set. This, however, produced a negative as shown in Fig. 1, in which the exciter, owing to its nearness to the camera, appears as large as the generator. To reduce this with all important details by retouching would have been very expensive. A print of the photograph was put in front of the camera at a distance such that the image of the exciter on the ground glass was of such a size that it appeared in its true proportion, and a negative was made. The exciter was cut out of a print from this reduced negative and pasted over the abnormal exciter on the original print. The artist then had only to paint in the brick work, windows, etc., around the edges of the exciter and shorten the supporting brackets.

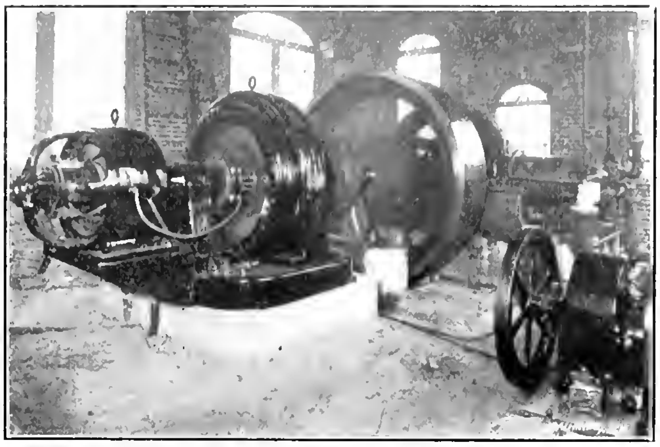


Fig. 1. Photograph taken with Wide Angle Lens showing the Objects to the Left in Exaggerated Proportions.

This method is often used in "faking" photographs, but this example is given as a case where "faking" was necessary to correct the "faking" of the wide angle lens. The retouched photograph is thus more accurate than the original print.

* For previous articles on shop photography, see "Shop Photography," December, 1907, and other articles there referred to.

† Address: Crocker-Wheeler Co., Ampere, N. J.

* * *

The cable companies, anxious to maintain their monopoly on the sending of messages between the new and the old world, have made the statement that they can send a message from the London Stock Exchange to the New York Stock Exchange, and receive a reply, in four minutes. These messages, however, are usually very short, and under such circumstances it makes very little difference whether the message itself is transmitted at the rate of 50 words a minute or 25 words a minute. The records are, of course, obtained by arranging everything beforehand, so that no obstacles have to be overcome, working the line direct between London and New York without any delays at all over the land lines. It is most likely that if similar arrangements were made in connection with the wireless stations, it would be possible to achieve similar results by wireless telegraphy, and ultimately, no doubt, the speed of working wireless telegraphy will be greater than that at present possible for cables, or, at least, fully as great. It seems unreasonable to condemn the wireless system because it has not sprung forth perfect from the start. It has, in fact, developed much quicker than the telegraph, and there are reasons to believe that its future development will be accelerated even in a greater proportion.

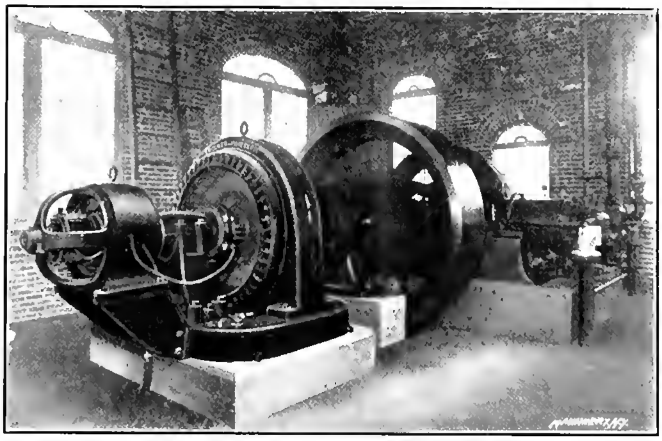


Fig. 2. Corrected Photograph.

* * *

A REMARKABLE MACHINE TOOL!

ONE 14 inch Sebastian gas engine lathe, good as new, cheap to quick buyer. Apply 630 Park av., near 14th st., Hoboken.

—*The Evening Telegram* (New York).

STANDARD DRAWING-ROOM METHODS.*

M. R. KAVANAGH †

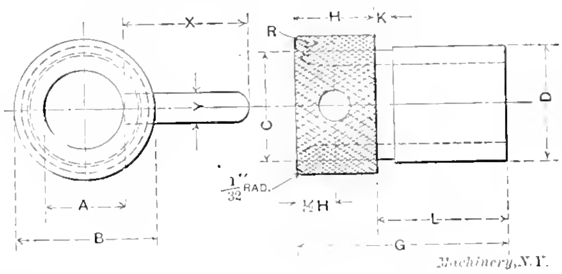
M. R. Kavanagh.‡

The theme of the standardization of methods in the drawing-room is one which is of vital interest to a large number of the readers of MACHINERY, who are connected more or less directly with this line of work. There are so many leaks possible in the drafting department of any firm, so many ways in which time may be saved by having a way to do things and a place to put them, that a few words upon this topic cannot fail to interest many.

Of course, good light and the least possible amount of noise and confusion in the room during working hours are a foregone conclusion, while the equipment and size of the quarters devoted to this branch of the business must necessarily depend upon the size of the company. Beyond this, however, the way in which the drawing-room ministers to the wants of the factory, and the accuracy and speed with which the drawings are turned out, depend greatly upon the efficiency of the system and the longheadedness of the chief.

About the first step in any good system is the adoption of a number of general rules, governing the production of any

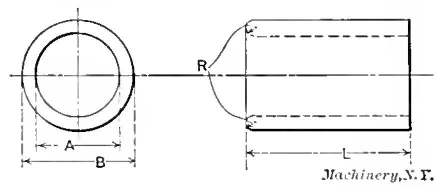
TABLE I. REMOVABLE BUSHINGS FOR TAPPED HOLES.



Tap Size.	Thds.	A	D	L	B	H	C	K	G	X	Y	R
3/16	24	No. 26	5/16	1/2	1/2	1/2	19/64	3/32	1	11/16	3/16	1/16
1/4	20	13/64	3/8	9/16	9/16	1/2	23/64	3/32	1 1/16	11/16	3/16	3/32
5/16	18	1/4	7/16	5/8	5/8	5/8	27/64	1/8	1 1/4	3/4	3/16	3/32
3/8	16	19/64	1/2	11/16	11/16	5/8	31/64	1/8	1 5/16	3/4	3/16	1/8
7/16	14	23/64	9/16	13/16	13/16	5/8	35/64	1/8	1 7/16	3/4	3/16	1/8
1/2	12	13/32	5/8	7/8	7/8	5/8	39/64	1/8	1 1/2	3/4	3/16	1/8
9/16	12	15/32	11/16	15/16	15/16	5/8	43/64	1/8	1 9/16	3/4	7/32	1/8
5/8	11	33/64	13/16	1 1/16	1 1/16	5/8	51/64	1/8	1 11/16	15/16	7/32	1/8
3/4	10	5/8	15/16	1 3/16	1 3/16	3/4	59/64	1/8	1 15/16	15/16	1/4	5/32
7/8	9	3/4	1 1/16	1 5/16	1 5/16	3/4	1 3/64	3/16	2 1/16	15/16	1/4	5/32
1	8	55/64	1 3/16	1 1/2	1 1/2	3/4	1 11/64	3/16	2 1/4	1	1/4	5/32

new work, which may be easily blue-printed and handed to any new man on his arrival, thus giving him a line on the general way in which the work is desired to be gotten out. These data may conveniently cover such points as sizes of drawings, methods of dimensioning, limits to be used on the work, methods of indicating varions finishes, styles of lettering, cross sections, etc. We have gone a good deal further than this in the drafting-room where the writer is employed, and have what we term our data sheets. These, in addition to the above, comprise a list of the stock of steel in the various sizes, shapes, and qualities, carried by the firm; stock patterns, examples and explanations of the various formulas in use in the shop; and, in general, a collection of data relative to our work, which the draftsman or designer might spend much valuable time in looking up. Each man is furnished with a copy of these data sheets, and he retains them while in our employ. That they are appreciated and valued by the men is evident from the tenacity with which they hold on to their copies. This system is by no means original with our firm, being in use in a number of the large firms throughout the country, such as the Westinghouse Co., the General Electric Co., the Brown & Sharpe Mfg. Co., and many others.

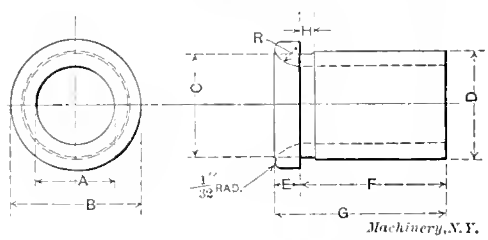
TABLE II. STANDARD PERMANENT BUSHINGS—PLAIN.



A	B	L	R	A	B	L	R
1/16	1/4	1/2	1/16	9/16	7/8	1 1/8	1/8
1/8	5/16	9/16	1/16	5/8	1	1 3/16	5/32
3/16	7/16	5/8	3/32	11/16	1 1/16	1 1/4	5/32
1/4	1/2	3/4	3/32	3/4	1 1/8	1 3/8	5/32
5/16	9/16	15/16	3/32	13/16	1 3/16	1 7/16	5/32
3/8	11/16	7/8	1/8	7/8	1 1/4	1 1/2	5/32
7/16	3/4	15/16	1/8	15/16	1 3/8	1 5/8	3/16
1/2	13/16	1 1/16	1/8	1	1 7/16	1 3/4	3/16

It is a fact, deplorable though it may be, that a large number of our American draftsmen are not really capable of sitting on the job. It is seldom that we find a man who combines with accuracy and expedition the knowledge of shop methods and practice which would make impossible some of the rather amusing "bulls" we find from day to day. It is on this account, as well as on account of the fact that everyone, no matter how careful, will occasionally go wrong, that an efficient checking method is essential to good work. We all know how glad the shopman is to find a mistake made by the drawing-room, and how quickly he will come back on the draftsman if he does find one. Mistakes, too, are always costly, and the fewer there are, the more valuable the drafting room is to the business. The method we follow is this: The chief explains to the draftsman, by sketch or verbally,

TABLE III. STANDARD PERMANENT BUSHINGS—SHOULDER.



A	D	F	B	E	G	C	H	R
3/8	11/16	3/4	13/16	3/32	7/8	43/64	1/8	1/8
7/16	3/4	13/16	7/8	3/32	15/16	47/64	1/8	1/8
1/2	13/16	15/16	15/16	3/32	1 1/16	51/64	1/8	1/8
9/16	7/8	1	1 1/16	3/32	1 1/8	55/64	1/8	1/8
5/8	1	1 1/16	1 3/16	3/32	1 3/16	63/64	1/8	5/32
11/16	1 1/16	1 1/8	1 1/4	3/32	1 1/4	1 3/64	1/8	5/32
3/4	1 1/8	1 3/16	1 5/16	1/8	1 3/8	1 7/64	3/16	5/32
13/16	1 3/16	1 1/4	1 3/8	1/8	1 7/16	1 11/64	3/16	5/32
7/8	1 1/4	1 5/16	1 7/16	1/8	1 1/2	1 15/64	3/16	5/32
15/16	1 3/8	1 7/16	1 9/16	1/8	1 5/8	1 23/64	3/16	3/16
1	1 7/16	1 9/16	1 5/8	1/8	1 3/4	1 27/64	3/16	3/16
1 1/16	1 9/16	1 5/8	1 3/4	1/8	1 13/16	1 35/64	3/16	7/32
1 1/8	1 5/8	1 11/16	1 13/16	1/8	1 7/8	1 39/64	3/16	7/32
1 1/4	1 3/4	1 13/16	1 15/16	1/8	2	1 47/64	3/16	7/32

* The following articles on drafting-room practice and kindred subjects have previously been published in MACHINERY: Drafting-room Practice, October, 1894; Drawings for the Shop, September, 1895; System in the Drafting-room, November, 1896; Modern Drafting-room Supplement, March, 1897; A Model Drafting-room, January, 1900; Drafting Office Photography, April, 1901; Working Drawings, October and November, 1901; Mechanical Drawing and the Shop, September, 1903, engineering edition; Drafting-room Practice, March, 1905; Drafting-room of the B. F. Sturtevant Co., September, 1905, engineering edition; Instructions for Draftsmen, and Drafting-room Practice, September, 1905; Tracing, Lettering, and Mounting, September, October and November, 1906; The Card Index in the Jobbing Shop, June, 1907, and also previous articles referred to in that issue.

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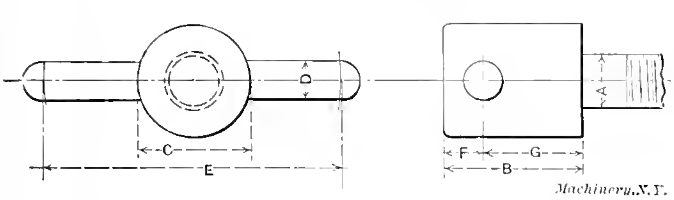
‡ M. R. Kavanagh was born in Chicago, Ill., 1882. After being graduated from the high school, he took courses in mechanical, electrical, and bridge engineering, in the American and the International Schools of Correspondence. He has been connected with the C. B. & Q. and Lake Shore Railroads; Burroughs Adding Machine Co., Detroit; Cadillac Automobile Co., Detroit; and has had charge of office, drafting-room, and cost department for National Mfg. Co. Mr. Kavanagh is now with the Ford Motor Co., Detroit, in the capacity of tool designer. His specialty is designing tools for interchangeable manufacturing

what he desires, and the drawing is made under the supervision of the chief who gives it his approval as regards design. It is then submitted to a committee consisting of the chief engineer, his assistant, and the two head designers. They either approve it or order such changes as they think advisable, and the drawing is returned to the draftsman for alteration, if necessary, or, if not, is passed to the checker, a competent man who does nothing but check the drawings. The drawing is then thoroughly checked by him for accuracy as to scale, dimensions, and mathematical calculations, as well as for its compliance with our system. If any corrections are found necessary, the drawing is again returned to the draftsman, who makes the necessary alterations and returns it to the checker, receiving his approval on same. The drawing then goes to the tracer, who makes the tracing and returns the original and the tracing to the checker. If any corrections are necessary on the tracing, the tracer makes them under direction from the checker, who finally approves the tracing. It is then ready for the blue-print room, and any errors which show up later are held against the checker. This system is very thorough and the errors that occur are few and far between.

Another feature of value, is the grouping of the various blue-prints covering the manufacture of a certain machine, or a number of machines of similar character, in bound packs or books, located at various points throughout the plant. This

TABLE IV. CLAMPING SCREWS.



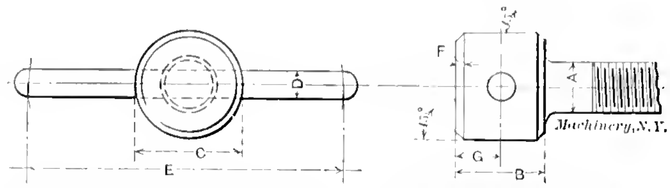
A	B	C	D	E	F	G	Threads.
5/16	7/8	5/8	1/4	2 1/4	5/16	9/16	18
3/8	15/16	11/16	1/4	2 1/4	5/16	5/8	16
7/16	1	3/4	1/4	2 1/2	5/16	11/16	14
1/2	1 1/16	7/8	1/4	2 3/4	5/16	3/4	12
5/8	1 1/4	1 1/16	5/16	3	3/8	7/8	11
3/4	1 3/8	1 1/4	5/16	3 1/2	3/8	1	10

obviates the continual replacement of lost prints, which consumes so much time where loose prints are used. Each book is reccipted tor by the foreman who has the work covered by it in charge, as are also the new prints made necessary by changes in design or dimensions. A record of the location of these books is, of course, kept in the drawing-room, and a man is detailed to keep them up to date. There is an exception to this rule in the screw machine department, as the prints of the parts are here mounted on boards and shellaced, the operator having one of these cardboard mounts on his machine where he can refer to it. The mounts not in use are kept in a cabinet for that purpose, where they are easily accessible to the foreman of the department in planning his work. In this connection it might be well to note that all the prints necessary to go into any one department are those referring to operations performed in that particular part of the works, and the drawing-room is generally the only place where a complete set of prints is available.

For some time a good system of handling and recording the changes in the various parts bothered us, but the system we are now using seems to fill the bill very well. If the change is a slight one, as for instance the change of a dimension, the tracing is changed, the date of change being noted in the lower right-hand corner, and the various prints are changed by the man in charge of that work. If the design is changed, a new tracing is made, the old one marked obsolete, new prints made and put in the books, and the new tracing filed with the old one. In each case a record of every change is made by the clerk in a book kept for that purpose, and as the parts are all arranged numerically it is very easy to refer to this record to find the details of the change in making repairs or filling order for old parts.

It is remarkable what a number of drawings will accumulate in the course of a few years, where old designs are being constantly brought up to date, and new machines being added to keep abreast of the times. Owing to this fact, we found it necessary to design and have built a number of cabinets, with drawers made to fit the different sizes of drawings. In these drawers the tracings are filed, as has been said, accord-

TABLE V. CLAMPING SCREWS.

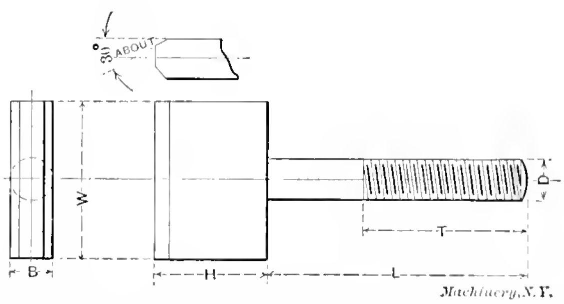


A	B	C	D	E	F	Threads.	G
5/16	5/8	5/8	3/16	2 1/4	1/16	18	5/16
3/8	5/8	11/16	1/4	2 1/4	1/16	16	5/16
7/16	5/8	3/4	1/4	2 1/2	1/16	14	5/16
1/2	5/8	7/8	1/4	2 3/4	1/16	12	5/16
5/8	3/4	1 1/16	5/16	3	3/32	11	3/8
3/4	3/4	1 1/4	5/16	3 1/2	3/32	10	3/8

ing to numerical order. We have also installed, and find it a great help, a card index giving the exact location and size of the drawing of the particular part sought, and in case the number of the part is not known, a cross index gives an alphabetical classification. As an auxiliary to this index we have a smaller one in which are grouped such tools as bits, reamers, special drills, counterbores, etc., which we find to be a great aid and convenience to the designers in making up similar tools, or, as often happens, in adapting the old tool to a new part. This leads on to the statement that in our drawing-room, as in many others that I know of, there are two distinct divisions, one for the design and production of the drawings covering the machines themselves, and one for the design of the tools necessary for the economic production of these parts. In the former department the data utilized can for the greater part be found in the standard mechanical works or the trade catalogues. In the tool designing department, however, we have a number of standards of which a few examples are here given, compiled mostly from the book of experience, of which, so far as I have been able to learn, there is no authentic edition.

Tables I, II and III give data covering the more common type of drill jig bushings. These bushings may, with the

TABLE VI. QUICK RELEASING JIG SCREWS.



D	Threads.	L	T	W	H	B
5/16	18	1 1/2	1	1 1/8	3/4	5/16
3/8	16	1 5/8	1 1/4	1 1/4	3/4	3/8
7/16	14	1 5/8	1 1/4	1 3/8	7/8	7/16
1/2	12	1 3/4	1 1/4	1 1/2	7/8	1/2

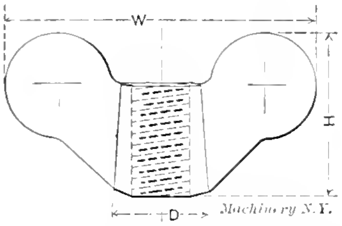
proper allowance for finish and lapping, be made up in quantities in the screw machine department, and sent to the toolroom for use when required. The material used in making bushings varies in different shops, and although some designers claim that tool steel is the best for this purpose, I have seen both tool steel and soft machine steel used with equal success, the latter of course being case-hardened. To prevent the movable bushing from turning with the drill, we use a simple knee pin placed as near as possible to the outside

diameter of the bushing, and just fitting over the pin shown in the bushing itself. This provides an efficient stop and allows the bushing to be turned nearly completely around in removing. The knurled portions of the bushings are also made ample, to allow of their being easily grasped by the operator.

Table IV gives dimensions of clamping screws used on fixtures where the head of the screw binds directly onto the strap or clamp. It is sometimes advisable to make the stud permanent in the body of the tool, and use a nut with a handle through it similar to the head of the screw here shown. Table V gives data for another form of clamping screw. In this case, however, the screw works through a plate or cover and clamps directly onto the work. These clamping screws are made of machine steel, case-hardened, and the handles, of cold rolled stock, are pressed into them.

In Table VI dimensions are given for a form of jig screw used for clamping the cover or bushing plate on a jig, the plate being so slotted that a turn of the screw will bring the head in such a position that the cover may be thrown back, releasing the work quickly. This is often used on fixtures where a slight pressure is all that is needed, and a quick release of the work is essential to rapid operation. These screws are made of machine steel and case-hardened.

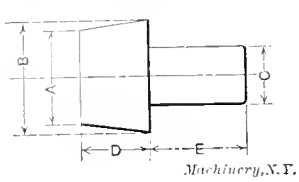
TABLE VII. WING NUTS.



Diam of Bolt.	Thds per inch.*	D	H	W
1/4	20	7/16	5/8	1 3/16
5/16	18	1/2	3/4	1 7/16
3/8	16	17/32	7/8	1 3/4
1/2	12	3/4	1 1/4	2 3/8

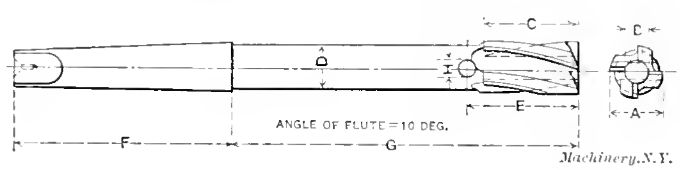
* This column dependent on shop standard.

TABLE VIII. INSERTED FEET FOR JIGS.



C	A	B	D	E
1/4	3/8	7/16	5/16	7/16
5/16	1/2	9/16	3/8	1/2
3/8	9/16	5/8	3/8	9/16
7/16	5/8	11/16	3/8	11/16
1/2	11/16	3/4	1/2	3/4

TABLE IX. FOUR-LIPPED COUNTERBORES.



A	B	C	D	E	F	G	H	No. Morse Taper Shank.
9/16	7/32	21/32	1/2	25/32	2 3/4	3 3/4	3/16	1
5/8	7/32	11/16	9/16	13/16	3 1/8	3 7/8	3/16	2
11/16	5/16	27/32	.612	1 1/8	3 1/8	3 7/8	9/32	2
3/4	5/16	7/8	11/16	1 1/8	3 3/16	4	9/32	2
7/8	3/8	31/32	13/16	1 5/16	3 3/16	4 9/16	21/64	2
1	3/8	31/32	.936	1 5/16	3 15/16	5 1/8	21/64	3
1 1/16	7/16	1 1/4	1	1 5/8	3 15/16	5 1/16	3/8	3
1 3/16	7/16	1 1/4	1 1/16	1 5/8	4	5 1/4	3/8	3
1 5/16	7/16	1 1/4	1 3/16	1 5/8	4	5 1/2	3/8	3
1 1/2	11/16	1 3/4	1 3/8	2 1/4	5 1/8	5 7/8	13/32	4
1 3/4	11/16	1 3/4	1 9/16	2 1/4	5 3/16	6 5/16	13/32	4
1 15/16	29/32	2	1 3/4	2 7/16	5 1/4	6 1/2	13/32	4

Table VII gives the general dimensions of the standard wing nut, and is merely for convenience in laying out. Table VIII gives data for the inserted feet we use in our cast iron jigs. These feet are made of machine steel, case-hardened, and are a press fit in the jig. Finally, Table IX gives dimensions of counterbores that we use in the works, and is exceedingly handy in working out counterboring fixtures for the various parts, and in proportioning the removable and permanent bushings in jigs where it is desired to drill and counterbore without removing the work.

There are a number of other tables of data, but as they are too highly specialized to be of general interest they will not be given here. There is a point in connection with the design of special screws for the different parts that merits mention. All screws of special shape are designed with the slot in the head having a certain relation to the diameter of the threaded portion. This prevents much of the trouble generally experienced in the assembling department due to screws being screwed in with such force as to break off the head, when the head is large and the body diameter small.

* * *

THE CONVENIENCE OF FORMULAS.

One of the difficulties of editing MACHINERY is the presentation of engineering matter necessarily requiring mathematical formulas in a way that will not be objectionable to the readers who have not acquired a certain amount of technical education. A few articles on design, no doubt, are beyond the comprehension of some readers, but if such readers could realize that much of the stuff that they call algebra is nothing more than a shorthand method of expressing very simple ideas, it would be very much to their own profit, and would often save needless criticism of editorial policy. To illustrate what we mean, we will quote from the the November issue. On page 159, engineering edition, in an abstract from a paper, "Modern Machinery and Its Future Development," the following expression appeared:

$$\text{Cost per piece in cents} = \frac{\text{Wages per hour in cents} + \dfrac{\text{Price of machine in dollars}}{125}}{\text{Number of pieces made per hour}} + \frac{\text{Cost of tools and setting up in cents}}{\text{Total number of pieces}} + \text{cost of material per piece in cents.}$$

This formula, for such it is, is expressed in kindergarten form, but please take notice how confused it is, how easily its meaning may be mistaken, and how long it takes to really figure out what the meaning of the formula is.

Now, if instead of using this form, we indicate each element by a letter, and define each letter, we will note a great improvement in the clearness of the expression. There are no typographical mix-ups as to what is a numerator or what is a denominator, or where the expression begins and leaves off.

Let W = wages per hour in cents,
P = price of machine in dollars, divided by 125,
C = cost per piece, in cents,
N = number of pieces made per hour,
C_{ts} = cost of tools and setting up, in cents,
T = total number of pieces,
C_m = cost of material per piece, in cents.

Then, instead of the cumbersome expression referred to, we have the following:

$$C = \frac{W + P}{N} + \frac{C_{ts}}{T} + C_m$$

* * *

The correspondents to MACHINERY, who send us descriptions of special tools for publication, would greatly increase the value of their contributions if in every case they made it a rule to plainly describe, in the first place, what the tool is to be used for, showing, generally, an illustration of the piece to be produced or to be worked upon. This would make it a great deal easier to at once grasp the idea. To simply describe a device, without making clear its use, or what parts it is to produce, often makes the descriptions almost valueless, or of much less value than they might have. It is, therefore, desirable to proceed in a logical manner when describing a tool or device: First, explain what the tool is intended for, showing the piece operated upon or produced; then, proceed to describe the device, showing how it produces the results desired; and, finally, if the making of the device involves operations of more than common interest, give a description of the manner of making the device last. If these simple rules are followed, the contributions will be of greater value to the readers, and less time will be required of the editors for preparation.

SCREW THREAD SYSTEMS.*

ERIK OBERG.†

Notwithstanding all that has been written about standard screw thread systems, data which completely cover all the recognized standards are very scattered, and it is often necessary to search for information in many different handbooks and works of reference. For this reason a review of the most important information regarding the more common screw thread systems has been compiled in the following article. While a great many more systems than are here reviewed have been proposed from time to time, only those which have been officially recognized by mechanical men, or which have gained prestige by means of universal use and adoption, here or abroad, will be treated.

The United States Standard Thread.

The United States standard thread, usually denoted U. S. S., has a cross section as shown in Fig. 1. The sides of the thread form an angle of 60 degrees with one another. The top and bottom of the thread are flattened, the width of the flat in both cases being equal to one-eighth of the pitch of the thread. In this connection it may be appropriate to define the expression pitch as well as lead, as these two expressions are very often confused, and the word pitch, in particular, often, through erroneously, used in place of "number of threads per inch." The pitch of a thread is the distance from center to center of two adjacent threads. It is equal to the reciprocal value of the number of threads per inch, or, if expressed in a formula:

$$\text{Pitch} = \frac{1}{\text{Number of threads per inch.}}$$

The lead of a screw thread is the distance the screw will travel forward if turned around one complete revolution. It is evident that for a single threaded screw the pitch and the lead are equal. In a double threaded screw, the lead equals two times the pitch, in a triple threaded, three times, etc. The definitions given for pitch and lead should be strictly adhered to, as great confusion is often caused by improper interpretation of the meaning of these terms. Confusion is also caused by indefinite designation of multiple thread screws. The most common way to state the lead and the class of thread is perhaps to say ¼ *inch lead, double*, which means a screw with a double thread, which, when cut, has the lathe geared for four threads per inch, but each thread is cut only to a depth corresponding to eight threads per inch. The same condition is also expressed by: 4 *threads per inch, double*. These two ways of expressing the number of multiple threads are both correct, but the expression which ought to be used in order to avoid misunderstanding under any circumstances would be: ¼ *lead*, ⅛ *pitch, double thread*.

Returning to the form of the U. S. S. thread, we find that if the thread is flattened one-eighth of the pitch at top and bottom, the depth of the thread is equal to three-quarters of the depth of a corresponding thread, sharp both at top and bottom. If p equals the pitch of the thread; d, the depth; and f the width of the flat, the following formulas express the relation between these quantities:

$$p = \frac{1}{\text{Number of threads per inch.}}$$

$$d = \tfrac{3}{4} \times p \times \cos 30^\circ = 0.64952\,p.$$

$$f = \frac{p}{8}$$

Formula for the Number of Threads in the United States Standard Thread System.

In order to fix definitely the number of threads per inch corresponding to any given diameter in the U. S. S. system, Mr. William Sellers, its originator, proposed the following approximate formula:

$$p = 0.24 \sqrt{D + 0.625} - 0.175,$$

in which formula p equals the pitch of the thread for any bolt or screw of the diameter D.

This formula is applicable to all screws ¼ inch and larger in diameter. For diameters below ¼ inch the formula is modified so as to read:

$$p = 0.23 \sqrt{D + 0.625} - 0.175,$$

This modification, which has met with general acceptance, changing the coefficient 0.24 to 0.23, was proposed by Mr. George M. Bond in 1882. The purpose of the change was to make the formula applicable to screw threads for bolts smaller than one-quarter inch in diameter. Mr. Bond's formula tends to increase the number of threads more rapidly as the diameter decreases, a distinct advantage in the case of small screws.

It will be proper to remark in this connection that screws 11/16, 13/16 and 15/16, which according to the formula given ought to have 10, 9 and 8 threads per inch, respectively, are in usual manufacturing practice made with 11, 10 and 9 threads per inch, respectively.

The Sharp V-thread.

The sharp V-thread, Fig. 2, is very similar to the U. S. S. thread, except that theoretically it is not provided with any flat, either at the top, nor at the bottom of the thread. In

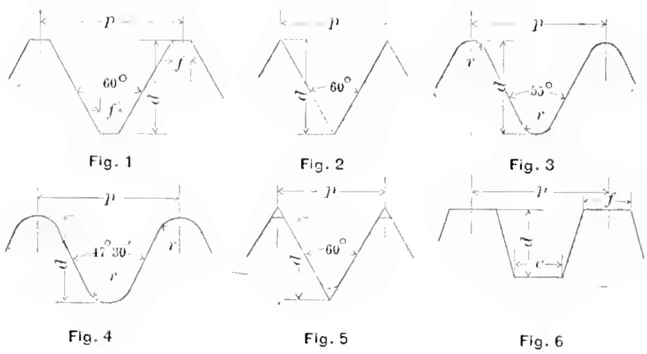


Fig. 1 Fig. 2 Fig. 3

Fig. 4 Fig. 5 Fig. 6

Machinery N. Y.

Figs. 1 to 6. Standard Screw Threads.

common practice, however, it has proved necessary to provide this thread with a slight flat on the top of the thread. The reasons for this were referred to in a short article in the engineering edition of MACHINERY, October, 1906. In this article the difficulties caused by providing a flat on the top of sharp V-threads were also mentioned, the principal one being that no definite standard for this flat has been settled upon. Some manufacturers have used the same flat as is used for the Briggs standard pipe thread, which, although theoretically rounded at top and bottom, is, in this country at least, made with a small flat on the top of the thread. The width of this flat is selected so as to give exactly the same angle diameter as is obtained when rounding the thread in accordance with Briggs' original proposition. This flat is equal to about one-twenty-fifth of the pitch.

If p equals the pitch of the thread; d, the depth; and f, the width of the flat on the top of the thread, the following formulas express the relation between the various quantities of the sharp V-thread:

$$p = \frac{1}{\text{Number of threads per inch.}}$$

$$d = p \times \cos 30^\circ = 0.86603\,p.$$

$$f = \frac{p}{25}$$

Attention must be called to the fact that the formula for the width of the flat is selected simply to give an arbitrary value, which is *not* recognized as any *standard element* of the sharp V-thread. In figuring the depth of the thread, this flat is not considered, and the depth is arrived at as if the thread were exactly sharp.

Comparison between the U. S. S. and the Sharp V-thread.

The two standards referred to hitherto are the two forms of thread most commonly used in the United States. The objections to the sharp V-thread, as compared with the U. S. S. thread, are that the comparatively sharp points of the teeth

* The following articles relating to screw thread systems have been previously published in MACHINERY: Whitworth vs. Sellers Thread, May, 1899; Screw Pitches in Foreign Countries, February, 1900; Screws, September, 1903; Proposed Standards for Machine Screws, June, 1906.

† Associate Editor of MACHINERY.

are very frail; that the groove at the bottom of the thread, being sharp, facilitates fracture under strain; that the depth of the thread, being considerably greater than that of the U. S. S. thread, subtracts from the effective area at the root of the thread of the screw, thus impairing the tensile strength of the threaded bolt, and finally, that in case of taps, the sharp V-thread has less endurance and shorter life, and is capable of smaller duty, owing to the frail and easily worn away points of the thread. In spite of all this, however, the sharp V-thread will long continue to be in general use, primarily because it has so thoroughly established itself in the mechanical industries. This form of thread has also another very strong claim, because of being admirably adapted to the making of steam-tight joints. It answers this purpose best of all common forms of thread, and all patch bolt taps, boiler taps and staybolt taps are, as a rule, provided with sharp V-threads.

The Whitworth Standard Thread.

The Whitworth standard thread, Fig. 3, is used chiefly in Great Britain, but to a certain extent also in the United States. Its use here, however, has greatly diminished since the U. S. S. thread commenced to gain general approval. The Whitworth standard is the older one of the two, and was the first recognized screw thread system. In the Whitworth standard thread the sides of the thread form an angle of 55 degrees with one another. The top and the bottom of the thread are rounded to a radius determined by the depth of the thread, which is two-thirds of a thread with the same angle which were sharp at top and bottom. The radius at the top is the same as the radius at the bottom. If p and d equal the pitch and the depth of the thread, respectively, and r the radius at the top and bottom, then

$$d = \frac{2}{3} \times \frac{p}{2} \times \cot 27^\circ\ 30' = 0.64033\ p.$$

$$r = 0.1373\ p.$$

The advantages of the Whitworth thread are that screws with this form of thread have all the strength possessed by screws with U. S. S. threads, and at the same time have no sharp corners from which fractures may start. Screws and nuts with this form of thread will work well together after continued heavy service when other forms of thread would fail. Whitworth threads are used in the United States chiefly on special screws, such, for instance, as screws for gasoline needle valves, where a liquid-tight and yet working fit is desired. It is also often used for locomotive boiler staybolts. The objections to the Whitworth form of thread are that the angle of 55 degrees cannot be measured or simply laid out with ordinary tools, and that the rounded corners at the top and bottom cannot be produced with any degree of accuracy without great difficulty. The Whitworth standard screw system is denoted B. S. W. (British Standard Whitworth screw thread) in Great Britain.

British Standard Fine Screw Thread.

The British standard fine screw thread is a system of threads recently adopted in Great Britain. The form of the thread is the same as that for the Whitworth standard, but there are a greater number of threads per inch corresponding to a certain diameter in the Whitworth system. The fine screw thread system is denoted B. S. F., and applies to screws ¼ inch in diameter and larger. For detailed information regarding this system see the article in MACHINERY, October, 1906, entitled British Standard Fine Screw Thread.

The pitches for the system of fine screw threads are based, approximately, on the formula:

$$P = \frac{\sqrt[3]{d^2}}{10},$$ for sizes up to and including one inch; and on the formula:

$$P = \frac{\sqrt[8]{d^5}}{10},$$ for sizes larger than one inch in diameter.

In the above formulas

P = pitch, or lead of single-threaded screw, and

d = diameter of screw.

This standard is not intended to make the regular Whitworth standard thread superfluous, but simply supposed to offer a possibility of a standard fine screw thread for such purposes where the regular Whitworth standard would be too coarse.

British Association Standard Thread.

The British Association standard thread is the standard system for screws of small diameter in Great Britain. It is, however, hardly used at all in the United States, except in the manufacture of tools for the English market. The characteristics of the thread form are similar to those of the Whitworth thread, but the angle between the sides of the thread is only 47 degrees 30 minutes, and the radius at the top and bottom of the thread (see Fig. 4) is proportionally larger, depending upon that the depth of the thread is smaller in relation to the pitch than in the Whitworth standard thread. If p, d and r signify the pitch, the depth, and the radius at the top and bottom of the thread, respectively, then

$$d = 0.6\ p. \qquad r = \frac{2\ p}{11}$$

The various sizes of screws in this system are numbered, and a certain number of threads per inch always correspond to a certain given diameter. The system is founded on metric measurements. It was first originated in Switzerland as a standard for screws used in watch and clock making. This system is therefore also at times referred to as the Swiss small screw thread system.

Briggs Standard Pipe Thread.

The Briggs standard pipe thread is made with an angle of 60 degrees. It is slightly rounded off, both at the top and at the bottom, so that the depth of the thread, instead of being equal to the depth of the sharp V-thread (0.866 × pitch), is only four-fifths of the pitch, or equal to $\frac{0.8}{n}$, if n be the number of threads per inch. The difficulty of producing a thread with rounded top and bottom has, however, caused the manufacturers in this country to modify the original standard. Instead of rounding the bottom of the thread, it is made sharp as shown in Fig. 5. The top is slightly flattened instead of rounded, the flat being carried down just far enough to tangent the top circle of the correct thread form. This thread, as indicated by the name, is used for pipe joints and for many purposes in locomotive boiler work. Taps for producing Briggs standard pipe thread are provided with a taper of ¾ inch per foot on the diameter.

Whitworth Standard Thread for Gas and Water Piping.

The form of the Whitworth standard thread for gas and water piping is simply the regular Whitworth thread form, and the only difference from the regular Whitworth standard is the number of threads per inch. Manufacturers of taps, when making what is called English pipe taps, use the Whitworth form of thread and the number of threads according to the Whitworth pipe thread system, but make the dimensions for the taps the same as for the Briggs standard in all respects. The taper is also made the same as for the Briggs standard, or ¾ inch per foot.

Square Thread.

The square form of thread is usually made about twice as coarse in pitch as the V or U. S. S. threads, and partly for this reason and partly because of the perpendicular sides of the thread, it is a troublesome thread to cut with taps and dies. There is no standard for the number of threads corresponding to a certain diameter. The depth of the thread is equal to the width of space between the teeth, this space being equal to one-half of the pitch. While theoretically the space between the teeth is equal to the thickness of the tool, each being one-half of the pitch, it is evident that the thickness of the tooth must be enough smaller than the space to admit at least an easy sliding fit. This form of thread is largely used in adjusting and power conveying screws.

The Acme Thread.

The Acme thread, shown in Fig. 6, has of late become widely used, having in most instances taken the place of a square thread on account of its better wearing qualities, and the comparative ease with which this thread can be produced.

Of all standard thread systems the Acme thread is the only one which has a standard provision for clearance at the top and bottom of the thread. The screw is made of standard diameter, but the nut is made over-size. The relationship between screw and nut is illustrated in Fig. 7. If the diameter of the screw is A over the top of the thread, and B at the foot of the thread, the corresponding diameters of the nut are $A + 0.020$ and $B + 0.020$ inch. The sides of the thread form an angle of 29 degrees with one another. Considering the screw only, if p is the pitch; d, the depth of the thread; f, the width of the flat at the top of the thread; and c, the width of the flat at the bottom of the thread, then:

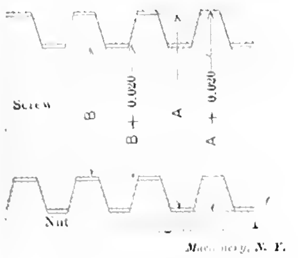


Fig. 7. Acme Standard Screw and Nut.

$$d = \frac{p}{2} + 0.010 \text{ inch},$$

$$f = 0.3707\ p.$$

$$c = 0.3707\ p - 0.0052 \text{ inch}.$$

The Acme thread has many good points, not the least of which is its strength, and the ease with which it may be cut compared with the square thread. This thread is recommended as a substitute for, and to be used in preference to, the square form of thread.

French and International Standard Threads.

The French and international standard threads are of the same form as the U. S. standard, and the formulas given for the latter form of thread apply to the former. The pitches, however, are stated in the metric measure, and are somewhat finer for corresponding diameters than the U. S. S. thread. This is a distinct advantage, especially in the smaller sizes. The standard thread of the international system is denoted S. I. and was adopted by the International Congress for the unifying of screw threads held in Zürich, 1898. This system conforms with slight variations with the system earlier adopted in France, the French standard thread, denoted S. F. In order to provide for clearance at the bottom of the thread in the nut, the congress referred to above specified that clearance at the bottom of the thread shall not exceed 1/16 of the height of the original triangle. The shape of the bottom of the thread resulting from such clearance is left to the manufacturers. However, the congress recommends rounded profile for said bottom. By this provision choice is given to the manufacturers to make the bottoms of their threads flat or rounded as desired, and yet have them conform to a common standard so as to interchange.

Instrument and Watchmakers' System.

The standard screw system of The Royal Microscopical Society of London, England, is employed for microscope objectives and the nose pieces of the microscope into which

WHITWORTH STANDARD THREAD SYSTEM FOR WATCH AND MATHEMATICAL INSTRUMENT MAKERS.

Diameter of Screw, inches.	No. of Threads per inch.	Diameter of Screw, inches.	No. of Threads per inch.	Diameter of Screw, inches.	No. of Threads per inch.
0.010	400	0.022	210	0.050	100
0.011	400	0.024	210	0.055	100
0.012	350	0.026	180	0.060	100
0.013	350	0.028	180	0.065	80
0.014	300	0.030	180	0.070	80
0.015	300	0.032	150	0.075	80
0.016	300	0.034	150	0.080	60
0.017	250	0.036	150	0.085	60
0.018	250	0.038	120	0.090	60
0.019	250	0.040	120	0.095	60
0.020	210	0.045	120	0.100	50

these objectives screw. The form of thread is the Whitworth form, the diameter of the male gage is 0.7626 inch. The number of threads per inch is 36.

In the table above are given the sizes and corresponding number of threads for Whitworth standard screw thread systems for watch and mathematical instrument makers. This system is adopted by many instrument makers both in the United States and Europe.

Lag Screw Threads.

There is no recognized standard for the sizes and corresponding number of threads for lag screws. The following table, however, gives the number of threads according to common practice. While lag screws are largely made according to this system, there are, however, a number of different systems in use.

Gas Fixture Threads.

Thin brass tubing is threaded with 27 threads per inch, irrespective of diameter. The so-called ornament brass sizes

LAG SCREW THREADS.

Diameter of Screw.	No. of Threads per inch.	Diameter of Screw.	No. of Threads per inch.
1/4	10	5/8	5
5/16	9	11/16	5
3/8	8	3/4	5
7/16	7	7/8	4
1/2	6	1	4
9/16	6	...	..

have 32 threads per inch. The standard diameters of the thread are 0.196 inch (large ornament brass size) and 0.148 inch (small ornament brass size).

Fine Screw Thread Systems.

We have previously referred to the British fine screw thread system recently adopted. There is a demand for the adoption in this country of a standard system with a U. S. S. form of thread but with a finer pitch than called for by this standard. The Association of Licensed Automobile Manufacturers has adopted such a standard, but it is, of course, not universally recognized. The objection to the adoption of a standard by a single body of manufacturers is obvious. Even if the standard is one which would recommend itself to general use, it would be better if the opinion and the needs of machine builders in general were considered. On the other hand it may be said in defense of the adopted system that automobile construction is so specialized a manufacture that here doubtless may arise requirements which would not present themselves elsewhere.

* * *

KEEP MONEY MOVING.

We hope that by the time this note is published the tight money trouble will be over and business will have resumed its normal channels. Whether it is or not, the advice contained in the little slips here reproduced is worth taking to heart by every business man:

Put Your Shoulder to the Wheel---NOW

In sending you the enclosed check for our account we do so in the hope that you will immediately continue it on its way to do its full share in restoring confidence and prosperity for us all.

The spirit of patriotic co-operation should govern us all at this time—and the most practical method is for us to pay the bills we owe

American merchants and manufacturers have never been found wanting in a patriotic emergency. Put your shoulder to the wheel with the rest of us—NOW

Yours for continued prosperity,

The S. Obermayer Company

To "The Man Who Signs the Checks"

The spirit of patriotic financial co-operation should govern us all at this time—and the most practical method is for us to pay each other the bills we owe

We are doing what we can in that direction. Will you help us? We'll promise to start your remittance on its way immediately upon receipt, to do its full share in restoring confidence and prosperity for us all

The S. Obermayer Company

The cause of business panics is fear, *i. e.*, simple cowardice. They belong in the same class as the stampede, caused in a crowded theater by some hare-brained monkey yelling "Fire!" when he has smelled only the smouldering butt of a bad cigar. But the majority does not stop to investigate. Men and women rush madly out, tearing clothes, bruising flesh and breaking bones as they go. The saner-minded set an example in calmness by quietly staying in their places. So it should be in the business world. In time of money trouble the solid business man who has his own best interests and those of the community at heart, will not withhold payment of debts as they come due so that he can hoard his cash. On the contrary, he will pay them with more than usual promptness, if possible, and so help "keep the ball a-rolling."

* * *

The results of the trials with the new turbine German cruiser, *Stettin*, are given by the *Mechanical Engineer*, as follows: The ship achieved a speed of 24 knots within 1 minute, 8 seconds, of starting the engines, and came to a dead stop, from full speed, in 1 minute, 45 seconds.

LAYING OUT CAMS FOR RAPID MOTIONS.*

F. H. SIBLEY.†

We may consider a cam mechanism as being made up of two elements. As generally constructed, one element is a revolving plate, cylinder, cone or sphere, and the other element is a bar or a roller which has some form of reciprocating motion. The revolving piece is usually made the driver, although the mechanism may be made to work in the reverse order. The shape of a cam will depend upon the kind of motion that the follower is required to have. The motion of cams that are used for driving parts of machinery may be one of four kinds, *viz.:*

1. *Uniform motion*, in which the follower is made to pass over equal spaces in equal intervals of time.

2. *Intermittent motion*, periods of motion being interrupted by periods of rest.

3. *Simple harmonic motion*, in which the follower is accelerated from rest to a maximum velocity and then retarded again to a state of rest, following the harmonic cycle.

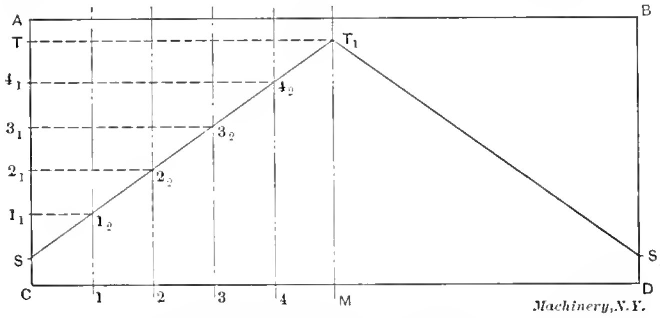


Fig. 1. Development of Uniform Motion Curve.

4. *Uniformly accelerated motion*, in which the follower is accelerated from rest to a maximum velocity and then retarded again to a state of rest, the acceleration being uniform, as, 1 inch per second, 2 inches per second, etc.

In slow-moving machinery it may not be important whether the follower moves with uniform, simple harmonic, or uniformly accelerated motion, but in machines where the cams have a high rotative speed, and the follower a reciprocating motion, as in the case of sewing machines and in some textile machinery, a uniform rate of motion will be unsatisfactory or impossible. The reason for this is that the follower is impelled from rest to its maximum velocity instantly, and also brought to rest from a maximum velocity instantly. This gives it a sudden jerk at each end of the motion, which is very trying to a machine when the reversals take place rapidly. Cams for high rotative speeds, where the follower has a reciprocating motion, should, therefore, be so designed that the follower will start gradually, attain its maximum speed near the middle of its path, and then gradually come to rest. In other words, the follower should have a uniformly accelerated motion during the first half of its movement, and a uniformly retarded motion during the last half.

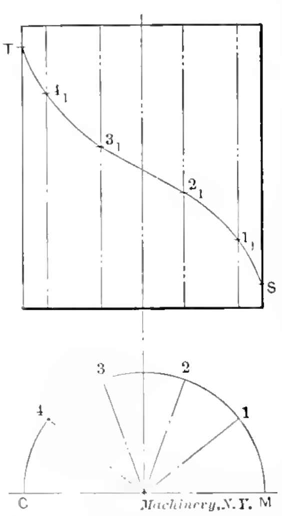


Fig. 2. Uniform Motion Curve scribed on Cylindrical Surface.

In uniformly accelerated motion $S = \frac{1}{2} Pt^2$ where S = the distance passed over, P = the acceleration and t = the time. This is the same as saying that the distance which the body has passed over at the end of any number of units of time varies as the square of the number of such units. For example, if a body has a uniform acceleration of 2 inches per second $S = \frac{1}{2}\ (2)\ (1)^2 = 1$ for the first second; $S = \frac{1}{2}\ (2)\ (2)^2 = 4$ for the next second; and so on. This is also the law of falling bodies whose motion is not resisted by the air or other medium. Uniformly retarded motion obeys the same law. If the time intervals of such a motion be plotted as abscissas and the corresponding space intervals as ordinates, with reference to coordinate axes, the resulting curve will be a parabola, and this is the curve that should be used for the outline of cams that are designed for high rotative speeds.

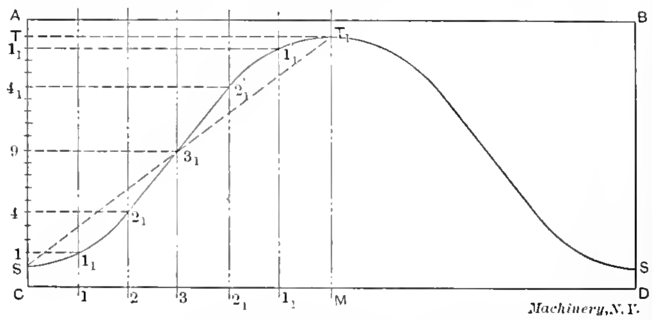


Fig. 3. Development of Uniformly Accelerated Motion Curve.

The cams shown in the following sketches do not necessarily represent any existing forms; they simply illustrate how the principle may be applied to certain shapes of cams and paths of followers. In Fig. 1, lay out on a sheet of paper $A\,B\,D\,C$ a line constructed as follows: Bisect $C\,D$ at M and divide $C\,M$ into any convenient number of parts, say five. Lay off on $C\,A$ any distance $S\,T$, and divide $S\,T$ into the same number of parts as there are in $C\,M$. Through the points 1, 2, 3, etc., on $C\,M$, erect perpendiculars to $C\,M$, and through the points 1_1, 2_1, 3_1, etc., on $C\,A$, draw parallels to $C\,M$ intersecting the perpendiculars at points 1_2, 2_2, 3_2, etc. A line $S\,T_1$ drawn through these intersections will be straight. The line $T_1\,S_1$ can be found in the same way. Now if the sheet of paper $A\,B\,D\,C$ be wrapped around the outside of a cylinder

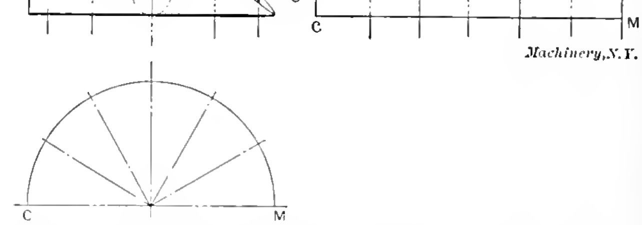


Fig. 4. Transferring Uniformly Accelerated Motion Curve to Cylinder.

whose circumference is equal to the distance $C\,D$, the line $S\,T_1$ will take the position $S\,T$, Fig. 2, and the line $T_1\,S_1$ will form a similar curve on the reverse side of the cylinder. If this curve be made the center line of a groove, as the cylinder revolves on its axis, the groove will drive a follower up and down, parallel to the elements of the cylinder, with a uniform speed. The follower will start and stop at either end of its motion with a sudden jerk.

In Fig. 3 let $A\,B\,D\,C$ represent the paper as before. Bisect $C\,M$ at 3, and $S\,T$ at 9. Divide $C3$ and $3M$ into any convenient number of parts, say three; then divide $S9$ and $9T$ into the square of three parts, or 9, as shown. Erect perpendiculars to $C\,M$ at the points 1, 2, 3, etc., and draw parallels to $C\,M$ through the points 1, 4, 9, 4_1, and 1_1. Through the points S and T_1 and the intersections 1_1, 2_1, 3_1, $2'_1$ and $1'_1$, draw a smooth curve. This line will be a parabolic curve, reversing at 3_1. The curve $T_1\,S_1$ is constructed in the same way. Now wrap the sheet of paper $A\,B\,D\,C$ around a cylinder whose circumference is equal to $C\,D$. The curve will take the position $S\,T_1$, Fig. 4, and the curve $T_1\,S_1$ will take a similar position on the reverse side of the cylinder. A groove made with these curves as center lines will drive a follower P up

* For additional information on this subject, see "Notes on Cam Design and Cam Cutting," August, 1907, and other articles there referred to.

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and down through the distance K, as the cylinder is rotated on its axis. The follower will start gradually at S, attain its maximum velocity, and then come gradually to rest again at T_1, the motion being uniformly accelerated and retarded. The sides of the groove are made parallel to $S T_1$, and drawn at a distance away from it equal to the radius of the follower P.

Fig. 5 shows the distortion of the curve $S T$ when the follower moves in the arc of a circle, with center at some point Q, instead of in a straight line. Points on the new curve are found by setting off from the intersections $b_1 d_1$, etc., the ordinates $a b$ and $c d$. The curve $S a_1 c_1 T$ is then made the center line of a groove which will drive the hinged follower with the same variation in speed attained by the follower in Fig. 4.

Fig. 6 shows how the parabolic curve is applied to a plate cam. The roller follower is supposed to oscillate between P and P_1 as the cam rotates about O. The curve $P 3_2 P_1'$ corresponds to $S T_1$ in Fig. 4, being the center line of the parabolic groove in the face of the plate. Only one-half of the cam is shown in the figure. Suppose this cam is to rotate 180 degrees, while the follower moves from P to P_1. Draw the base circle with radius $O P$, the length of which will depend upon the size of the cam. Draw $O A$ perpendicular to $O P$, and divide the arc subtended by $P O A$ into any convenient number of parts, say three. Draw radii $O1_2$, $O2_2$, etc. Divide $P P_1$ into two equal parts at 9, and divide $P9$ into the square of three parts, or 9, as shown. With O as a center, and radius $O1$, find the intersection 1_2. In the same way find the other intersections 2_2, 3_2, etc., and draw a smooth curve through these points. This curve has the same relation to the curve of uniform motion shown dotted, that the parabolic curve has to the straight line in Fig. 3. If a similar curve be laid out on the other side of $P P_1'$, and made the center line of a groove then the follower P will be pushed up and down mechanically by direct contact. If a curve parallel to $P3_2 P_1'$, and drawn at a distance equal to the radius of the follower away from it, on the inside, be made the outline of the cam, then the follower will be pushed up mechanically to P_1, and allowed to fall by its own weight. It will remain in contact with the cam theoretically, because the principle of uniformly accelerated motion is the same as that of a falling body. In practice, however, the friction and the inertia of the connected parts would probably prevent the follower from remaining in contact with the cam on its return motion if the oscillations were rapid.

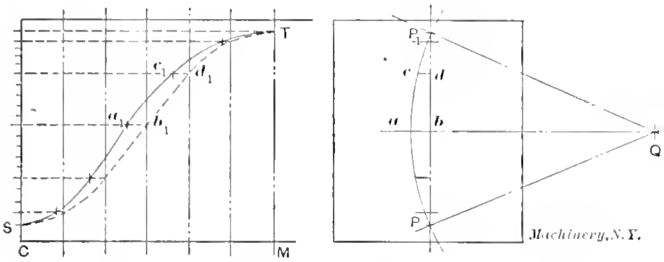

Fig. 5. Accelerated Motion Curve, when Follower moves in the Arc of a Circle.

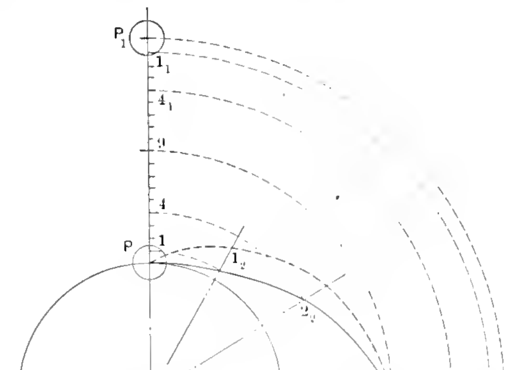

Fig. 6. Accelerated Motion Curve applied to Plate Cam.

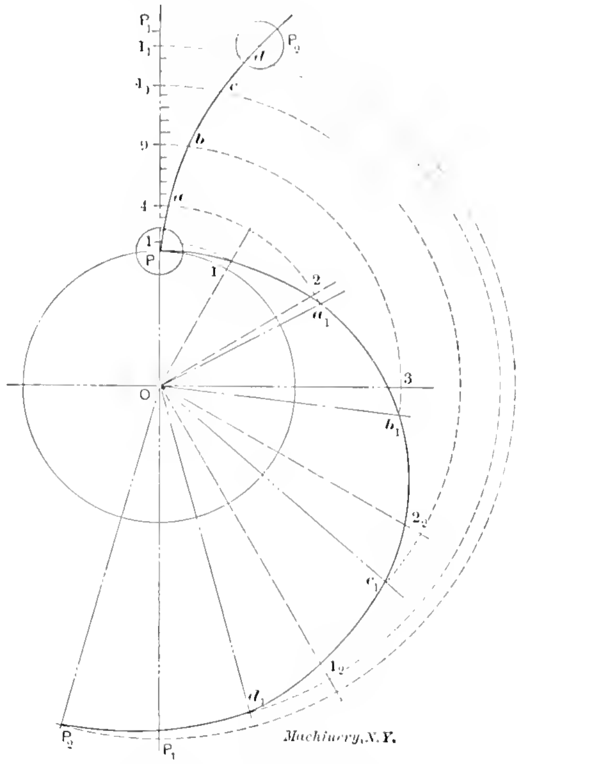

Fig. 7. Accelerated Motion Curve applied to Plate Cam, with Follower moving along a Curve.

Fig. 7 shows the parabolic cam constructed for a follower which moves in any curved path. The construction is the same as in Fig. 6 except that points in the curve are located on radial lines Oa_1, Ob_1, etc., offset from the first radii by the distances $2a_1 = 4a$, $3b_1 = 9b$, and so on.

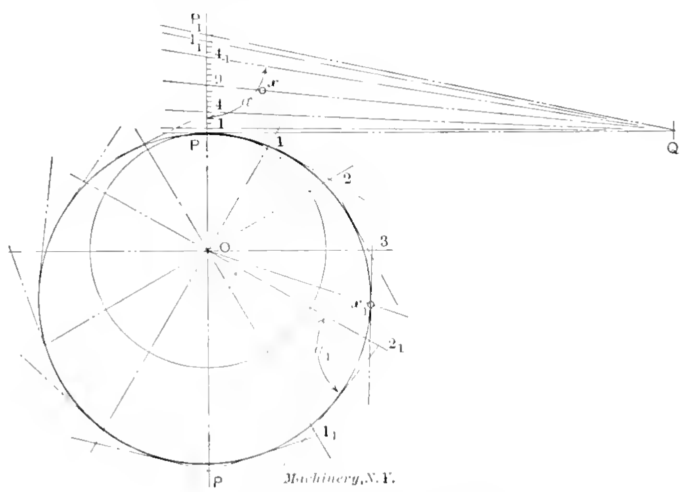

Fig. 8. Plate Cam for Bar Follower.

When a plate cam is to be laid out to drive a bar follower through a certain cycle of operations, the construction is more complicated. The base circle is divided as in the previous case into any convenient number of parts and the square of the number of such parts laid out from P to 9 and from 9 to P_1, Fig. 8. If the bar is to oscillate about Q as a center, it will take the positions $Q1$, $Q4$, $Q9$, etc., as the radii $O1$, $O2$, $O3$, etc., come to the position OP. The intersections 1, 2, 3, and so on, are found just the same as in the previous cases. Now instead of drawing the curve for the cam outline through these

points, straight lines which represent the edge of the follower must be drawn through the points making the same angle with a given radius as the follower makes with OP when the radius in question is in the position OP. For example, angle a equals angle a_1. Now the cam outline is a smooth curve drawn tangent to these straight lines. If the bar follower, instead of being centered at Q, moves up and down parallel to its first position, then all these angles are right angles. If the face of the bar is curved, then the cam outline must be drawn tangent to the curves after they have been properly located with respect to their several radii.

In drawing cams like Fig. 8, the proper relation between the diameter of the base circle and the distance PP_1 must be assumed. If the base circle is too small, the cam outline will not be tangent to the edge of the follower in all positions, and the latter will not have uniformly accelerated and retarded motion. There is a rolling and sliding contact between the cam and its follower in the case of Fig. 8. The rolling action tends to carry the point of contact outward to the right of OP, during the upward motion, and to bring it back towards OP during the downward motion. The point of contact x does not necessarily occur when Ox_1 is perpendicular to Qx.

* * *

VERTICAL CAMERA BRACKET.

ETHAN VIALL.*

In photographing small objects that cannot be readily hung up or pinned to the wall, one is often at a loss to know how to get a satisfactory picture. This is especially true of drills, reamers and objects of that class, and makeshifts of various kinds are resorted to to hold the camera in a vertical position in order that the articles may be laid on the floor.

None of the camera catalogues that I am familiar with list a bracket for this purpose, and so I made one, which is

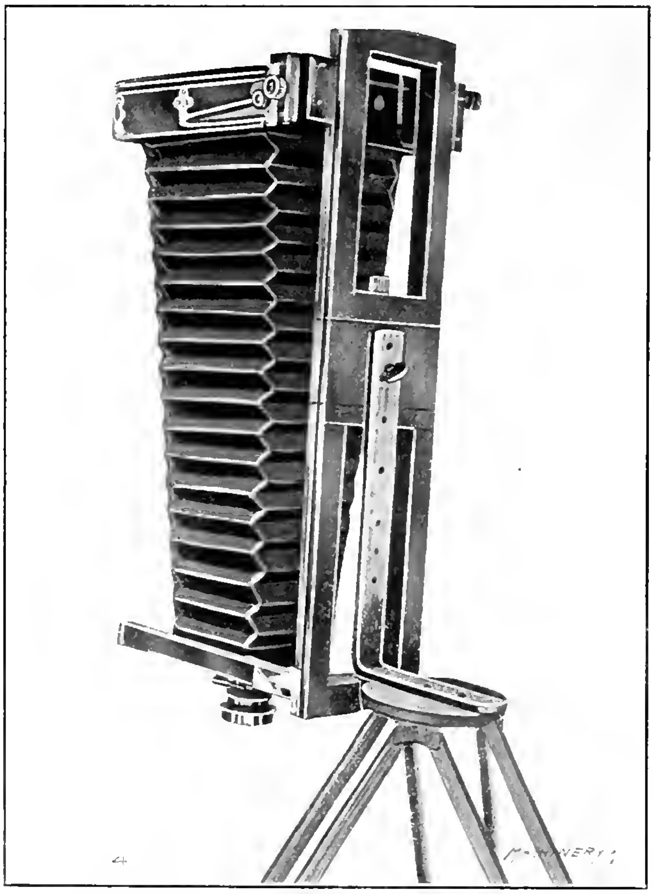

Fig. 1. Bracket in Use with Long Arm screwed to the Camera.

strong, rigid, and answers every requirement. It is easily carried in the camera case, taking up but little room. My camera is a large, heavy, view camera, and so the bracket I made is heavier than would be needed for a light instrument.

The bracket was made of a flat piece of stiff steel, ¼ inch thick, 1¼ inch wide, and 18 inches long. This was bent into the form of an L, the long arm being 12 inches and the short one 6 inches long. Holes were drilled and tapped in several places in each arm. These holes were tapped the regular ¼ inch 20 threads, used almost universally for camera fittings. A thumb-screw similar to the one in the tripod top was made. The bracket was polished and was then ready for use.

In Fig. 1 the camera is shown with the bellows drawn out full length and the camera fastened to the long arm. This position is often very convenient. For copying pictures I generally use the long arm down, as this position, with the bellows extended, brings the lens close to the floor.

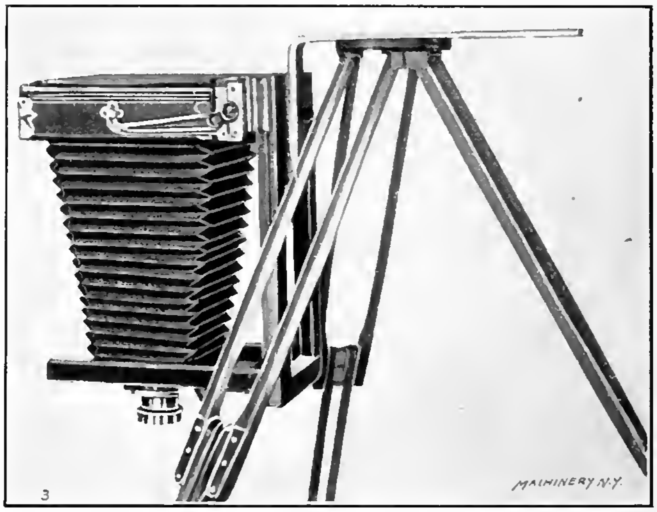

Fig. 2. Bracket in Use with Short Arm screwed to the Camera.

Fig. 2 shows the bracket in place with the short arm screwed to the camera, and the long arm extending over the tripod top. This was done so that if it were necessary to set the tripod legs in such a position that the camera would overbalance, a weight could be hung on the long arm. In ordinary work where the tripod legs are properly spread no tendency to tip is noticed.

A photographer will soon find that this bracket quickly pays for the hour's time taken to make it, and he will wonder how he ever got along without it. By using the different holes in the bracket and the adjustments of camera and tripod, any position may be obtained as one using it will quickly see.

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* * *

A committee of the Chicago Association of Commerce has reported adversely on the question of the inauguration of a parcels post, proposed by the Postmaster-General. The chief objection stated is that a parcels post would involve a much larger annual loss in the running of the post office department than is at present the case. A number of other reasons are also mentioned, amongst others, that it would cause the government to enter into business competition with private concerns. This probably is, if it were possible to analyze the true reason of the opposition, the main objection. The monopoly of the express companies must, by all means, be considered, even if the public at large is the loser. While it seems that a question of this kind does not strictly pertain to mechanical matters, such as are dealt with in MACHINERY, it is still worth while mentioning the fact, because it is undeniable that the benevolent influence that would in reality be the result of a parcels post, would react on all kinds of business in the country, placed on a legitimate basis, and therefore it is in the interest of mechanical men, as well as others, that reforms of this character are carried through. Progress in one direction always tends to stimulate progress in all other lines.

* * *

A CORRECTION.

An error was made in the note, appearing in the December issue, which described a novel machine foundation built in the Stockbridge Machine Co.'s shop, Worcester, Mass. The machine erected on this foundation is a Bullard "vertical turret lathe." This machine was described in our October issue on page 119, engineering edition.

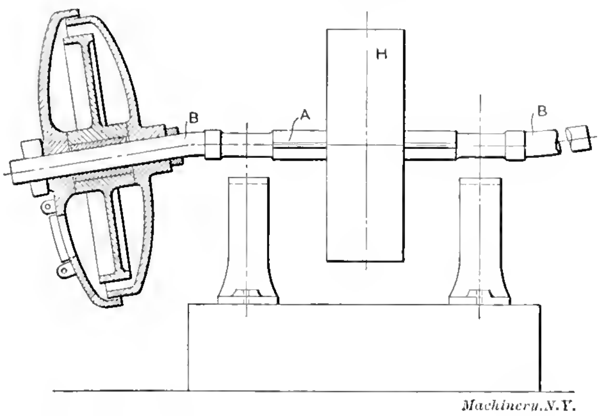
ITEMS OF MECHANICAL INTEREST.

NOVEL USE OF ELECTRIC FLAT-IRONS.

It is not often that heating units from electric flat-irons are put to as severe a test as in the instance given below. The problem was to replace a crank-pin on the high-pressure side of a 500-horse-power cross-compound Russell engine. The new pin, 6 inches diameter with a taper of 1/64 inch, was to be fitted into a crank-disk, 5 inches thick, which was fixed on a 12-inch shaft. To expand the disk by heating it with blow-torches would have taken too long, besides making a dirty and unsatisfactory job, so several heating units from General Electric 6-pound flat-irons were grouped around an iron core 3¼ inches diameter, and placed in the 6-inch hole in the crank-disk. In four hours after the current was turned on the disk had expanded sufficiently to allow the crank-pin to slip in. Although the heating units were at about white heat all of the time, they were not injured except that the brass tubing on two was slightly melted in one place. After having served for fitting the crank-pin, the heating units were replaced in the flat-irons and continued in their normal use.

CLEANING CAST GEARS.

Some time ago a new procedure for cleaning cast iron gears from scale and molding sand was shown in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge.* This process consists in placing the gear inside a casing, together with any desired cleaning material, the casing being fastened on a bent shaft, so that when revolved, the whole mechanism gets a kind of



Device for Cleaning Cast Iron Gears.

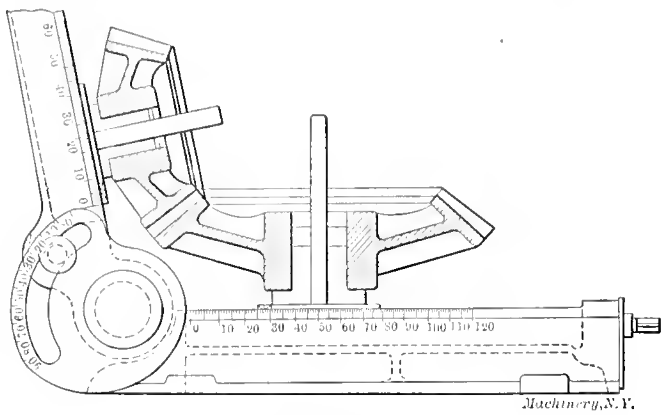
oscillatory motion. Referring to the cut herewith, *A* is a shaft having bent portions *B* at each end. The device is driven by pulley *H* on shaft *A*, to each of the bent portions of which gear wheels are clamped. The advantage of making the apparatus double, that is of having a bent portion on each end of the shaft, the bends being made in opposite directions, is to secure a balance at the high rotation of speed desirable. A perfect balance, however, cannot be obtained in this manner, as it is easily seen that the cleaning material, for instance, will not be distributed equally in the casings, but will always tend to fall toward the bottom, thus preventing a balanced condition to be produced. At anything but the very highest speeds, however, this question of balancing cannot be of very great importance in an apparatus of this kind.

R. G.

GERMAN BEVEL GEAR TESTING DEVICE.

A recent issue of the *Zeitschrift für Werkzeugmaschinen und Werkzeuge* contains a description of a fixture for testing bevel gears. As shown in the cut, it is essentially a protractor, provided with sliding blocks carrying pivots on which are mounted the gears to be tested. Besides the protractor graduations for setting the gear axes to the required angle, graduations are provided for showing the setting longitudinally of the sliding blocks on the two arms. The only use we can see for these graduations would be in case the device was opened out to 180 degrees, and used for testing spur gears, in which case it could be set to give the required center distance. In measuring bevel gears the angle is generally a matter of prime importance, the hub lengths being fitted to suit. As may be seen, the lower member or bed of the device is provided with a traversing screw for adjusting the sliding block, carrying the pivot and the gear; doubtless the upper one is also so arranged. Means are provided for clamping all adjustments after they are made.

This device serves the same purpose as those made for sale in this country by firms making a specialty of gear-making

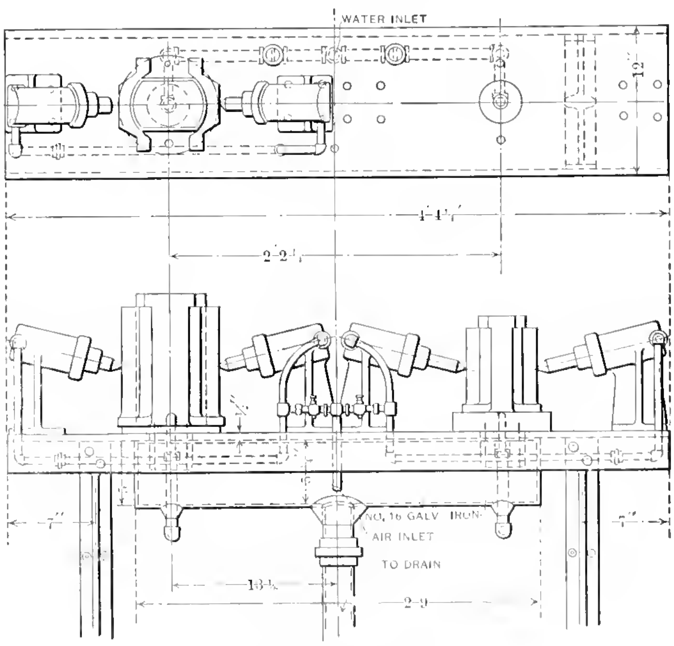


Protractor for Testing the Accuracy with which the Teeth of Bevel Gears are cut.

machinery. They are in common use in gear cutting. Such advantage as this particular device appears to have lies in its comparative smallness and lightness, and being a fixture or bench tool rather than a complete machine.

LINING CAR BRASSES.

The accompanying cut reproduced from the November issue of the *American Engineer and Railroad Journal,* shows a device in use at the Collinwood shops of the Lake Shore & Michigan Southern Railway, for lining car brasses. The apparatus consists of two pairs of air cylinders, suitably mounted on a 12-inch channel beam, as shown. The cylinders are bored to 2 3/16 inches diameter. The piston rod is inclined downward and pointed at the end, so that, when air is admitted to the cylinders, the brasses are held firmly against



Device for Holding the Car Brasses.

the mandrel. A coil spring is fitted in the cylinder, so that, when the pressure is released, the piston will be forced back, and the brass can easily be removed. The mandrel is cored hollow, and streams of water are played on the inside by means of a pipe cap with four ⅛-inch holes in it, which is placed on the end of the supply pipe, thus cooling the lining metal as it is poured. Guide strips are cast on each side of the mandrel to hold the brasses the proper distance from it. The brasses are tinned before lining.

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FEBRUARY, 1908.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

HINDLEY WORM GEARING.

It is generally conceded by designers and intelligent users of worm gearing that the Hindley or hour-glass worm has certain advantages over the common type, and they will in the same breath describe its disadvantages. Its chief advantage is that it fits the worm-wheel over a considerably greater area than is possible with the ordinary worm. The larger area of contact reduces the pressure per unit of surface, and that means better lubrication, longer wear and less frictional resistance. Its disadvantages are that it must be exactly located, it is not interchangeable with worm-wheels of the same pitch but of greater or less number of teeth, and it must be made by special machinery. The disadvantages of non-interchangeability and of requiring special machinery are probably least important; but to locate the Hindley worm exactly and preserve that location are not easy. Change of position due to wear of the thrust bearing does little or no harm to the common worm, but it is absolutely ruinous to the Hindley type. Notwithstanding the drawbacks, its superior efficiency and longer life have made its use considerable. Curiously, however, there is an almost total lack of published data on dimensions, and we would gladly receive contributions on the subject for our data sheets.

* * *

ARE SPRING AND WEIGHT EQUIVALENTS?

In United States patent practice a mechanical equivalent has been legally defined as that which performs the same function in substantially the same manner as the compared device. A recent decision (1905) holds that a spring and weight are equivalents in certain competitive plumbing fixtures, inasmuch as one effects the same action as the other in the infringing device. The decision undoubtedly is sound for the case in contention; but, unfortunately, it reads further on: "The interchangeable use of springs and weights is the stock illustration for equivalents."

Our criticism is that the "stock illustration" holds good only when springs and weights *are* interchangeable; and this condition exists within a narrow range only, as every engineer knows. Springs and weights are not broadly interchangeable. A weight must act in accordance with the law of falling bodies. It can fall at no greater speed than expressed by the formulas $v = gt$, or $s = \frac{1}{2} gt^2$; whereas a spring, having little weight in proportion to the energy exerted within a narrow range of action, may, because of its less inertia, perform functions in a small fraction of the time required for a weight. Hence, a weight often is inoperative where a spring works successfully. Again, a difference of great importance is that a weight must act in a direction toward the earth, or that approximately. A spring, of course, works practically as well in one direction as another.

Now, if the stock illustration means that a spring and weight are equivalents *only* when interchangeable, and being thus interchangeable because of the limitation implied, then there is nothing more to be said. Otherwise the statement is loose and technically untrue, and tends to show that scarcely anything is more difficult than exact definition.

* * *

CHOOSING A TRADE.

The choice of a trade, though important, is often made without investigation. Boys enter a trade blindly, with little understanding of what they are to learn or the position their chosen occupation occupies in the world's affairs. They do not know whether it is lasting or ephemeral. For that matter, of course, no one can judge with certainty of the permanency of any skilled occupation; but we may infer much from past experience and a knowledge of its relative position in the general manufacturing industry. We know that once flourishing trades have become obsolete because of changed customs, improved machinery, exhaustion of materials, etc.; and the skill acquired by their craftsmen is now of no value. Such changes, if they come quickly, are little less than tragedies to the individuals directly affected.

The beginner then should, first of all, get an idea of the probable permanency of his proposed occupation, the prospects for advancement and the possibilities it offers as compared with others. To do this thoroughly is a considerable undertaking, and one beyond the intelligence of most boys; but their mature friends often could prevent bad mistakes if they would make even superficial investigations.

New occupations are constantly springing up. Some of them will be of long duration and well paid, but the majority are short-lived and to be avoided by the prudent. Of all the trades in existence, probably there is no other that is as important or that offers the same permanency as the machinist's trade. It is a basic art upon which all other manufacturing industries depend. In olden times the blacksmith was the chief craftsman, inasmuch as he made tools for all the rest—and for himself; but the supremacy of the blacksmith long ago departed. The cold working of metals has very largely displaced forging to shape while in the hot and plastic state, and, in machine construction forged work now enters to a very small extent. Many tools and machines are made in which the primitive art of the blacksmith appears in no shape whatever. The rolling mill shapes the shafting, and itself is the product of the machine shop. The lathe, drill, planer, shaper, milling machine, power press and other metal-working tools have almost entirely displaced the smith. Now it is the machinist and machine shop that produce tools and machines for all manufacturers. The machine shop is the fountain head of all modern mechanical industry. All machinery of every description, the printing press, sugar mills, hoisting machinery, locomotives, stationary and marine engines, etc., are the product of the machine shop and the skill of the machinist, machine designer and mechanical engineer. So it may be reasonably claimed that no trade to-day offers as much security as those which have to do with the operation of machine tools and the hand processes which should be included in the education of an all-around machinist.

The demand for skilled machinists is growing, and it will continue to grow with the years. We speak of this as a mechanical era, but we are only at its beginning. Not all can be machinists, of course, no matter how great the development; but the fathers who read MACHINERY can safely advise their sons and their friends' sons who have an inclination in that direction, to enter the trade. Specialization which tends to keep the rank and file employed merely as operators, gives all the more opportunity to the bright and ambitious.

LOOK FORWARD.

The bright side is the one to look for always, and the man who has the ability to find it possesses a source of strength that, with work, is almost certain to triumph over difficulty. We should not overdo it as was the case with some of the daily newspapers that recently published misleading reports of trade revivals, doing more harm than good. The more evenly each of us keeps balanced just now, the better it will be for all; and somewhere between the extremes will be found the facts which every business man needs to shape his course.

An investigation of conditions in our branch of the machinery industry shows that since January first there has been considerable general improvement and as much as could be expected of recovery, after the staggering blows in the last months of 1907. The situation is fundamentally sound. Money is becoming more plentiful. Confidence is gradually returning, and although the days go by slowly now, before the end of the year, stronger and perhaps wiser, we shall be looking forward to another period of prosperity.

* * *

PRODUCTION AND USE OF DENATURED ALCOHOL.

The annual report of the Commissioner of Internal Revenue, just issued, shows that the production and use of denatured alcohol has not yet attained much importance in the United States. It states that only ten stills have been set up for producing denatured alcohol, and it is claimed that the cost of the product is much greater than that confidently predicted at the time the industrial alcohol law was passed by Congress. It is further alleged that the present prospects for denatured alcohol competing actively with kerosene and gasoline are not at all encouraging. Those who worked hard for the measure feel considerably disappointed that the good results experienced in Germany have not been realized here.

In our opinion it is still too soon to feel disappointed and discouraged that denatured alcohol has not quickly become an important internal combustion engine fuel or a general illuminant. The change on the part of the public requires time, and time is also required by distillers to get their plants into efficient working shape. Moreover, the internal revenue regulations first prescribed were quite sufficient to discourage any would-be small producers. They were required to work under conditions but little less rigorous than those prescribed for the regular distillers of liquors for general consumption. The revised regulations which went into effect September 1, 1907, are much less restrictive, and considering the nature of the business, are probably all that can be asked for.

There is still another factor to reckon with, and that is the effect of nearly fifty years of stern enforcement of the laws against illicit distilling. Possible small producers have a dread of doing something that will subject them to the wrath of the internal revenue officers, and coupled with that feeling is the prejudice existing in many communities against engaging in a business that is seemingly contrary to temperance sentiments. The fact that the product is distinctly not for drinking will not immediately remove that prejudice. Initiative in production has also been lacking, because of general ignorance of the business, but when the ice is once broken there will be numerous small plants started, no doubt.

While it is possible to make alcohol from almost all vegetable refuse, it appears that it is not profitable under present conditions to make it from corn or other grains. Potatoes offer the cheapest source of alcohol at the present time, but even they are somewhat too costly. It is safe, however, to predict that the ingenuity of our inventors and the enterprise of our manufacturers will develop processes which will utilize the vast quantities of vegetable refuse now rejected and wasted.

We therefore believe that although the farmers have not yet gone into the making of denatured alcohol in large numbers, the prospects for its general industrial use are bright. Prejudice, the opposition of the vested interests, uncertainty as to the meaning of government regulations, and ignorance of the business in general have been quite sufficient to hold back its development. With time will come more knowledge and experience, and a greatly reduced cost of the product, with the correlative of enormous use.

* * *

PIRATING SPECIAL MACHINE TOOLS.

Some months ago an incident was brought to our notice which illustrates the peculiar folly into which machine tool builders sometimes fall; that is, pirating special machinery. It is a practice of which we have recently heard little, for almost all manufacturers have had about all they could do to attend to their own work, but as business slackens such incidents may increase. The moral aspect of such competition is elusive, and we will merely point out its unprofitableness in general.

There are those who build special machines intelligently, with the wisdom of long experience in similar lines of work and a comprehensive idea of the needs of the work. Their would-be competitors build with a hazy knowledge of the special requirements, and only a general idea of the essential features of design. The last are copyists; or, more plainly speaking, pirates, who do not hesitate to steal the ideas of men who have spent years to perfect features of machine design.

The incident referred to centers around a Western manufacturing concern which bought a heavy special machine tool from an Eastern builder. It was for a purpose and of a design which precludes a general sale; perhaps not more than five or six could be sold in the whole United States. The concern in question having purchased one machine found that they needed another, but, although the price was satisfactory, could not get delivery from the builders as soon as desired. Thereupon, another machine tool company, young at the business, and of the "unafraid" type, tackled the job and produced a copy of the first machine which was delivered two months earlier than the time stipulated by the Eastern builder. But the pirating concern, building the second machine, lost money, or at least made no profit—and the purchaser got a poor machine. It appears from this incident that three concerns were losers; whereas if strictly legitimate business methods had been followed, there would have been a satisfied customer, a machine sold at a profit, and profitable employment for the "butting in" concern at its own particular business, in which it excels.

To be a successful builder of special machinery, a concern must not only be a specialist in design, but in production as well when it enters into competition; and if this incident teaches any particular lesson it is simply that builders of special machinery make a mistake when they initiate cutthroat competition, because this branch of the machine tool trade generally yields only moderate profits at the best.

* * *

A committee appointed by the Association of Railway Superintendents of Bridges and Buildings to report on the action of sea water on concrete, has collected the opinions of a number of men engaged in work of this kind. The following statements embody the substance of the expressed opinions. Where there is no ice formation, concrete, if made in air with fresh water and then sunk into sea water, works well, but shows a tendency to disintegrate slightly on the faces between low and high water levels. Concrete should not be deposited direct into sea water. Where the salt water permeates the whole mass of the concrete, the faces disintegrate faster than where the concrete is mixed with fresh water and made in air and then sunk into position in the sea water. Between low and high water the faces of the concrete show a tendency to disintegrate. All opinions agree that concrete should be faced with granite above low water, on account of this tendency of the rise and fall of the tide to disintegrate the concrete. It is also agreed that frost and ice formation, where the tide rises and falls, has a greater tendency to disintegrate the concrete. It will be recollected that, in a note in the engineering review of MACHINERY, October, 1907, we mentioned an article on this subject contributed by Mr. M. H. Le Chatelier to the *Annales des Ponts et Chaussées*, in which he claims that all hydraulic binding agents used for cement and concrete may be decomposed by sea water.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

One of the most complete railroad testing laboratories in this country has been completed by the Union Pacific Railroad, at its new Omaha shops. This laboratory includes complete equipment for physical and chemical tests of all kinds, as well as bacteriological investigations, electrical experiments, metallurgy, etc.

The *Moniteur Industriel* mentions the fact that the "Compagnie des Omnibus" in Paris has found it to be greatly advantageous to use alcohol instead of petrol as fuel for their motor cars. In Paris the price of petrol, at the present time, is about 48 cents a gallon, while alcohol is sold at the price of 34 cents a gallon; but to obtain equal results 5 per cent more alcohol is required.

A new example of the industrial development of Japan has been given by the announcement of the fact that the new armored cruiser *Ibuki* was successfully launched only six months after the keel was laid. All the materials used were of Japanese make, and the building and launching of this vessel is considered in ship building circles as marking an epoch in the history of naval construction in Japan.

It is stated that a new British torpedo boat destroyer, the *Mohawk*, is the fastest vessel in the world. She maintained for six hours at her official trial an average speed of 34¼ knots, and for six runs over a measured mile the speed was 34½ knots, which is equal to about 40 statute miles per hour. The vessel is fitted with steam turbines and uses oil fuel. The oil consumption is so low, comparatively, that the vessel will have a much wider radius of action than have much slower vessels.

The *Journal of the Franklin Institute* contains some interesting figures regarding the magnitude of the Baldwin Locomotive works. According to the figures given, the men employed are about 19,000. The horse-power employed in steam and oil engines amounts to nearly 17,000, and the consumption of coal per week is 3,000 tons, and of iron, 5,000 tons. The machinery is largely driven by motors, there being 1,115 motors in the works, representing 14,200 horse-power. The area of the buildings comprises 6 1-3 acres.

It is stated by the *Zeitschrift des Vercines Deutscher Ingenieure*, which journal had this information from an English source, that the cost of repairs on the English cruiser *Amethyst*, which is driven by steam turbines, has been decidedly lower than the repair costs on vessels of the same type driven by reciprocating engines. If the cost of maintenance of turbines, as compared with that for reciprocating engines, should, in general, prove to be lower, this will be one very important point in favor of the turbine.

An assistant professor at the Paris University, Mr. George Urbain, claims to have discovered a new metal, by separating the element ytterbium into two component parts. The new element he gave the name of *lotherium*, and he is preparing to present a complete report upon the subject before the Academy of Science. According to the *Scientific American*, Mr. Urbain states that he has already made a number of researches regarding the new element, and observed its different characteristics by chemical tests, and that he has come to the conclusion that it possesses some new properties, which will make it of great interest, from a scientific point of view.

In an article on pressure gages in the August 30, 1907, issue of *Engineering*, a few interesting facts about high pressure gages are stated. It is there mentioned that the highest mercury column is that placed in a well at Butte-aux-Cailles, France, which is about 1,650 feet high, and records up to 660 atmospheres. The next highest is that in a mine near St. Etienne, France, which is about 1,330 feet high, recording 530 atmospheres, and the one on the Eiffel tower 1,000 feet high, recording 440 atmospheres. The highest mercury column in England is at the Municipal Technical College at Manchester, which is only 175 feet high. In these very high mercury columns, it is of course impossible to use glass tubes from top to bottom. Steel or iron tubes are, therefore, used with glass tubes fixed either at regular intervals up the entire height, or at those points only where readings of pressures are likely to be taken.

The opening of the famous Simplon Tunnel, under the Alps, between Switzerland and Italy, referred to several times in our columns, has placed the people of the village of Simplon, located by the old Simplon Road, which runs over the Alps at this place, in a rather curious position, and instead of facilitating their communication with their fellow-countrymen, it has made communication somewhat difficult. Since the opening of the tunnel, the highway is not kept open in the winter, but it can be traveled down on the Italian slope, and, thence, it is possible to return to Switzerland by the tunnel, but if any goods are taken along, they have to pass through the custom-houses of Italy, and then, returning to Switzerland, the custom-houses of that country, and cattle are subject to inspection as exports from Switzerland to Italy, and then, within a couple of hours, as exports from Italy to Switzerland. The highway is closed from October to May.

It is stated in *Mercator* that a railway ferry connection between Sweden and Germany has now practically been setttled upon. This railway ferry will make it possible to run direct passenger trains from Berlin to the principal Scandinavian cities. As terminals for the ferry, Trelleborg in Sweden and Sassnitz in Germany have been selected. These two points are about 65 miles distant from each other, and the crossing of the Baltic is intended to be made in three hours and a half. The ferry is expected to be the largest railway ferry in Europe, having a length of about 365 feet. There already are railway ferry train connections between the cities on the Continent and the Danish Islands, and thence from Copenhagen by two routes to Sweden, but the present railway ferry will make it possible to shorten the time considerably, and to run trains from the Continent through to Sweden and Norway, without touching Denmark.

A recent report of the ship-building industry in the United States, issued by the Census Bureau, indicates a constant, though not as heavy an increase as has taken place in other industries. The years compared are 1880 and 1904. In the former year the capital invested was approximately $21,000,000, but in 1904 the investment had increased to $121,600,000, the number of employes increasing from about 21,000 to nearly 51,000 in the same period. The value of the work done was about $37,000,000 in 1880, and about $83,000,000 in 1904. Since 1900 there has been an increase of over 50 per cent in the production of boats under five-ton rating, due to the development of gasoline engines for such craft. Although the number of vessels of five tons and over, launched during 1904, was 167 less than the number launched in 1880, the tonnage had increased 40½ per cent during this period. The average value of the vessels launched in 1880 was not quite $8,000, whereas in 1905 the average value was $32,700.

The secretary of the Civil and Mechanical Engineers' Society of Great Britain called a meeting January 2 at Caxton Hall, Westminster, to discuss the subject of standard notation for engineering formulas. The society asks the coöperation of other engineering societies and associations in this much-needed reform. Our American engineering societies and associations should give their attention to the matter, and, if possible, agree on a standard notation. Scarcely any books agree on the meaning of symbols save a few, and, con-

sequently much space is taken up by the ever-recurring explanations of the notations. Obviously, a symbol used in engineering formulas pertaining to any subject should invariably have a definite significance. The mixed notations now used cause much confusion, and are about on a par with the confused mess of screw thread systems which we had prior to the adoption of the Sellers standard. Engineers should recognize that standards in engineering literature are just as needful as in engineering construction. The Civil and Mechanical Engineers' Society ask that schedules of suggested symbols for use be submitted. These should be sent to the secretary, Mr. A. S. E. Ackermann, 25 Victoria St., Westminster, S. W., England.

According to a recent news item, a Chicago architect by the name of Yorke has devised an arrangement of elevators for tall buildings, which seems, on the surface, at least, to be reasonable as well as ingenious. The inventor proposes to have two elevators in each shaft in a twenty-story building. For instance, the first elevator would be loaded at the bottom floor for passengers for stories from the tenth to twentieth. The second elevator, meanwhile, will be in the basement, awaiting the filling of the first. After being filled, the first elevator will run express to the tenth floor, and thence distribute its load between there and the twentieth. The lower car has, meanwhile, been filling at the first story, and it starts on an upward distributing trip from the first to the tenth stories, reaching the tenth story at about the same time that the upper car does the twentieth. The operation is reversed when coming down, the first car collecting from the twentieth to the tenth and running express to the bottom, which the lower car, running local from the tenth has already reached, discharged its passengers, and descended out of the way to the basement.

The idea is, of course, to reduce the space required for elevators in very tall buildings. This is a serious matter when there are twenty stories or more, as a glance at the floor plan of any such building will show. It ought to be possible to provide the necessary safety devices for preventing the cars from colliding, and, if this is the case, the idea ought to be a feasible one. It is said that the plan is to be tried in the immediate future in buildings in both New York and Chicago.

An interesting note in the *Zeitschrift des Vereines Deutscher Ingenieure*, for December 7, 1907, makes mention of a new means of transmission of power, introduced by the Eloesser-Kraftband-Gesellschaft, Charlottenburg, Germany. The power transmitter employed is made of thin steel bands, used instead of leather belting or rope drive. These steel belts, as they may be called, run either on ordinary pulleys, the same as leather belts, or, better, over pulleys provided with a special covering for giving greater friction. The dimensions necessary for these steel belts may be most easily comprehended by referring to the dimensions of belts used in actual installations, which the company referred to has carried out. Powers from 200 to 250 H.P. with a belt speed of about 5,400 feet per minute, are transmitted with a steel belt 4 inches wide and 0.02 inch thick. It is stated that these steel belts need be made only about one-sixth the width required for leather belts, for transmitting the same power. This, of course, is a great advantage, as it permits pulleys to be much narrower, and, at the same time, permits the bearings for the shaft on which the pulley is mounted, to come much closer together, consequently permitting, in many cases, smaller diameter of shaft, as it often is the case that the diameter of a shaft has to be provided not so much for taking care of the turning moment produced by the transmission of the actual power, but for giving sufficient stiffness to resist the bending moment between the bearings. Another advantage, with this kind of belting, is that the steel belt does not lengthen when in use, at least, not to any appreciable extent, like the leather belt, and that a correct tension in the belt is far easier to obtain. Experiments with these steel belts, carried out by Prof. Kammerer, have shown that it is possible to run them at a peripheral speed of the pulleys of 12,000 feet per minute.

NOVEL USE OF THERMIT.

Industritidningen Norden, December 6, 1907.

Thermit, as our readers may recollect from former references made to this subject, is a welding process, invented in Germany, in which a mixture of aluminum and iron oxide is employed for welding. When the aluminum, which is introduced in a pulverized form, is ignited, it takes oxygen from the iron oxide, thereby producing aluminum oxide, and free iron. By this an enormously high heat is developed, estimated to be over 5,000 degrees F., so that the iron is easily melted, and this makes it possible to employ this means for welding. A new and peculiarly interesting example of the use of thermit has been proposed by the German inventor, Mr. Hasenkamp. In iron structures, particularly in the case of bridges where several members are in tension, it often happens that some of the members do not take their full share of the stress, or, in other words, that they would need to be shortened so as to take their share of the load. For correcting this, in many cases, the members have been taken down, and adjusted as to length through forging in an ordinary blacksmith shop. This way of doing the work takes a long time, is expensive, and, at the same time, it makes it necessary to stop the traffic on the bridge while this work takes place, to prevent any accident from failure of the remaining members. These difficulties are avoided by bringing the members to a red heat while in place, by means of thermit, at several points between their ends. In order to prevent the member from lengthening while it is hot, clamps are provided which are fastened at both sides of the place which is heated. These clamps are connected with one another by means of bolts, and these bolts take the stress while the member itself is brought to a high heat, at which time, of course, the member would be unable to take any stress, without increase in length. Adjusting the bolts connecting the clamps shortens the member to the desired degree and when the member cools off, it will remain short, the adjustment required having been effected. The process can be carried out in a few minutes, and stoppage of the traffic is unnecessary.

TRAINING OF APPRENTICES IN FOUNDRY WORK.

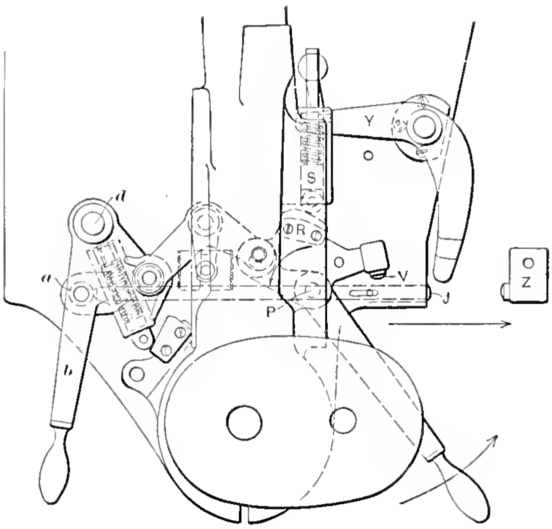
The Iron Trade Review, August 15, 1907

The foundries of the Ingersoll-Rand Co., located at Phillipsburg, N. J., employ some 900 men, and of these fully 98 per cent have been trained in the employ of the company. At a time when particular interest is taken in apprentice systems and industrial training, the plan carried out by this company merits attention. This plan was originally outlined eleven years ago, and, with some modifications, is still pursued.

The minimum age for enrollment of apprentices is fourteen years, and the course covers four years. The core department has been christened "The Kindergarten," as it is here that the embryo molder is first introduced to the mysteries of foundry practice. To acquaint himself with his surroundings, the boy is given only light duties to perform during the first few weeks of his employment, and his tutor, aside from the chief of the department, is a youth who has had not less than three months training. The pair work together during a similar period, when the one most advanced progresses to the side of another who has probably worked for nine months, and the three months' apprentice is charged with the duty of leading another through his first steps. This mode of procedure is carefully followed until the end of the first year, when the boy is graduated from the core department and his compensation increased from $1 to $1.25 per day. Instead of placing him immediately on the floor to acquire the rudiments of molding, he is intrusted to the tender mercies of the melter for three or four weeks, to obtain a knowledge of charging, melting, tapping, and cupola repairs. As a result of this practice every molder in the plant can melt successfully. Objections might be raised to the employment of the apprentices in such large numbers in the core department, but the success of the venture is indicative of the wisdom of this practice. The core boxes, largely metal, have been made practically "fool proof," and after a brief experience the most intricate shapes are produced in large

numbers daily. The boys are taught the various mixtures and the methods of baking, thus giving them the equipment of those making a specialty of core work. Nor is this apprenticeship system limited to boys alone, as laborers in the plant inclined to take up this trade are permitted to take up the course.

With the advent of the apprentice on the molding floor, he is made an assistant to another slightly more advanced, and in some cases works with an experienced molder. His lot is not that of an ordinary helper, as he is given every opportunity to advance, and as he masters the simpler sections, he is given more complicated work. The supply of common labor is liberal, and such duties as are only too often associated with the learning of this trade and are styled as "breaking in chores," are left to the laborers to perform. The undivided attention and effort of the apprentice can thus be applied to obtaining a knowledge of his chosen calling, and his forward strides are consequently rapid. The mode of advancement in the core room applies in the molding department, and with the third year the daily wages are increased to $1.75. At this period many of the boys have the equipment of the average molder and are permitted to make those sections for which they are best fitted. During the fourth year many of the apprentices are paid the same wages as the skilled mechanics, as the question of pay then is governed alone by their ability. No agreements are signed by the company, nor is one required of the parents of the boys. If, after a reasonable period the apprentice shows no talent for the work, he is dropped, and the cause for this action is carefully explained. Notwithstanding the average ages of the employes, the discipline is remarkable. The only penalty is suspension for a week, and it is seldom that this must be enforced. Shop rules have never been posted and those that govern are such as are generally understood and are passed from one employe to another.



COMBINED AUTOMATIC VERTICAL AND HORIZONTAL FEED ON A VERTICAL MILLING MACHINE.

Zeitschrift für Werkzeugmaschinen und Werkzeuge, October 15, 1907.

A German machine tool builder, the firm of de Fries & Co., Düsseldorf-Heerdt, has brought out a vertical milling machine, having a rather peculiar feed mechanism. With this, the tool may first be fed a certain distance vertically into the work, and then a certain distance horizontally, the feed mechanism acting automatically, and being before hand adjusted to the required distance of feed motion. Feeds of this character are commonly required when milling keyways and slots with end mills. In Fig. 1 is shown a plan, front and side view of the most important parts of the machine, and in Figs. 2, 3, and 4, are shown the parts of the operating mechanism at different stages of the cut. Fig. 2 shows the mechanism while the end mill is being fed vertically into the work; Fig. 3 when fed horizontally, and Fig. 4 when the feed motion has been automatically thrown out of engagement at the end of the cut.

The feed mechanism is operated through a clutch *A*, Fig. 1, having teeth on both sides. This clutch is keyed to a shaft, which in turn is driven from the main spindle by a shaft *B* through a combination of spiral gears and worm-gearing. The clutch, while it cannot turn on its shaft, is, of course, free to move sideways into engagement with either of clutches *C* or *D*. When clutch *A* engages with clutch *C* on the hub of gear *E*, a screw *F* is turned through the medium of bevel gears *G*. A nut *H* is mounted on screw *F*, and the rotation of *F* feeds this nut downward, the nut on its downward motion bringing with it the sleeve *K* to which it is connected. The sleeve *K*, in turn, is fastened to the spindle bearings of the machine, and the spindle with its tool is thus fed downward by the downward motion of nut *H*. At the predetermined end of the downward feed, however, clutch *A*, though a mechanism which will be described later, is thrown out of engagement with clutch *C*, and engages clutch *D*, located on the hub of gear *L*. Through this gear the table of the machine is now

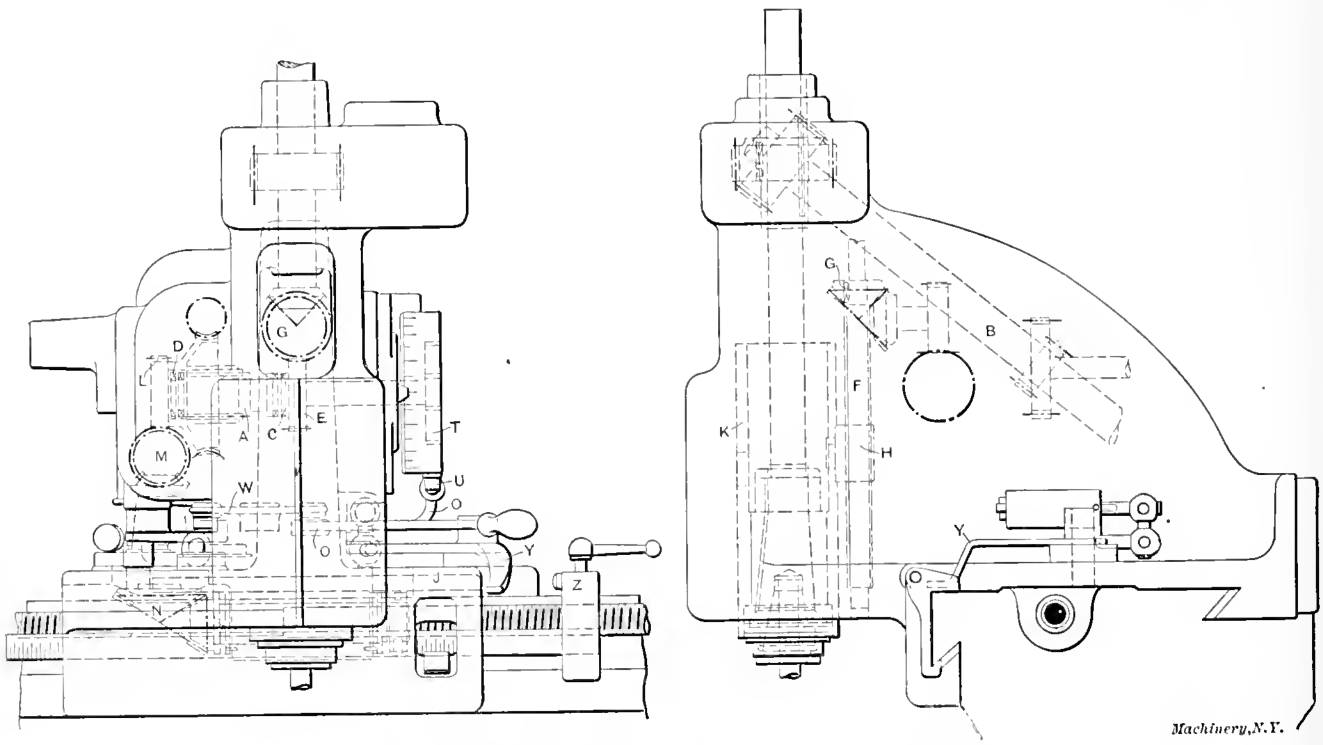


Fig. 1. General Arrangement of Vertical Milling Machine with Combined Automatic Vertical and Horizontal Feed.

fed forward, horizontally, by means of the intermediate gear drives M and N. At the end of the horizontal movement, the mechanism returns the clutch A to a middle position, so that all feed motion ceases.

If we now examine the mechanism operating the automatic feeds mentioned above, we will find it to consist of an ingenious combination of levers. The reference letters in the

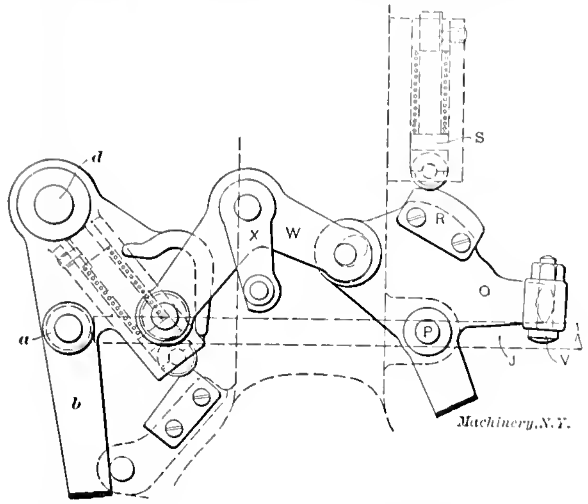


Fig. 2. Position of Levers during Vertical Feed Movement.

following refer to all the cuts with this article, it being necessary during the description, to refer from one illustration to the other, in order to adequately explain the construction. A lever O, turning around a stud P, is provided with a cam surface R, against which a plunger S, at its end provided with a roller, presses under the action of a spring. When the lever O is in the position shown in Fig. 2, the roller of plunger S rests on a surface of cam R which is at right angles to a line through the center of the plunger and the center of pivot P. Consequently, there is no tendency for the lever O to turn around its pivot under the action of the plunger and its spring. In order to make it possible to predetermine the amount of vertical feed, a graduated disk T is provided, on which an adjustable dog U is fastened. This dog is set by means of the graduations to any length of downward travel desired. When the tool has reached the end of its vertical travel, the dog U strikes a pin V in lever O, and turns this lever so that the plunger S with its roller descends on the inclined surface of R, thereby producing a quick turn-

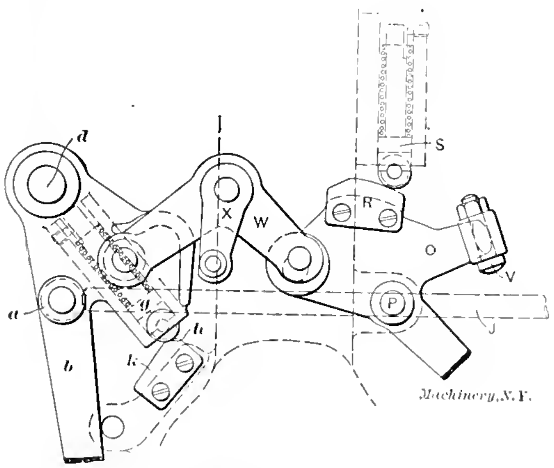


Fig. 3. Position of Levers during Horizontal Feed Movement.

ing motion around pin P. In turning, lever O also turns lever W around its pivot, and as lever X is fastened to lever W, the lever X is moved from its position in Fig. 2 to that in Fig. 3. The lower end of lever X, however, is connected to clutch A, and the motion imparted to this lever throws it out of engagement with clutch C and in engagement with clutch D, thereby throwing out the vertical, and throwing in the horizontal, feed.

This horizontal table feed is automatically stopped at the end of the cut by the following action of the mechanism. The plunger S is first withdrawn from its seat on cam surface R on lever O by means of lever Y, which, in turn, receives its motion from striking the dog Z, as the table advances. The lever O is then free to move, and if a force is exerted to return it to its position in Fig. 2, or to the position shown in Fig. 4, there is no resistance to be overcome. In the next place, a rod J is forced against dog Z, but as this rod is free to move in the table of the machine, it slides back in a direction opposite the direction of motion of the table, and finally, pushes against projection a of the lever b. It thereby turns lever b around its pivot d and, in doing so, permits a plunger g, operated in the same way as plunger S, previously referred to, to descend from a surface h, where it is in equilibrium, to an inclined surface k. The action of the spring back of plunger g then accelerates the motion of lever b until the roller at the end of the plunger rests at the lower corner of the inclined surface k, as shown in Fig. 4. The motion of lever b, however, causes a turning motion of lever W, as can be plainly seen from Figs. 3 and 4, and lever X, connected with

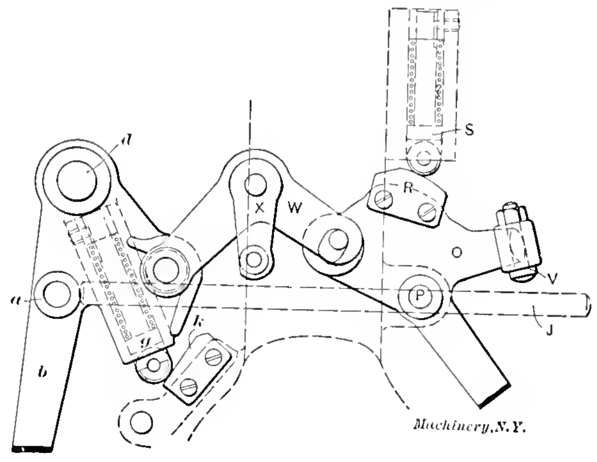


Fig. 4. Position of Levers when Both Feeds are thrown out.

clutch A, is turned back so that the clutch occupies a central position, not engaging with either feed motion. On account of the previous release of lever O from the pressure of plunger S, the return of lever X to its middle position is easily accomplished without the exertion of any great force back of plunger g. When a new piece of work is put into the machine the feed levers are returned to their original position by hand.

THE ART OF GALVANIZING.

Alfred Sang, in *Transactions American Foundrymen's Association.*

One of the most persistent problems which confront the worker in iron and steel is the prevention of corrosion. There are two general ways of preventing this corrosion, which might be called respectively the non-metallic and metallic methods. In the non-metallic method, the articles are coated with an organic substance, usually oil or varnish, the efficiency of which depends on its being more or less air tight. The metallic method consists in coating the iron with some other metal, and it is this method which will be discussed here.

Considered merely as a mechanical protection, the coating should be able to resist impact and abrasion, the latter being the most important. The soft metals, such as tin and zinc, do not stand up well against abrasion, but unless their adherence be very defective, they will stand impact well, on account of their malleability at ordinary temperatures. It would be desirable to obtain a coating which would be as good a protection as zinc but tougher and harder. Aluminum is being used with some success and if the metal were cheaper it would become an interesting competitor of zinc. This latter metal is, of all the commercial metals, the one which most closely fulfills all the requirements placed on a good coating. I shall, therefore, now proceed to describe the various processes which have been used to apply zinc to metal surfaces.

Cold Galvanizing.

In the early years of the last century the process of electrolytic zincing, which is nowadays known as cold or electro-galvanizing, was first discovered, but until about ten years

ago the lack of suitable equipment prevented its commercial application. The articles to be treated by this process are first thoroughly cleaned of scale, rust, and grease, by an acid pickle, sand-blasting, hot lye or by other means, singly or in combination, and are then placed as cathodes in a solution of some salt of zinc—usually the sulphate—in presence of zinc and which regenerate the solution, while a current of low voltage is passed through the arrangement and deposits zinc from the solution upon the articles.

The surface of an electrically galvanized article is matt or frosted, provided the work has been properly done. It always shows a few pores. If improperly done, or if the work was not perfectly clean before treatment, it is either honeycombed with pin holes or spongy. Above a certain limit of thickness, below which the coating is worthless, first class electro-galvanizing is superior to hot-galvanizing, and it is cheaper to produce where automatic machinery can be employed, although less zinc is deposited than by a hot dip. This is no doubt due to the better contact between the zinc and iron.

Hot Galvanizing.

Sixty years ago the process of hot galvanizing was introduced on a commercial scale. It consists in dipping the articles into a bath of molten spelter, with or without other metallic additions, at temperatures ranging from 750 to 900 degrees F. The articles must be first cleaned, as for electrolytic work, but a slight falling short of perfection does not have such disastrous effects on the quality of the work. Very heavy pieces may be heated before dipping, so as not to chill the bath. The coating is crystalline or amorphous, and does not adhere as perfectly as does the electrolytic one. Properly treated sheet metal goods have an attractive spangled appearance, but most articles look like castings, and sharp edges are lost. Metallic chlorides are used as fluxes. They are expected to remove the injurious salts of iron left by the pickling, but it is a question if they themselves are not the main cause of the decay which starts underneath the coating in hot galvanized work. The fumes given off in hot galvanizing are injurious to machinery, and in a manufacturing concern it is necessary to erect a separate building for this work.

Dry Galvanizing.

The latest process for applying a zinc coating is the dry process. This process of galvanizing or Sherardizing metals was awarded a gold medal at the St. Louis Exposition of 1904, and the President's gold medal for 1905 was presented to its discoverer by the British Society of Engineers. The inventor, Sherard Cowper-Coles, is one of the most eminent metallurgical engineers in Europe, and is well known for his reintroduction on a commercial scale of the process of electric galvanizing.

For the purpose of Sherardizing, the articles are placed, after cleaning, in a retort, usually a drum, and are covered with zinc-dust, which is commonly called blue-powder, and is the flue-dust, and, therefore, a by-product of the zinc smelting furnace known as the Belgian furnace. It contains as a rule from 75 to 90 per cent of pure zinc; the supply of zinc-dust is ample at a price below that of spelter, and if the demand increases it can be produced in any quantity that may be required. A small amount of powdered charcoal is added to prevent oxidation of the zinc by the air inside the retort at the beginning of the operation, and the receptacle is closed and heated to a temperature about two hundred degrees below the melting point of zinc. By Sherardizing, a homogeneous deposit of zinc is obtained, varying in thickness according to the length of time the article is allowed to remain in the retort, its lower portion being an alloy of zinc and iron or of zinc and copper, as the case may be. In the case of copper the alloy is a hard brass. The drum is occasionally turned a fraction of a revolution to insure an even coating where the articles are crowded together, and the heating may last from a few minutes to several hours, and two or three drums can be used in connection with one furnace.

A Sherardized surface resembles, in general appearance, an electrically coated surface. It is, however, of a soft silver-gray, more lustrous and metallic, and, on that account, it is to most people, more pleasing to the eye, and it is distributed with great uniformity, which is not the case in hot galvanizing. Whereas in hot galvanizing the amount of zinc which is alloyed to the metal of the article is very small and most of the coating forms an exterior perishable skin, in Sherardizing, the coating is thoroughly incorporated with the metal which it protects, forming an alloy having the appearance of pure zinc, but much harder and more durable. It is on account of this thorough alloying that the protection afforded by Sherardizing is superior to that afforded by either hot or electric galvanizing. The zinc having penetrated the iron, the old surface cannot be recovered by either chemical or mehcanical means.

If an excessive amount of zinc is deposited by Sherardizing, the outside surface is composed of zinc somewhat hardened by the presence of a small percentage of iron, and zinc-dust accumulates and clusters in a way which renders the surface rougher and less attractive. No special advantage is derived from the additional expense unless the conditions under which the articles are to be used are exceptionally severe.

The process of Sherardizing is not confined to zincing; the dusts of antimony and of other metals can be used in a similar manner. The fact that zinc-dust, even at temperatures higher than its melting point, does not melt or cake, is of great value in Sherardizing, as it eliminates the danger of spoiled work from carelessness in handling the temperature. Furthermore, zinc-dust containing as little as 35 per cent of pure metal can be used.

The Efficiency of Dry Galvanizing.

The efficiency of dry galvanizing has been proved by thorough testing both in England and Germany. Considered merely as a covering, it fits as closely as does an electrically-deposited coating, and it is impenetrable because of being free from pores or cracks. As a mechanical protection it resists both abrasion and impact better than work done either by the hot or cold galvanizing process, because of the qualities of the ferro-zinc alloy.

Commercial Scope of Dry Galvanizing.

It is a noteworthy fact that while many articles have appeared in technical and scientific journals about Sherardizing, not one word of criticism or denial of its claims has as yet been offered. The process has always appealed to scientific men because they are in position to appreciate the solid scientific foundations of its claims.

The new process has not entered the field as a competitor to galvanizing alone; in a great many instances it can take the place of coppering, of nickel-plating and of tinning, where the articles are not to be used for the preparation or handling of foodstuffs. To these I should add the large amount of copper and brass articles, from tubing to typewriter and sewing machine parts which are now nickel-plated. An interesting point in relation to the various methods of protecting metals is the price of the metals themselves. Nickel is 7¾ times, tin and aluminum 7 times, copper 4⅛ times, and antimony 3¼ times as high in price as spelter, and at equal efficiency against corrosion, the lightest coating is one of zinc as applied by dry-galvanizing. Analyzing the various items which go to make up the cost of Sherardizing, we find that in every instance there is a saving either over the hot process or over the electric process. A plant for Sherardizing is less expensive than a hot plant and very much less so than an electric plant.

Various Applications of Dry Galvanizing.

Sherardizing will not fill an uncalked seam and act as a solder; this is its one limitation but it has a great variety of new applications to make up for it. A brilliant and permanent polish which can hardly be distinguished from nickel-plating, but bluer and more like silver, and a better reflector of light, can be given to Sherardized articles by means of the usual burnishing tools and machines, but unlike nickel-plating it is absolutely rust-proof. This polish is not temporary like that of electro-galvanizing, and it is hard and durable if worked down, as it should be, to the ferro-zinc.

Sherardized aluminum can be electro-plated, and the objectionable soft surface be overcome, not to mention the finish and appearance. Sherardizing has been found to protect silver

from sulphated hydrogen, which blackens it, and it can be applied very lightly before polishing without altering the color. When aluminum has been Sherardized it can be readily soldered; this is expected to do away with the very unsatisfactory riveting of articles made from aluminum sheets.

SHAFT-TURNING MACHINE.

Bernh. Dreyer in *Werkstatts-Technik*, December, 1907.

The machine here described and illustrated has been designed for the purpose of overcoming some of the difficulties experienced when using cold rolled shafting, and the time wasted when straightening and turning shafting in an ordinary lathe. Machines, turning shafting according to the new method referred to, have been in use in Germany since 1901, and are installed in many of the leading machine shops.

The objections to straightening shafting in the ordinary way, with hammer blows, or, at best, with a shaft straightening device, is that this work is difficult to do, and consumes a great deal of time. Besides, internal stresses are often produced through the hammering and bending, which have an unfavorable influence on the strength of the shafting. The turning of long shafting in ordinary lathes is also difficult, takes a great deal of care and time, and requires a skilled operator, if straight work of uniform diameter is demanded. Cold rolled shafting does not answer the requirements for a high-grade shaft, as it is not perfectly straight, not fully round, and not always of the exact size required. The rolling process also produces internal stresses, which are likely to spring the shaft out of shape. That this is so is proved by cases where a shaft, apparently straight and of the correct diameter, afterward is found to produce considerable friction in the bearings, due to the distortion of the shaft. This often results in serious losses of power, or, at times, in complete derangement of the power transmission system.

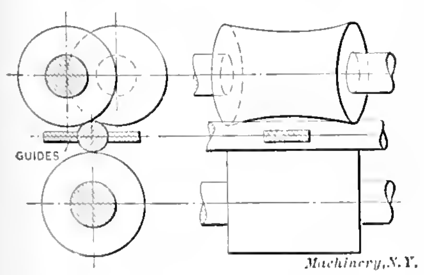


Fig. 2. Straightening Rollers for Shafting.

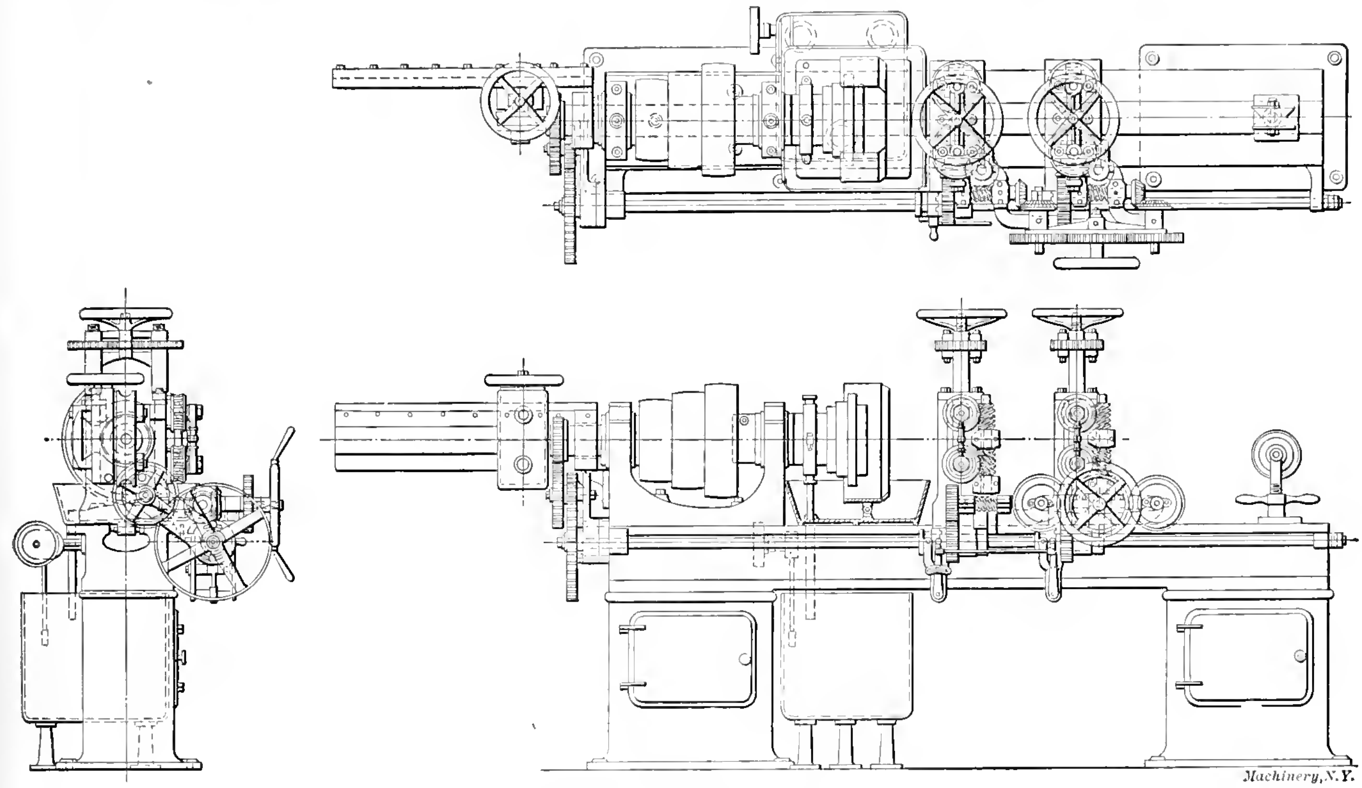


Fig. 1 Machine for Hollow Milling Shafting to Size.

The objections stated to shafting as ordinarily produced seem to call for a better method of straightening and turning. This is supplied by the straightening process, described below, and by the machine shown in Fig. 1. The shaft is first mechanically straightened, and then turned, or rather hollow milled, and finally tested and polished. The straightening is accomplished by straightening rollers, as shown in Fig. 2. These rollers are mounted with their axes at a slight angle with each other. One of the rollers is concave on its face, while the other has a straight, cylindrical surface, the latter roller being placed in line with the shaft to be straightened, while the concave roller is placed at an angle with the axis of the shaft.

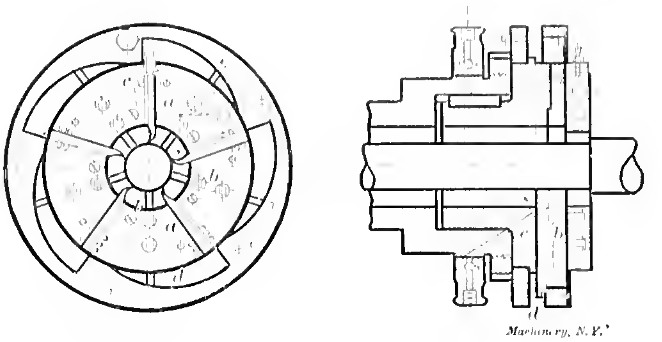


Fig. 3. Hollow Mill used in Machine shown in Fig. 1.

When the shaft passes between the rollers, it is guided on the sides by the guides, as shown in Fig. 2. The rollers are provided with adjustment, so that different sizes of shafts may be straightened between the same pairs of rollers. The angle to which the upper roller is turned is also adjusted according to the size of the shaft. This process permits a more perfect straightening of the shaft than do other commonly used shaft-straightening devices.

When straightened, the shaft is placed in the machine, Fig. 1, already referred to, and is guided and held centrally with the spindle of the machine by guiding rollers placed in the uprights shown where the carriage usually is placed on the lathe. A hollow mill of special construction, as shown in Fig. 3, is mounted on the end of the hollow spindle. This hollow mill is provided with five adjustable cutters, *a*, and five guides or supports, *b*. These latter are so arranged that they are adjustable to any size of work, within a range of the hollow mill, by means of eccentric cam grooves, *d*, cut in a ring bolted to the body of the mill. The hollow mill is cooled off by water entering into channels in its body. When the shaft has passed through the spindle, it again enters between two guiding rollers, at the left-hand end of the

head-stock of the machine. Guiding the shaft in this manner, by two sets of guide rollers before it enters into the hollow mill, and one set to receive it when having passed through the spindle, keeps the shaft in absolute alignment while the process of hollow milling to size is being performed, and obviates all chance of errors from lack of alignment, or from the springing or bending of the work under its own weight.

The cutting speed of the hollow mill is usually from 70 to 100 feet per minute, and the feed from 5 to 8 inches per minute. This cutting speed and feed make it possible to finish about 30 feet of shafting, 2 inches in diameter, per hour.

SECRECY IN THE ARTS.

Extract from paper by Dr. James Douglas, presented before the American Institute of Mining Engineers, November, 1907.

If it is the fact that technical science has progressed of late with such unwonted speed through the coöperation of many workers, and that this coöperation has been made possible by the publication and exchange of ideas and experiences in the technical and scientific journals, would not our progress be even more rapid and thorough if all barriers of secrecy were broken down, and every encouragement were given to our technical workers to describe, in print and by conference, their notions and their actual experiments? This is the attitude of some, I may almost say of most, of our large concerns, but unfortunately it is not that of all. It is impossible to compare, as to efficiency and profit, works, the gates of which are fast shut, and in which obscurity and secrecy are imposed and practiced, with those to which free admission is granted and in which freedom of information is encouraged. But the following reflections force themselves upon us in this connection. We know that very few technical papers issue from certain establishments; that on their officials silence is imposed; and that to these works inquisitive visitors are politely but peremtorily refused admission. There are not many such, but they are and have been very successful. But suppose that in imitation of their practice and regulations all were tempted to adopt it, so that the same policy became universal; what a sudden paralysis of industry would follow! Our secretaries would find it difficult to fill even their shrunken volumes of transactions with papers worth printing; our students would have to content themselves with the antiquated learning which their professors could supply; for there would be no more summer classes for practical work in mines, smelters and electrical factories, and the professors themselves would have to learn from old books. Every manufacturer and smelter would be obliged to bribe his neighbor's workmen and tempt away his neighbor's superintendents for information. As a result, before long, the very works which now find it so profitable, or think they do, to tap their friends' stock of knowledge and experience, and give nothing in return, would be driven in upon their own resources, and would undoubtedly then find them not so complete as they imagine. Of course, I am supposing an impossibility, because the spirit of intellectual freedom in our professions is too strong and too widespread to submit to such tyranny, and because, before such darkness of ignorance had settled down on our great industries, the most pronounced advocates of secrecy would feel and acknowledge the ultimate consequences of concealment, and would become reformers. To-day they may have secrets, as valuable as Sir Henry Bessemer's method of making plate glass and bronze powder, which it may pay them to conceal from their competitors, so long as they are admitted freely to their competitors' open shops; but even this is doubtful. For the spirit of secrecy is intimately allied with the spirit of suspicion and distrust; and the mind which is always suspecting is closed tight against the admission of fresh and fair impressions. Being jealous of others, it is prejudiced against their suggestions, and correspondingly prejudiced in favor of its own preconceptions. Progress therefore ceases.

This is a temper of mind foreign to a new country like ours, whose special industries have not been established long enough to wear grooves of rigid practice, and sink into ruts of self-satisfied indifference. About the best correction we can apply to the growth of dry-rot is the banishment of secrecy. A curious instance of its blighting influence is seen in some of the older, not the newer, industries of the old world. The iron and steel works of Europe have not kept pace with ours in size and production, but the ironmasters of Great Britain and Germany, in coke-making and in blast-furnace economies and in steel-making processes, have been our teachers. Nor have they been shy of communicating their improvements, or, through jealousy of our success, slow in adopting ours. No nobler monument of international comity in thought and experience exists than in the seventy volumes of the *Proceedings of the Iron and Steel Institute;* and with few exceptions the iron and steel works of England, Scotland, Germany, and France are open to any accredited worker in the same domain. Yet before England was conspicuous as a maker of iron, she was famous the world over for her copper and tin production. But, between self-conceit and the inbred habits of trade secrecy, her copper-smelting industry has fallen from its high estate. And it is not accidental, but linked as closely as any effect with its cause, that this decline is in great part the result of habits of secrecy which grew with the growth of age. At Swansea, every gate to the smelting works is guarded, and as a result it has been as difficult for thought to escape out as for suggestions to find their way in. Swansea should still enjoy the leadership which her skilled labor, splendid coal and commanding maritime situation put within her reach; but she has preferred to gloat over her secrets behind closed doors rather than go out into the world in search of new business as well as technical methods, while also inviting the world to enter and exchange ideas with her. What is the consequence? New Zealand copper comes here to be refined, notwithstanding that the first practical application of electrolysis to metals was made by Elkinton in England, and the Vivians adopted the Manhès method before Farrel introduced it into this country.

There are, however, of course, exceptions in England to this too prevalent habit of secrecy. To the works of the Rio Tinto at Port Talbot or of the Cape Copper Co. at Briton Ferry in South Wales, where metallurgical novelties have been tried, introductions are not refused. But the alliance of decay and suspicion in the instance I have given can hardly be accidental; and we may be sure that what is baneful in its effects in Europe is not likely to be beneficial here; for while the Atlantic separates continents it does not delimit the operation of laws.

In political life, vitality is maintained only when every man takes his full share as a debater in the discussion of political questions, and as a voter in the determination of state affairs. So in scientific and technical matters, the banishment of deceit, mystery and jealousy, and the freest admission of daylight by means of the unreserved diffusion of information through the press and personal intercourse, will instill into the whole body of workers a feeling of healthful rivalry, which, while stimulating their mental activity, will correspondingly benefit the financial interests of their employers.

* * *

Vibration in steamships is probably unavoidable, no matter what means of propulsion are employed. The turbine steamers *Lusitania* and *Mauretania* vibrate considerably in certain parts, much to the disappointment of those passengers who expected to be entirely relieved of this discomfort. The steam turbines, being perfectly balanced, contribute little or nothing to the vibrations, but the propelling screws and the action of the waves, which are also important sources of vibration, have to be reckoned with. The steel hull is a highly flexible and elastic structure which responds to every exterior and interior impulse. Even if it were made of one solid mass of steel, the elasticity and flexibility of a structure 790 feet long would still be very appreciable. The possible extensibility of a steel bar 790 feet long when subjected to a stress of 30,000 pounds per square inch is about 9½ inches, taking the modulus of elasticity as 30,000,000. The hull of an ocean steamer is, of course, much more extensible proportionally than a solid steel bar because of the shape and unavoidable looseness of structure. A small fraction of the possible relative motion of the parts of such a structure repeated many times a minute is quite enough to produce a very disagreeable effect.

MAKING THREAD GAGES.*

A. L. MONRAD.†

The method of making thread gages, described in the following, may not be new, but it has very lately come under the observation of the writer. It seems to be the general idea that screw plug gages must be made of tool steel, but it has been found very practical to make them of cold rolled stock, which is very soft and easy to cut, but which, when hardened, gives a surface which is fully as hard as tool steel. This hard surface extends deep enough into the thread gage to permit grinding 0.005 inch deep, enough hard surface still remaining to prevent rapid wear when in use. Another reason for using this soft steel is also that it is not likely to change its shape, after having been finished, the same as does even the best tool steel, if it has not been properly seasoned after hardening.

For setting a thread tool for cutting a correct thread, a cylindrical thread gage is made, as shown in Fig. 3. This thread gage has the advantage over the ordinary thread gage on the market, that it can be placed between the centers of the lathe, and consequently one does not depend upon any secondary surface, against which to set the thread gage. This is the case with the ordinary thread gages, which have to be lined up either against the side of the face-plate of the lathe, or against the side of the work, and in this way small errors are almost always introduced. The thread gage in Fig. 3 is made of machine steel, hardened and ground all over. The main body, *A*, is provided with three grooves, having an inclusive angle of 29, 55, and 60 degrees, respectively, to correspond with the Acme, Whitworth and United States Standard threads, respectively. When the gage is hardened, the grooves are ground with the same setting of the slide-rest, the piece *A* being reversed on the lathe centers while grinding. This insures that both sides of the angle in the gage make the same angle with the axis of the gage.

In one end of the body *A* a hole is drilled, and ground until the bottom of the hole comes exactly in line with the axis, or center line of the body *A*. A hardened and lapped plug *B* is inserted into this hole and held with a set-screw, having a brass shoe at the end. The purpose of this plug *B* is to afford a means for setting the thread tool in the lathe at the correct height, or, which is the same, exactly in line with the axis of the spindle. This is done by merely loosening the clamp which holds the thread tool in its holder, then with the thumb of the left hand on the plug *B*, and the forefinger on the thread tool, it is brought instantly in position, so that the upper face of the thread tool touches the lower side of the plug *B*, as shown in the end view of Fig. 3. When in this position, the clamp of the thread tool holder is again tightened, and the tool is now placed in the correct position as to height. This is the best way of setting the thread tool to the same height as the axis of the lathe centers. [This method of setting of the thread tool to height does not necessarily, however, insure that the thread tool in all cases will be set absolutely correct. If the thread tool holder should be tipped somewhat out of the horizontal position, the top of the thread tool itself would not be horizontal, and consequently, when the gage pin *B* was brought down upon the top of the thread tool, so that the top face would lie perfectly in line with the lower face of gage pin *B*, this pin would not be fully horizontal, and the thread tool would not be set to the exact height of the lathe centers.—EDITOR.]

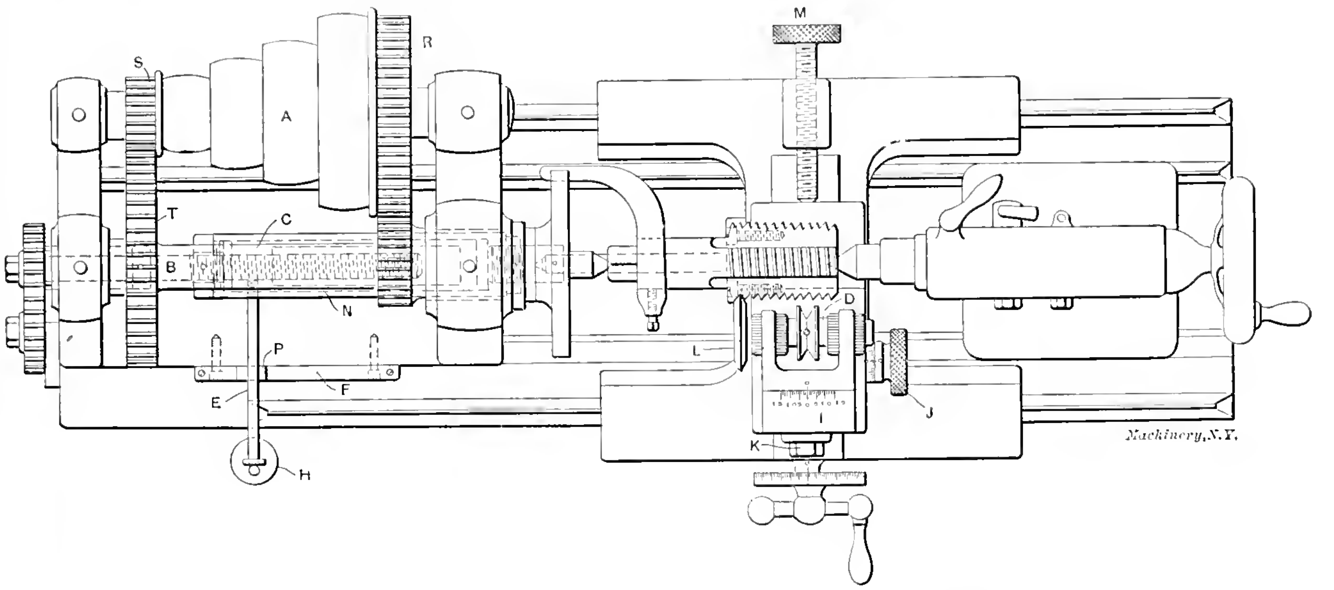


Fig. 1. Lathe for Grinding Taps in the Angle of the Thread.

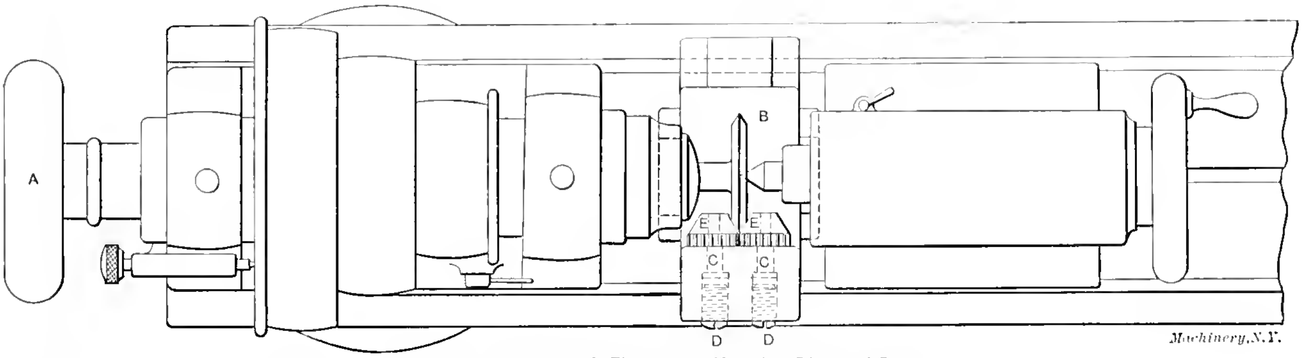


Fig. 2. Bench Lathe with Fixture for Charging Diamond Lap.

With the gage remaining between the lathe centers, the angle of the thread tool is set to a correct central position, sideways. This setting is also a check on the accuracy of the angle of the thread tool. A piece of white paper should be used under the gage and the tool, and a magnifying glass should be employed. First, when the tool fits the gage so that all light is shut off, the setting and the angle may be considered satisfactory. The thread tool being set, we are now ready to proceed to finish thread our screw plug gage, which has previously been roughed out by a chaser having three or four teeth, leaving about 0.005 inch for the finishing single point thread tool. The finishing of the thread is continued

* For additional information on kindred subjects, see the following articles previously published in MACHINERY: Measuring Screw Thread Diameters, September, 1907; Tools and Methods for Accurate Thread Cutting, July, 1903.

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until 0.0015 inch is left for lapping. The chaser, as well as the single point tool, should have a clearance of 15 degrees on the front face of the thread tool. This angle has proved to be the most advantageous for all practical purposes.

After having been finish threaded, the screw plug is case-hardened and ready for lapping. A lap made as shown in Fig. 4 is used. It will be seen that this lap is somewhat different from those ordinarily used for this work. The con-

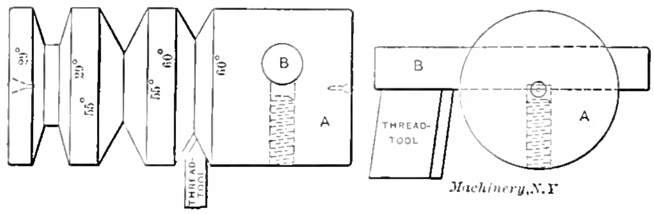


Fig. 3. Gage for Setting Thread Tools.

struction shown has been adopted because of the difficulty met with in circular laps which are split on one side for adjustment, but have nothing on the sides to hold the two sections in perfect alignment. Consequently, each of the sides has a tendency to follow the lead of the screw plug when lapping, and difficulty is experienced in getting a thread with perfect lead. The lap here shown, therefore, has a dowel pin *A* on each side for the purpose of holding the two sections in perfect alignment, and the adjusting screws *C* are inserted outside of the dowel pins. The two screws *B*, finally, clamp the two halves together. When the lap is assembled and screwed together, it is roughed out in the lathe with a threading tool, or tapped with three or four different sized taps, following one another in proper rotation. The lap is then taken apart, and planed on the inside to permit of adjustment; three grooves are cut in the thread on each side of the lap, for holding reserves of emery and oil. This will permit constant lubrication of the lap, and constant charging when lapping the screw plug to size. The lap is finished with a master tap, which must be made with extreme accuracy. This

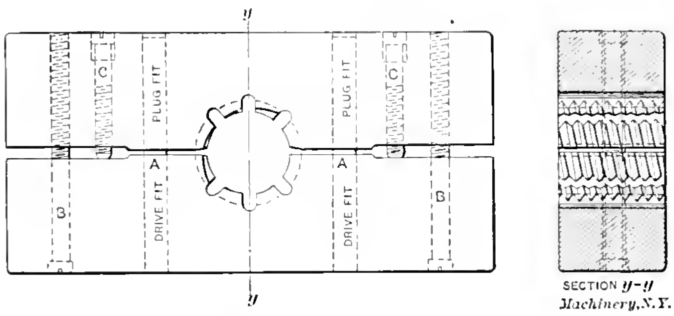


Fig. 4. Lap for Screw Plug Gages.

tap is ground in the angle of the thread, as shown in Fig. 1, and it is finished to a dimension 0.002 inch below the size diameter of the thread plug to be made, in order to permit the lap to wear down to the size when lapping.

The lathe must be revolved very slowly when grinding the master tap, the revolutions of the spindle being from 20 to 100 per minute, according to the size of the tap. As will be seen in the cut, the cone pulley is placed where the back gears ordinarily are located. Gear *R* is disconnected, and the drive is through gears *S* and *T*. The reason for having the cone pulley in the back, is because it is wanted to use the space directly under the usual location of the cone pulley in the center of the lathe for a mechanism intended to permit a slight adjustment of the lead of the tap when grinding in the angle of the thread.

The feed screw *B* is placed in the center of the lathe bed, directly under the driving spindle, and fits into a solid nut, *C*, from which, through the medium of a casing *N* and a connecting-rod, the carriage is moved. A rod *E* is screwed into the nut *C*, this rod extending over the side of the lathe, and resting upon the edge of plate *F*, which can be so adjusted that it inclines from one end to the other from 0 to 20 degrees. Between this plate and the rod *E*, a shoe *P* is placed. On the extreme end of the rod hangs a weight *H* which holds the rod against the plate *F*. This arrangement serves the purpose of giving a slight change in the lead of the tap being ground, as it is evident that when the rod *E* travels along the plate *F*, on the incline upward, it slightly turns the nut and moves it forward a trifle in excess of the regular forward motion imparted to the nut by the motion of the lead screw. By inclining the plate *F* in the other direction, the motion of the nut may be correspondingly retarded.

A grinding fixture *I* fits the slides on the top of the carriage. On the right-hand side of this fixture is placed a knurled handle *J*, graduated to thousandths of an inch. This handle is for the fine adjustment of the fixture, enabling the grinding wheel to be set correctly to the center of the thread, before starting the grinding operation. The top of the fixture swivels in a vertical plane, so that the wheel *L*, which is made of tool steel and charged with diamond dust, can be set at an angle to the vertical, either to the right or the left, according to the pitch and direction of the thread. This adjustment is made by loosening the nut *K* which binds the head in position when set to the correct angle. The wheel *L* is provided with a shank which fits a tapered hole in the

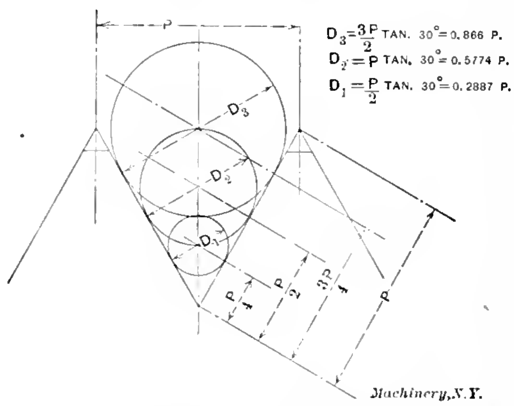


Fig. 5. Formulas and Diagram for Determining Ball Points for U. S. Standard and V-threads.

spindle *D*, which latter runs at a speed of 20,000 revolutions per minute. A solid backstop *M* is provided to hold the fixture securely in place while working. The lathe spindle, with the tap, and the grinding spindle run in the same direction, the same as in an ordinary grinder.

A good supply of sperm oil should be used when grinding the tap, and it is necessary to have a cover over the wheel, to prevent the throwing out of oil. This cover, however, is not shown in the cut. Care should be taken not to force the wheel into the work, as if that is done, the shape will soon be destroyed. The wheel should just barely touch the work, and should be fed in a very small amount, say, 0.00025 inch at a time. A sound magnifier or listener should be used, to hear whether the wheel is cutting moderately.

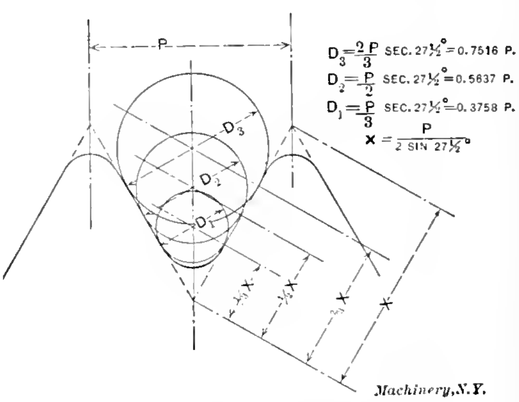


Fig. 6. Formulas and Diagram for Determining Ball Points for Whitworth Standard Thread.

The wheel is charged in the following manner. A chuck, with a tapered hole which fits the shank of the diamond wheel, is placed in the spindle of the bench lathe, as shown in Fig. 2, and the tail-stock center is pushed up at the other end to get a good support when charging. Fixture *B* is placed in the bench lathe, and clamped with a bolt and nut from underneath the lathe, about the same as an ordinary slide-rest. The front end of the fixture extends up vertically

above the center of the spindle. In this projecting part, two holes are drilled, reamed, and counterbored, at the same height as the center of the lathe spindle. In these holes are fitted two studs *C C* having a T-head inside the counterbored hole. Between the T-heads of these studs and the screws *D D* lie

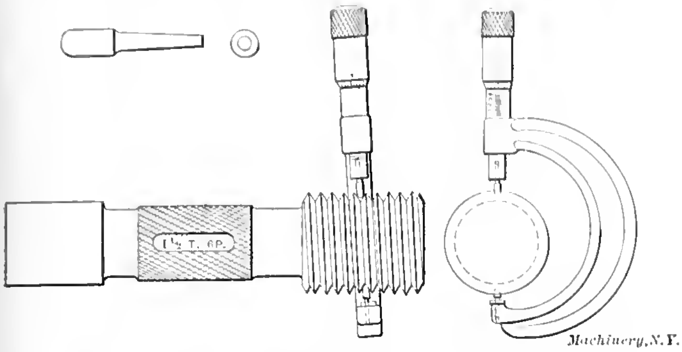


Fig. 7. Comparing Angle Diameters with Ball Point Micrometer.

fiber washers, which act as friction stops. On the other end of plugs *C C* are placed hardened and ground rollers *E E* having one end beveled to a 30-degree angle, while the other end has spur gear teeth milled, which mesh into each other. With the slowest speed of the bench lathe, the fixture is fed in by hand, and having two slides at right angles to each other, the same as an ordinary slide-rest, it can be located to the proper position without much trouble. A piece of soft steel wire should be flattened out to make a spade, with which to take up the diamond dust for charging the wheel. One should not try to use a piece of wood, or a brush, as that will only be a waste of diamond. The master tap, which is to be ground, is relieved up to within 1/16 inch from its cutting edge with a file, this being done in order to prevent any more grinding than is absolutely necessary, and to permit the tap to cut freely. The length of the threaded part of the master tap should be about two times its diameter.

The master tap being finished, the lap for the screw plug gages, Fig. 4, is tapped, and ready for use. When charging this thread lap, great care should be taken not to force the lap too much. The spindle of the lathe, where the lapping is done, should be run very slowly, with the back gears in, until the lap is thoroughly charged with emery mixed with sperm oil. Then the lathe may be speeded up to a higher speed, according to the size of the screw plug. It is poor practice to use too much emery on the lap. Reverse the lap often, and use it the same amount on either side. If a large number of screw plugs are to be lapped, all of the same size, lap them all, one at a time, with the lap at the same setting. In this way the lap keeps its shape better, and can be used a long while before being retapped. Do not attempt to tap the lap with the master tap when charged with emery, but use a roughing tap first, and also wash out the lap in benzine before tapping. When the screw plug has been lapped to within 0.0005 inch of its size, it is ground on its outer diameter, if it be a U. S. Standard thread plug, and then finished by lapping after being ground. This will permit the top corners to be kept sharp, and better results will be obtained all around.

Great care must be exercised during the lapping operation to see that the angle of the thread is correct. The gaging of the angle of the thread is accomplished in the following manner. Three micrometers are used to measure the correct angle. Two ball points of the same size are placed in tapered holes in each micrometer, as shown in Fig. 7. These ball points are ground all over, and made to a shape as shown in the upper left-hand corner in Fig. 7. The body of these ball points is ground parallel, and then the end is turned and ground to a ball shape as shown. Three sets of ball points are used for each pitch, one to measure the thread near its bottom, one at the center, and one near the top, as indicated in Figs. 5 and 6. The master screw plug is used for comparison; one micrometer is set to the master screw plug at the bottom of the thread, in the manner indicated in Fig. 7, and is then tried on the thread plug being made. The difference in diameter between the measured diameter on the master gage, and that on the plug being made, is noted. Then the two other micrometers, measuring at the center and near the top of the thread, are used, and the difference between the master gage and the screw plug diameters at the places where these micrometers measure, is also noted. If all three micrometers show the same amount of difference in relation to the master plug, then the angle of the thread evidently must be correct. After that, the micrometer measuring at the center of the thread is used to measure the size of the screw plug, comparing it with that of the master gage, until the plug is finished to size.

Figs. 5 and 6 show how formulas are derived for the size of the ball points used in measuring. Fig. 5 applies to a

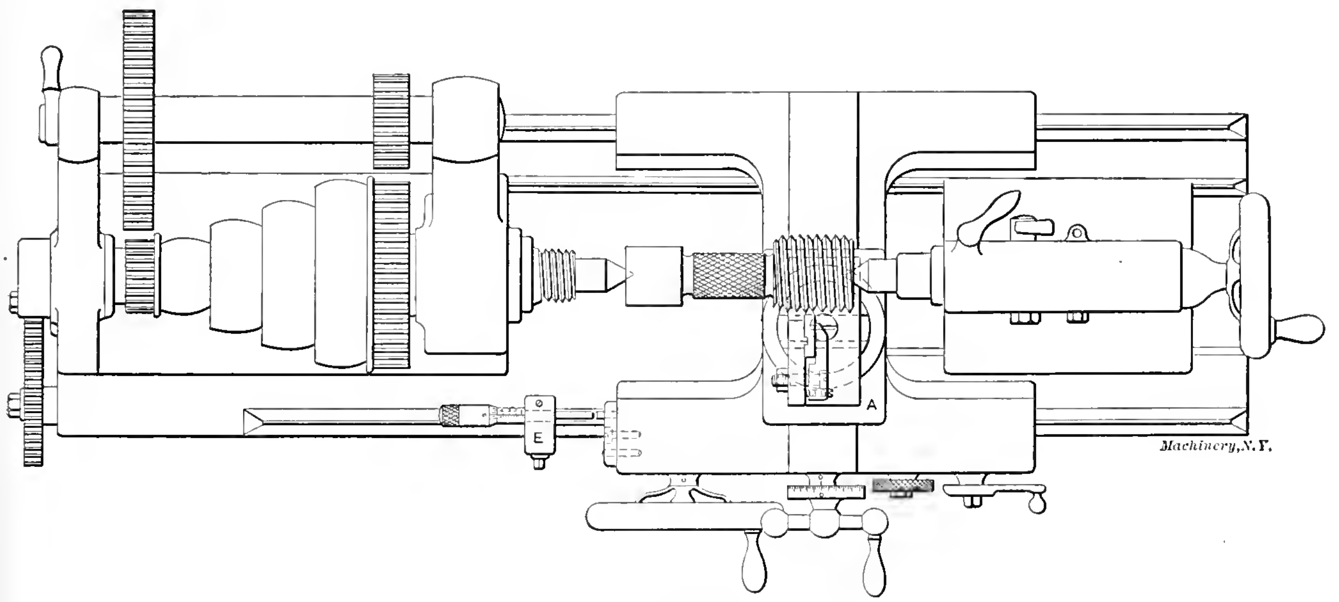


Fig. 8. Final Test of Pitch and Angle of Thread.

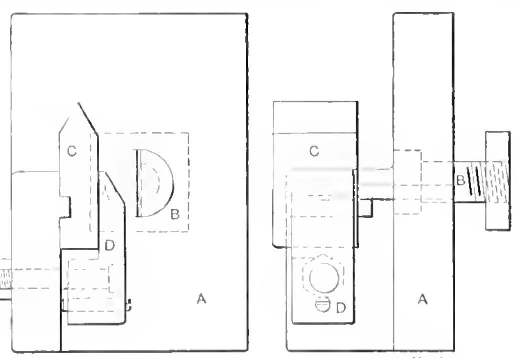


Fig. 9. Gage for Testing the Angle of the Thread.

60-degree thread, either sharp V or U. S. Standard, while Fig. 6 gives the formulas for a Whitworth thread. The diameters D_1, D_2, and D_3, respectively, are the diameters of the cylindrical portions of the ball points used, and are, of course, also the diameters of the half-spheres on the end of the ball points. Tables I and II give these diameters for a number of different pitches, figured approximately from the formulas.

For testing the angle of the screw plug, when finally finished to a limit of 0.0005 inch, it is tried in a testing machine, such as shown in Fig. 8. This machine is simply an ordinary lathe, fitted with a fixture *A*, shown separately in Fig. 9. The tool-post is taken off the lathe, and replaced with this fixture, which is clamped in the T-slot of the tool-post slide, with bolt *B*, Fig. 9. The thread gage *C* is ground all over, and the angle fitted to a master gage. The gage *C* is held by the tongue and groove on the left-hand side of the fixture, and clamped with a strap *D*. To set this gage correctly, in relation to the axis of the spindle of the lathe, as regards height as well as angle, the angle gage, Fig. 3, is used in the same way as has been previously explained in relation to thread cutting. When the fixture has been placed correctly in position, the screw plug is inspected by placing the gage with the hand first to the right and then to the left side of the thread angle. A strong magnifying glass is used with a white paper underneath, and any imperfection of the angle is easily detected, and can be corrected, when lapping the last 0.0005 inch to size. If the test gage shows an opening either at the bottom or at the top, the fault is that the lap is worn and must be retapped, or it may be that too much

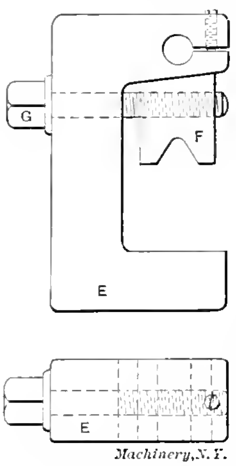


Fig. 10. Holder for Micrometer Stop.

TABLE I. BALL DIAMETERS TO BE USED IN DETERMINING CORRECT ANGLE OF THREAD FOR V, U. S S. AND BRIGGS STANDARD THREADS.

Threads per inch.	D_3	D_2	D_1
32	0.028	0.018	0.010
28	0.030	0.020	0.010
24	0.035	0.024	0.012
22	0.040	0.026	0.014
20	0.045	0.028	0.014
18	0.050	0.030	0.016
16	0.055	0.035	0.018
14	0.060	0.010	0.020
13	0.065	0.045	0.022
12	0.070	0.050	0.024
11	0.080	0.055	0.026
10	0.085	0.060	0.030
9	0.095	0.065	0.030
8	0.100	0.070	0.035
7	0.120	0.080	0.040
6	0.140	0.095	0.050
5½	0.160	0.110	0.050
5	0.170	0.120	0.060
4½	0.190	0.130	0.065
4	0.220	0.140	0.075
3½	0.240	0.170	0.085
3	0.280	0.190	0.095
2⅞	0.300	0.200	0.100
2¾	0.320	0.220	0.100
2⅝	0.320	0.220	0.110
2½	0.340	0.240	0.110
2⅜	0.360	0.240	0.120
2¼	0.380	0.260	0.130

emery has been used. If, for some reason or other, it is impossible to correct the screw plug within 0.0001 inch, when lapping, take a piece of hard wood, or flatten a piece of copper wire, charge it with emery, and hand lap the high points of the angle, while the screw plug is revolving slowly in the lathe. In this way, it is comparatively easy to overcome this trouble, but great care must be taken to follow the thread properly with the hand lap.

To find if a screw thread has a perfect lead, the micrometer stop *E*, Fig. 8, is placed on the left-hand side of the carriage. The holder for this micrometer stop is shown separately in Fig. 10. The construction of this stop is very simple. The micrometer head is an ordinary one, as made for the trade by manufacturers of these instruments. The holder *E* is made similar to a C-clamp, with a hole drilled and reamed to fit the micrometer head. A slot is sawed through the upper jaw, with a stop screw on the top, which prevents the micrometer from being clamped too hard in the holder, in which case the thimble would not revolve freely. Underneath this hole

TABLE II. BALL DIAMETERS TO BE USED IN DETERMINING CORRECT ANGLE OF THREAD, WHITWORTH STANDARD THREAD

Threads per inch.	D_3	D_2	D_1
32	0.024	0.018	0.012
28	0.026	0.020	0.014
24	0.030	0.024	0.016
22	0.035	0.026	0.018
20	0.040	0.028	0.018
18	0.040	0.030	0.020
16	0.045	0.035	0.024
14	0.055	0.040	0.026
13	0.060	0.045	0.028
12	0.065	0.045	0.030
11	0.070	0.050	0.035
10	0.075	0.055	0.035
9	0.085	0.060	0.040
8	0.095	0.070	0.045
7	0.110	0.080	0.055
6	0.130	0.095	0.060
5½	0.140	0.100	0.070
5	0.150	0.110	0.075
4½	0.170	0.120	0.085
4	0.190	0.140	0.095
3½	0.220	0.160	0.110
3	0.260	0.190	0.120
2⅞	0.260	0.200	0.130
2¾	0.280	0.200	0.140
2⅝	0.280	0.220	0.140
2½	0.300	0.220	0.150
2⅜	0.320	0.240	0.160
2¼	0.340	0.260	0.170

the holder is beveled off, and a V-block *F* is held in position by a screw *G*, entering from the side. The micrometer head is placed in the hole provided for it, with its division reading faced upwards, and the screw *G* clamps the micrometer head and the holder *E* at the same time. When the lead of the screw plug is tested, the carriage is moved one inch along the thread. It is understood that the lead screw of the lathe is not employed in this case, but one depends upon the micrometer for measuring the correct lead of the screw plug.

The master plug may, of course, also be placed between the centers and comparison be made with the master plug. In this case, the micrometer serves as a comparator. A plate is screwed on the left-hand side of the carriage, provided with a hardened stop against which the end of the micrometer screw bears. It is evident that the carriage must not be moved against the micrometer with too much force, but simply brought up to barely touch against the end of the micrometer screw.

* * *

The tables in the data sheet for January, 1908, by Mr. Joseph Holveck, giving the horse-power transmitted by cast iron and raw hide pinions, are for 1 inch width face, only. For wider faced pinions, multiply the values given in the tables by the width of face in inches.

* * *

Bids were opened by the city of Atlanta on November 25 for one 20,000,000-gallon vertical triple-expansion crank-and-fly-wheel pumping engine with a guaranteed duty of not less than 170,000,000 foot-pounds per 1,000 pounds of dry steam. The following bids were tendered:

Allis Chalmers Company	60-inch stroke	$134,000
Allis Chalmers Company	66 " "	149,300
Bethlehem Steel Company	66 " "	132,000
Camden Iron Works (R. D. Wood & Co.)	66 " "	147,700
Holly Mfg. Co.	66 " "	156,000
William Tod Co.	66 " "	157,400
William Tod Co. (same pump with special terms of payment)		165,000
Wisconsin Engine Co.	60 " "	139,500

The latter company was awarded the contract.

FINISHING GAS ENGINE FLY-WHEELS ON THE GISHOLT TURRET LATHE.

We believe that the following description and the accompanying line engravings will have suggestive value to mechanics interested in the making of automobile or other gas engines, as well as to others who have turret lathe work of a similar character to do.

Operation for Finishing a Fly-wheel at One Setting.

Fig. 1 shows an arrangement of tools by means of which it is possible to finish a fly-wheel complete at one setting. The hole for the shaft has to be bored and reamed, the hub has to be faced on both sides, and the sides and periphery of the rim are to be finished, all four corners of the rim being rounded. The outfit of tools shown is designed to accomplish this. It consists of boring bars, reamer and facing heads in the main turret, a turret tool-post on the slide rest (carrying in this case three tools) and a special supplementary wing rest attached to the front of the carriage at the extreme left.

The work is held by three special hardened jaws *B* in a universal chuck. These grip the work on the inner side of the rim, leaving room for a tool to finish the rear face without striking the chuck body or the jaws. Three rests *C* are provided between the chuck jaws; the work is pressed against these while it is being tightened in the chuck, and they serve to locate it so that the arms will run true so far as sidewise movement is concerned, and so that the work will be properly placed with relation to the stops for the turret and carriage movements. The chuck carries a bushing *R* of suitable diameter to support boring bars in the main turret, as will be described.

In the first operation, boring bar *M* is brought in line with the spindle and entered in bushing *R* in the chuck. Double-ended cutter *N* is then fed through the hub of the pulley to true up the cored hole. While boring the hole, the scale on the front face of the rim and the hub is removed by tool *J*. Tool *K* is then brought into action to rough turn the periphery, after which tool *E*, in the wing rest, is fed down to clean up the back face of the rim. As soon as the scale is removed, the hole is bored nearly to size by cutter N_1 in bar M_1, and finally finished with reamer *Q*, mounted on the floating arbor.

Next, cutters *F*, *G*, and *H*, in the facing head, are brought up to rough face the hub and rim, and round the corners of the latter on the front side. This operation is all done by broad shaving cuts. The facing head in which the tools are held is provided with a pilot bar *T* which fits the finished hole in the work, and steadies the head during the operation. The various cutters *F*, *G*, and *H*, are mounted in holders which may be so adjusted as to bring them to the proper setting for the desired dimensions. This finishes the roughing operations.

The periphery of the rim is now finished by cutter *L* in the turret tool-post, which is brought to the proper position for this operation. The rear face of the rim is finished by tool *E*, the same one with which the roughing is done. *E* is removed and replaced with *D* which rounds the inner corner of the rim. This is in turn replaced with a third tool for rounding the outer corner of the back side. For finishing the front faces of the rim and hub and rounding the corners of the former, a second facing head, identical with the first one, is employed. This is shown in position in the engraving. Blades F_1, G_1, and H_1, correspond with the blades *F*, *G*, and *H*, previously referred to, and perform the same functions.

The only remaining operation, the finishing of the back of the hub, is effected by cutter *P*. This cutter is removed from the bar, which is then inserted through the bore and the cutter replaced in its slot, when the rear end of the hub is faced by pressure on the carriage away from the head-stock. This completes the operation required for finishing the wheel complete at one setting.

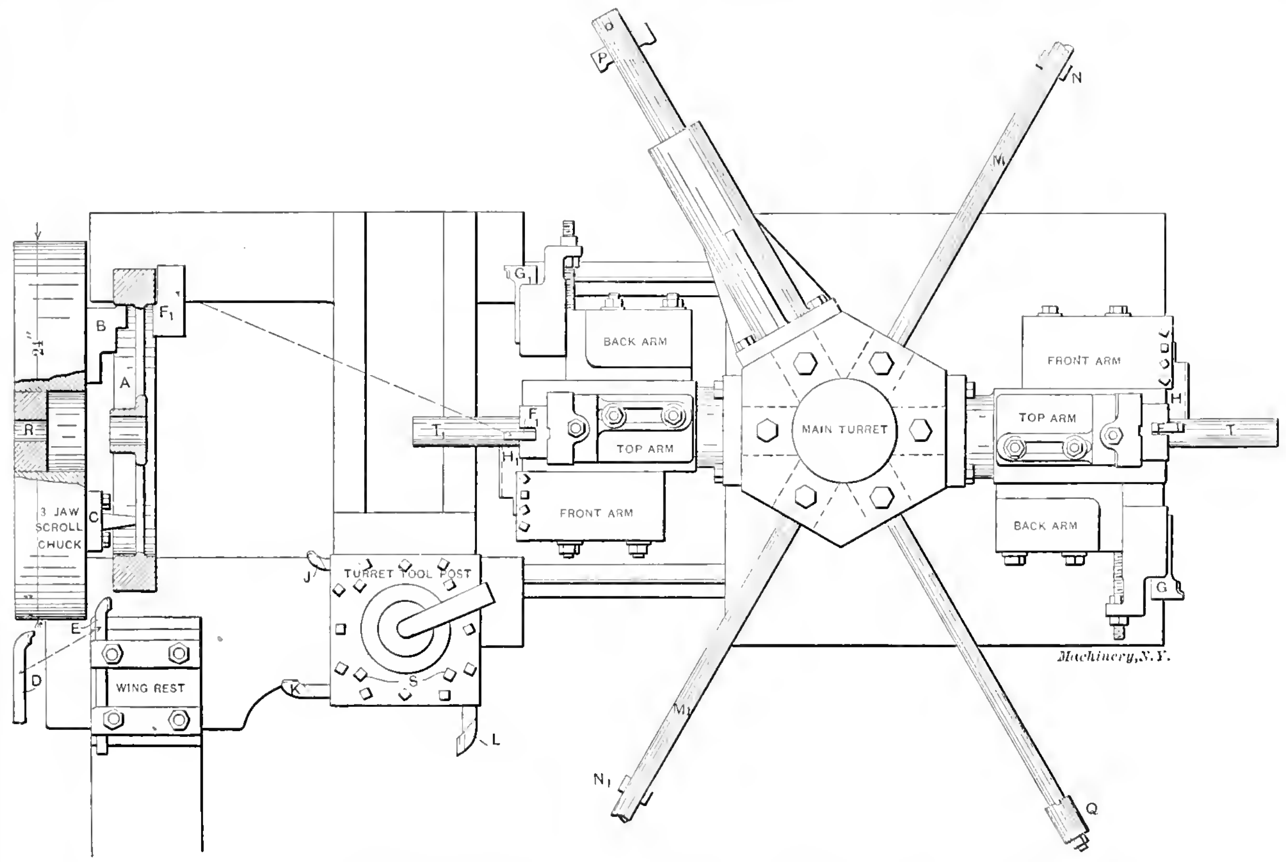


Fig. 1. Arrangement of Machine and Tools for Finishing a Fly-wheel Complete at One Operation.

Finishing a Webbed Fly-wheel All Over in Two Settings.

In Figs. 2 and 3 are shown the arrangement of tools for finishing a webbed fly-wheel which has to be machined all over. This, of course, requires two operations. In the first of these, Fig. 2, the rough casting is chucked at *A* on the inside of the rim with regular inside hard chuck jaws *B*.

The engraving shows the first operation in progress. The cored hole is being rough bored with cutter *N* supported in the end of boring bar *M*, and guided by the drill support *D* pivoted to the carriage. Next, the boring bar M_1 is brought into position, the drill support being thrown back out of the way. This bar is steadied by its bearing in bushing *R* in the chuck, the same as provided in the case of Fig. 1. Two cutters, N_1 and N_2, are used to roughly shape the hole to the desired taper, the small end being finished to within 0.002 of the finished size. While boring with the bar M_1, the scale is broken on the web and hub of the piece with the tool *K* in

the turret tool-post. The latter is then shifted to bring the tool J into position for removing the scale on the periphery of the wheel. Next, the hole is reamed with taper reamer Q, the pilot of which is supported by bushing R.

with the soft slip jaws B, which are bored to the exact diameter of the piece. The work is further supported and centralized by sliding bushing C, which is tapered to fit the finished hole in the work, and has an accurate bearing in bushing R in the chuck as well. As shown, it is provided with a threaded collar for forcing it into the work and withdrawing it.

First, the scale on the web and the inside and face of the rim is broken with the tool K in the turret tool-post. These

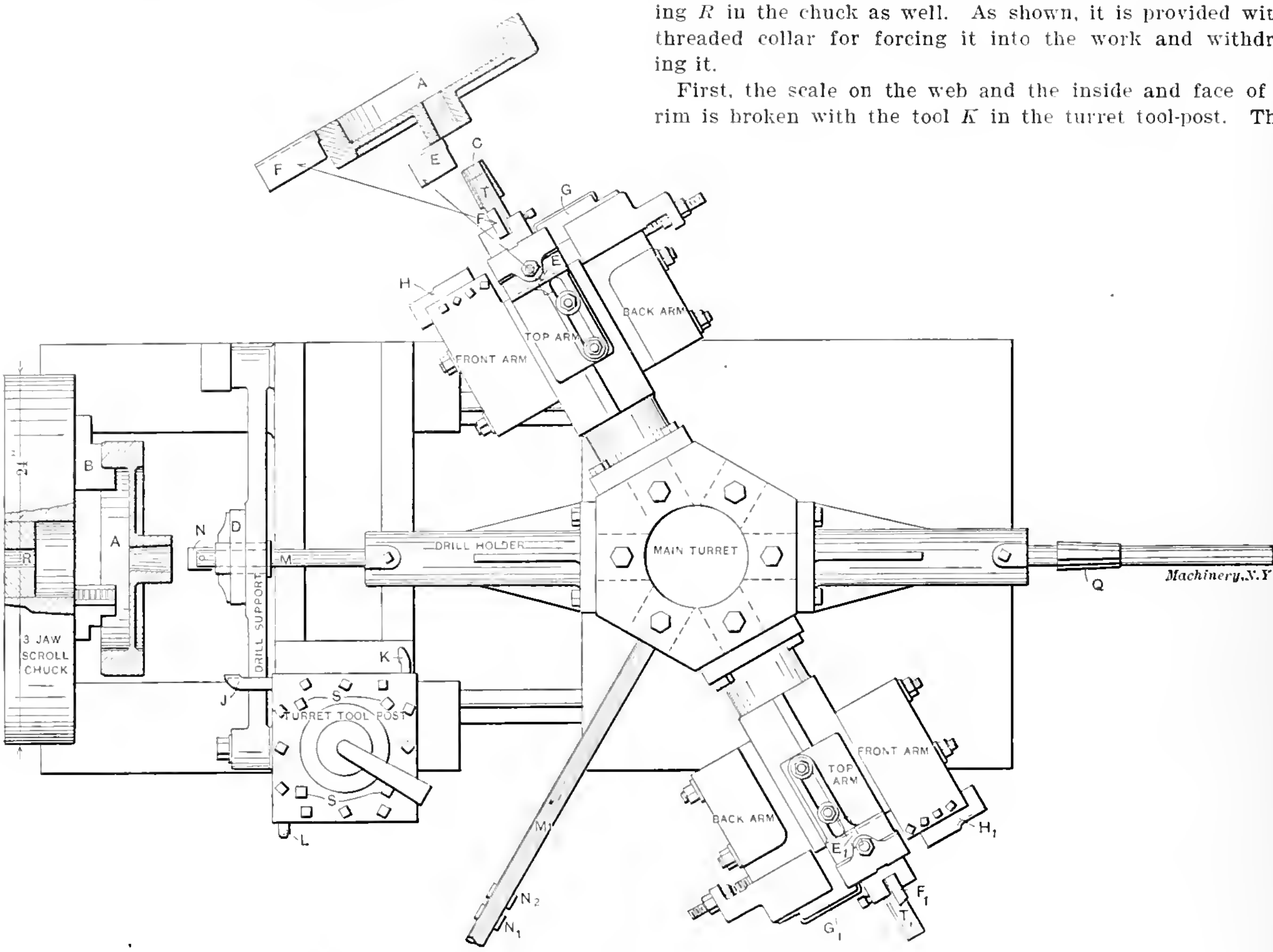


Fig. 2. Finishing the Periphery, Front Face, and Bore of a Webbed Fly-wheel.

The first of the facing heads is now brought into action. This facing head carries a guide T which is steadied in a taper bushing C, driven into the taper hole of the work for that purpose. Blade F turns the periphery, blade G turns the

surfaces are then roughed off with cutters F, G, and H, in the facing head. This latter is steadied by a pilot T which enters the hole in the sliding bushing C on which the work is supported. This brings the piece approximately to size. Next,

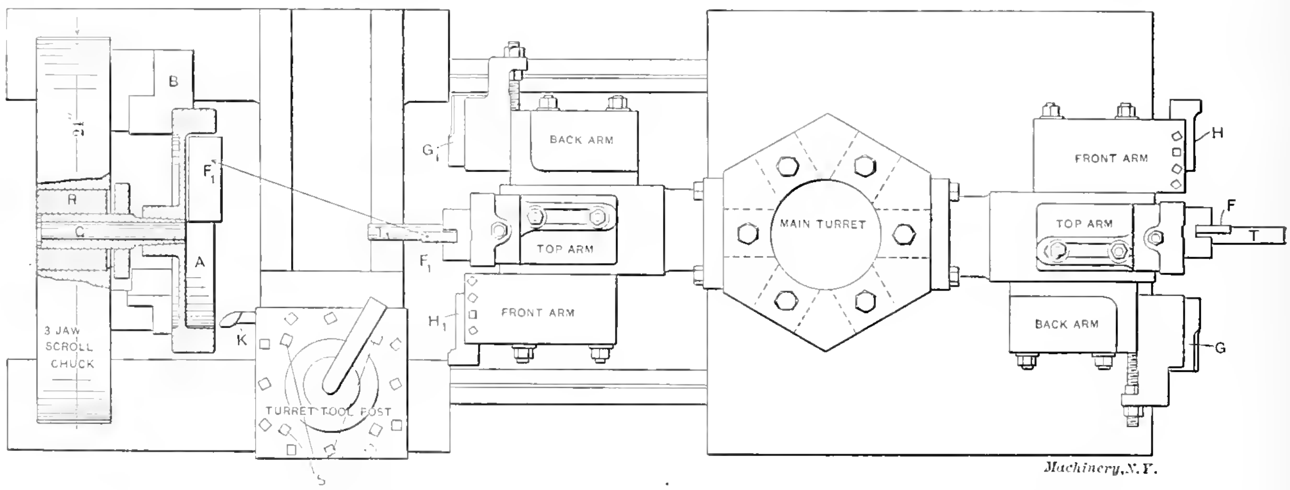


Fig. 3. Finishing the Rear Face of the Work shown in Fig. 2.

hub and faces the web, and blade H faces the rim. A fourth blade E on the under side of the head faces the hub. This brings the piece approximately to size. For finishing, the similar cutters E_1, F_1, G_1, and H_1, in the other facing head are used, this latter being supported by the taper bushing C in the same way. Only a very light cut is taken for finishing. Tool L in the carriage turret is then used to round the outer and inner corners of the rim, this completing the work on this face of the casting.

In the second set of operations, shown in Fig. 3, the same piece, reversed, is shown chucked on the outside diameter

a light cut is taken with blades F_1, G_1, and H_1, in the finishing facing head, which completes the operation.

The tools and operations shown represent the practice of the Gisholt Machine Co., 1316 Washington Ave., Madison, Wis.

* * *

The construction of a lighthouse at the Ar-Gazeck reef near Ushant on the French coast, is being conducted under great difficulties owing to the swiftness of the currents which prevented more than 52 hours' work on the foundation during 1904, more than 206 hours in 1905, and more than 152 hours in 1906, making 51 eight-hour days during three years.

LETTERS UPON PRACTICAL SUBJECTS.

A TOGGLE-JOINT PUNCH.

Punch and die work on sheet metal is done principally upon two kinds of punch presses, namely, the single-acting and the double-acting press. The kind of press to be used depends upon the nature of the work to be done. The single-acting press has one eccentric, or crank, on the shaft, which transmits the required motion to the punch; while the double-acting has two eccentrics, or cranks, set in such a relation to each other that there is produced a follow-up motion. The punch is attached to one eccentric arm, or connecting-rod, and another punch or plunger to the other arm, or connecting-rod. The plunger works on the inside of the punch, and is generally used to form the metal into some desired shape after the blank is cut out. The plunger comes into action just after the punch has cut the blank. By means of the double-acting press, the work is punched and formed in one stroke, and in some classes of work, it is pushed through the die and falls into a box under the press. The single-acting press will do the same work, but the dies are more complicated, and the work comes up on the die by means of springs, and is

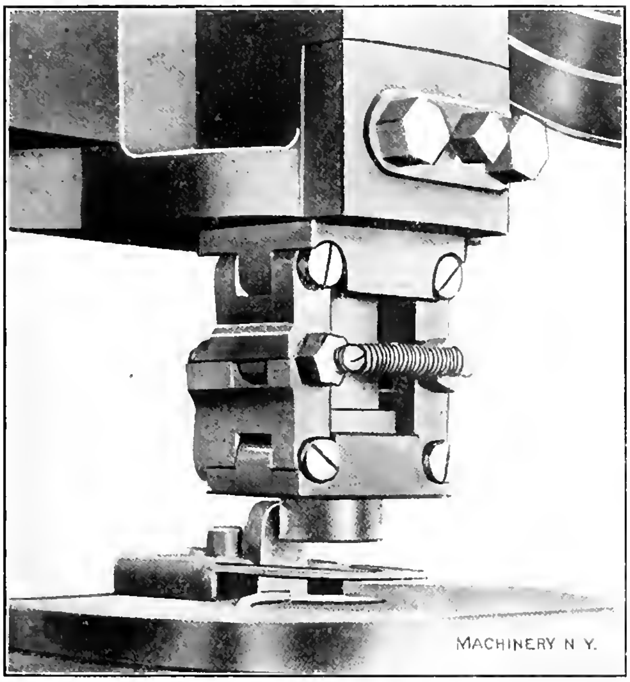


Fig. 1. View showing the Punch in the Up Position.

removed from the die by being brushed off or by sliding off by gravity, since many presses are made so that they can be set in a tilted position. The advantages of the double-acting press are many. The punches and dies are very much more simple and durable than those for the same work on the single-acting press, and the work can be done much more rapidly. Many manufacturers who do their own stamping work purchase the single-acting press, because of lesser first cost over the double-acting press. This is not the most economical method in the long run, if there is a great deal of punching work to do that could best and cheapest be done on a double-acting press.

I shall describe a punch and die which I have designed, which does the work of a double-acting press on a single-acting one. In this design, I have employed the well known toggle-joint. The work of this punch and die is the punching and forming of can bottoms from heavy stock. There are many sizes of cans, and the parts of the punch and die are interchangeable for the different sizes. When the punch is in the up position (Fig. 1), the toggle-joints are in line and are held there rigidly by means of two springs. The punch holder *A* (Fig. 2) is attached to the lower joints of the toggles, and slides up and down on the forming plunger *B*. In operation the punch *C* comes down on the stock and cuts out the circular blank on the die *D*. Just after the blank is cut, the arms *E*, of the lower joints, strike the opening wedge *F* and open the toggle-joints. This causes the punch *C* to slide up on the plunger *B*. Then the plunger *B* continues downward and presses the blank over the rounded shoulder *a*. There is enough clearance between the plunger and the inside of the forming ring, below the shoulder *a*, to allow for the

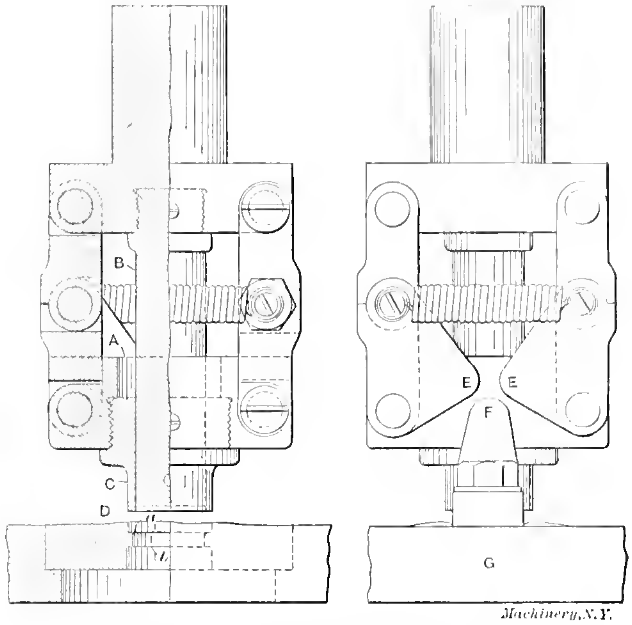


Fig. 2. Front View and Half-section, and Rear View of Punch.

thickness of the metal. After the plunger pushes the formed can bottom through the forming ring at *b*, it starts on the upward stroke. The finished can bottom is stripped off the plunger at the shoulder *b* in the die, and drops into a box under the press. After the arms *E* of the toggle pass above the opening wedge *F*, the toggles close by means of the springs.

It will be noticed that the plunger does not extend flush with the bottom of the punch *C* when the punch is in the

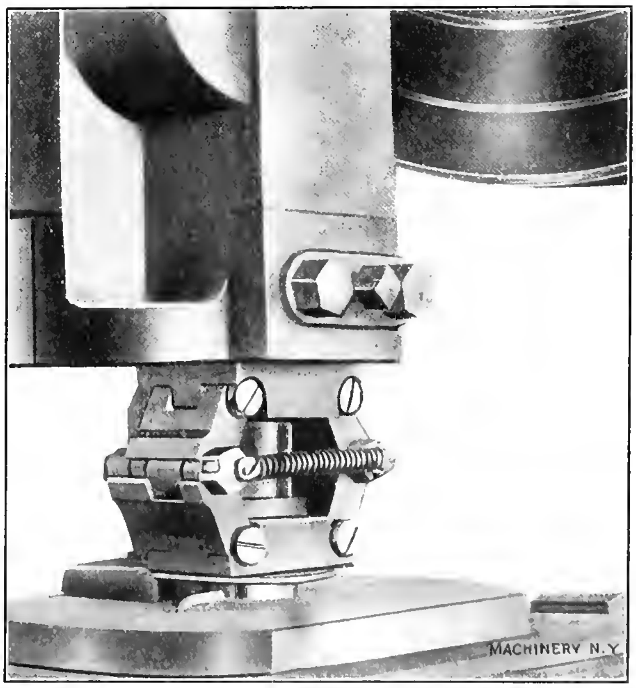


Fig. 3. View showing the Down Position of Punch.

up position. This is for the purpose of allowing the punch to cut the blank before the plunger comes into action. A feature of this punch is that the toggle-joints hold the punch holder perfectly rigid until the blank is cut and the toggles opened. The strain does not come on the bolts, but on the curved shoulders, plainly shown in the isometric views (Fig. 4). If the strain did come on the bolts, there would be a tendency to shear them, especially when cutting heavy stock,

and they would soon be worn enough to throw the whole punch out of true. In this design, there is little wear on the bolts. Figs. 1 and 3 show the up and the down positions of the punch, also the stripper for removing the scrap stock from the punch piece. There is also a stop shown by means of which the holes in the stock are spaced as near together as possible in order to save metal.

This punch will work as fast as the stock can be fed in. There is no trouble caused by bits of metal getting into the die, as there is in dies which throw the finished work up to be brushed off the bolster plate. There is no stopping of the punch to allow the finished work to slide off or be brushed off the bolster plate, as is the case with the old form of punch and die. The opening wedge *F* (Fig. 2) is bolted to the bolster plate *G*, and it is of such a height as to open the toggles just after the blank is cut, and before it is formed. The rubbing surfaces of the wedge and opening arms are case-hardened to prevent wear. The curved shoulders *c* and *d* (Fig. 4) are machined out accurately with an end mill. The punch *C* and the die *D* (Fig. 2) are made of tool steel and hardened. The die is afterwards ground. The cutting edge of the die is waved in order to get a good shearing effect on the stock. The plunger *B* and the punch piece *C* each have a shoulder. These pieces are screwed firmly in their respective holders. There is also a headless set-screw in each holder to prevent any possibility of the piece working loose. When it is desired to change the size of the can bottom, the

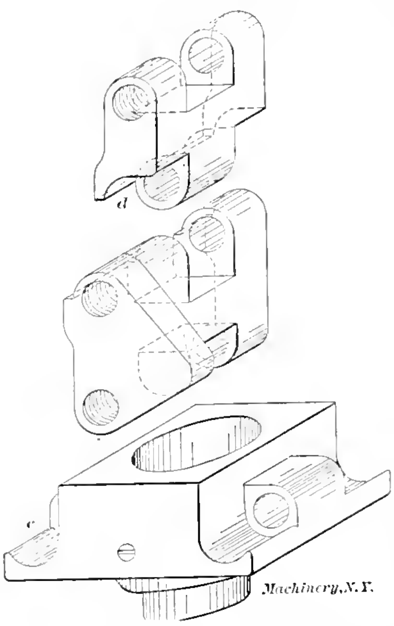


Fig. 4. Isometric View of Toggle-joint and Punch Holder.

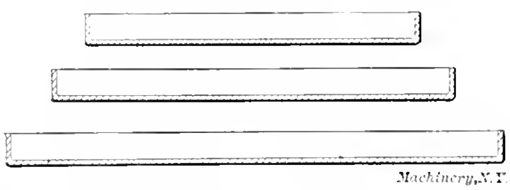


Fig. 5. Can Bottoms which are formed by the Toggle-joint Punch.

only parts to be changed are the plunger *B*, the punch piece *C*, and the die *D*. The plunger and the punch are unscrewed with a spanner wrench. Three different sizes of the can bottoms formed with these punches and dies, are shown in Fig. 5.

This punch and die, after much service, has been found very satisfactory, and has given very little trouble. I have designed a similar punch and die for making square and rectangular can bottoms which has also given satisfaction. Toggle-joint punches can be made for many other purposes, and this type of punch is a time and money saver when used on single-acting presses. J. E. WASHBURN.

Cleveland, O.

SOME GAS ENGINE TROUBLES.

A gas engine had a sparking device arranged as shown in Fig. 1, in which *A* is an insulated point in the sparking plug located in the cylinder head, and *B* a movable point also in the sparking plug but not insulated. This point is driven by a cam on the engine, making and breaking the current to cause the spark. *C* is a spark coil; *D* a battery of four cells; *E* a single-pole double-throw switch, and *F* a small dynamo driven through a friction wheel from the rim of the fly-wheel, and wired up to the other parts as shown. It was customary to throw the switch over to the right and so use the battery current for starting, after which the switch was thrown to the left, and the current taken from the dynamo for the spark. One morning all efforts to start the engine failed, until it was discovered that when the spark plug was held in the hands it would emit a brilliant spark, but if allowed to touch any part of the engine, a very feeble one. A further investigation showed that one of the brush holders

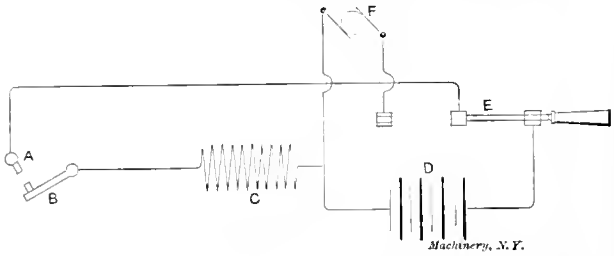


Fig. 1. Diagrammatical View of the Ignition Apparatus.

on the dynamo was grounded, and that the current instead of going through the spark coil *C*, took the easier path up to the dynamo brush, thence to the frame of the dynamo, and then through the gas engine frame to the point *B* as shown by the dotted line in Fig. 2. Hence the spark was very feeble. When the wires were disconnected from the dynamo brushes, the engine was started without difficulty. After putting fresh insulation on the dynamo brush holders, a

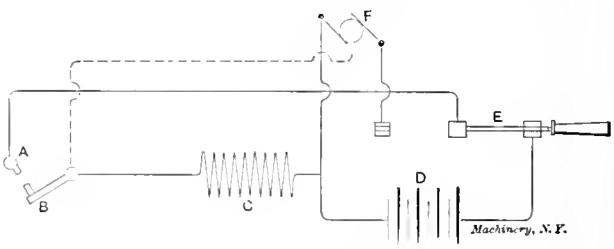


Fig. 2. Diagram showing by the Dotted Line how the Current followed the Path of Least Resistance when the Dynamo Brush was grounded.

change was made in the wiring by substituting a double-pole switch for the one having a single pole, so that the wiring diagram now corresponds to Fig. 3. If the dynamo should get in a bad condition, it would have no effect on the battery current when starting the engine, since both lines are broken by the double-pole switch. The discovery that the spark behaved differently when the sparking plug was in its place in the cylinder than when it was held in the hands, was purely

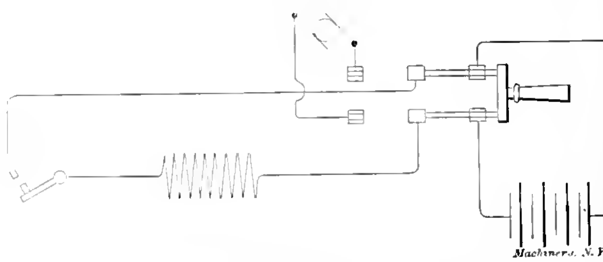


Fig. 3. A Change in the Wiring which prevents the Short Circuit illustrated in Fig 2.

accidental, and the designer of the engine came in for a good share of the blame for not arranging things so that the spark could be inspected under normal conditions. The dynamo is now wiped off clean every morning, and no further trouble has been experienced. L. K. W.

THE GROWING INEFFICIENCY OF WORKMEN.

In the December issue of MACHINERY I noticed an editorial, "The Growing Inefficiency of Workmen," and I can say that it is only too true; but what is the cause of this sad condition to-day?

When the writer and hundreds of others of the old-time mechanics learned their trades twenty-five or thirty years ago, we took pride in doing our work, even if it was only babbitting a journal box. The proprietors of our shops encouraged us in doing work right. What are the circumstances to-day? To-day it is quantity. It is how much work can you turn out? Are you a specialty man? To-day the manufacturers divide their work; they have lathe hands, planer men, milling machine men, bench hands, and floor

men. If you apply for a job as an all-around man they look upon you as a curiosity. In the days when we learned our trades there were no specialty men; they were either all-around mechanics or handy men. A mechanic in those days could fit locomotive links, run a bolt cutter, cut and thread a piece of pipe, or do whatever else the job demanded to make it complete. What is the average so-called mechanic to-day? Is he ever sent out to take charge of a big erecting job or to fit up a complicated piece of work? Not that anyone knows of!

In our day we served three, and sometimes four, years. Our foreman encouraged us not only to think but to put our ideas into execution. He used to say: "Study, boys; learn why you do a piece of work this way or that way. Never take anything for granted on some person's say-so; if you do you only become a machine, you will never become any better than one, and you will always be treated like one." Our old foreman's reasoning holds true to-day. I sometimes think that the average man who passes as a mechanic to-day is more of a machine than a human being. He seemingly has gotten into an automatic way of doing things, and has no conception that circumstances alter cases, or that what might prove effective in one case might be almost disastrous in another. Who is to blame? In the first place, there is a demand for something cheap by a class of people who buy cheap if they buy at all. Then there is a class that manufactures for the cheap trade, and a class of merchants that buys cheap goods and palms them off on unsuspecting people for first-class articles.

In the second place, the unions take in the specialty men, and give them union cards. They go out and represent themselves to be mechanics, whether they know anything or not. They come into competition with men who have learned their trades and who *are* mechanics. The average manufacturer uses the cheap specialty man to hold the real mechanic cheap. What inducement will there be for a man to become a first-class mechanic until manufacturers hire first-class mechanics only, and establish apprenticeship systems that will turn out first-class mechanics?

Let honest manufacturers and mechanics cooperate to put the cheap manufacturer, the dishonest dealer and the cheap mechanic out of business, or, at least, to put them into a recognized position where the general public will know who and what they are. Let honesty be the watchword of both the manufacturer and the mechanic, and let them be satisfied with fair profits and fair wages. Let us leave behind us the present era of bloated dividends, won from the making of dishonest goods—goods in which cheap materials, poor workmanship, plenty of paint and the buffing-wheel create a mockery for the unwary buyer.

When the days of the honest manufacturer and honest workman come—if they ever do—we will have mechanics who are all that the name implies, but not until then. Now, do not think that I believe all manufacturers and workmen of the present time are dishonest; far from it, but anyone who has kept in touch with the manufacturing conditions knows that in the mad rush for wealth they, both high and low, have trampled the good principles of our forefathers under foot to worship at the shrine of Mammon. E. G.

MILLING FIXTURE FOR FINISHING GEAR SEGMENTS.

Some years ago the writer met with a job requiring the finishing of 500 gear segments, of the type shown in Fig. 1. As seen from the cut, these segments were provided with an arm longer than the radius of the gear segment itself, which prevented them from being turned in a lathe, excepting by working the lathe back and forth by hand. As this method was very inconvenient, the following device was designed and put into operation:

A plain milling machine was selected for doing the work, as it would be comparatively easy to mill the face and the sides of the gear segments if a suitable fixture for revolving the work were provided. The pinion for feeding the table of the milling machine was disconnected from the shaft. Then a bracket *B*, as shown in Fig. 2, was made and bolted to the table. This bracket was provided with a projecting lug, which contained a set-screw *F*, for facilitating the setting of the device to the proper position on the table, before being bolted down. The bracket *B* carried an arbor *C* for holding the blank while it was being milled. The arbor *C*, with the blank, was driven from the pinion *D*, which was placed on the end of the feed shaft of the table, which, in this particular machine, came through the frame of the machine, so that one could tap a stud for the gear into it. It was, however, not

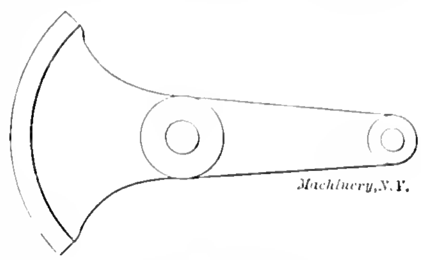


Fig. 1. Gear Segment

possible to use a gear on stud *C* as large as would be required to mesh with the gear *D*, on account of interference with the supporting arm of the milling machine, and therefore the idler *E* was placed between the gear *D* and the gear on arbor *C*.

For finishing the blank, three milling cutters were used, one face and two side or straddle milling cutters, and the work of milling the face and the sides of the gear segments

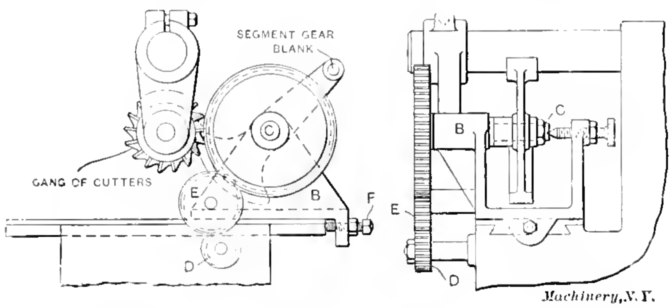


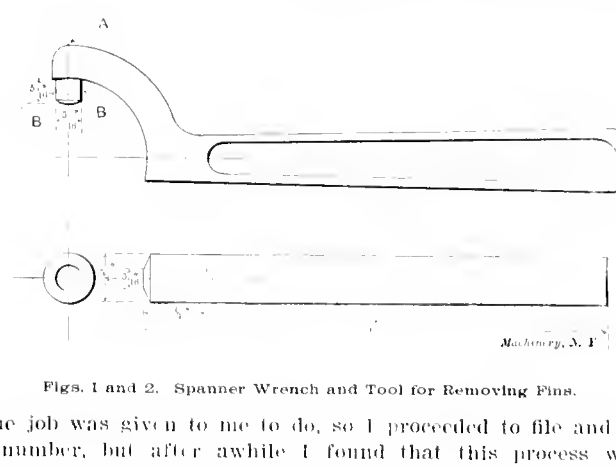
Fig. 2. Attachment for Finishing the Gear Segments on the Milling Machine.

was completed in one cut. The device worked very well, and the blanks were finished at a fraction of the time which had been required by other methods previously employed.

W. ALTEN.

REMOVING FINS FROM THE PINS OF SPANNER WRENCHES.

A manufacturing firm had received a large number of drop-forged spanner wrenches of the type shown in Fig. 1, the pin of which was to fit in a 5/16-inch hole in a packing-nut. The wrenches, it was found on inspection, would not fit the hole, because the pins had a fin projecting about 1/16 inch on each side at *B*. The only remedy for this fault seemed to be to file and fit each of the wrenches to a 5/16-inch gage.



Figs. 1 and 2. Spanner Wrench and Tool for Removing Fins.

The job was given to me to do, so I proceeded to file and fit a number, but after awhile I found that this process was going to take too long, and cost too much, so after some thought I decided upon the following plan, which did the job in about one-tenth of the time it would have taken by the previous method: I took a piece of 5/8-inch tool steel 6 inches long, and drilled a 5/16-inch hole in the center of one end, about 3/4 inch deep; then I filed the stock to a bevel around the hole, as shown in Fig. 2. The drilled end of the

piece was then hardened in the same manner as an ordinary punch or die. The piece was then fastened perpendicular to the bench in a strong, heavy vise, and was ready for service.

The process of removing the fins was performed by holding the wrench so that its pin came directly over the 5/16-inch hole in the tool steel rod. Then one or two blows with a heavy hammer at the point *A*, Fig. 1, removed the fins quickly, so that all the wrenches fitted well, and the work was finished nice and smooth. A little oil on the tip of the wrench kept the stock from tearing. ROY B. DEMMING.

Geneva, N. Y.

A GOOD BOX TRUCK.

For convenience in handling our small brass fittings, both before and after machining, they are put into small wooden boxes and carried wherever wanted by means of a small truck, which is light, and easily handled, and which takes up little space when not in use.

The boxes are made of a good grade of one-inch lumber, and are 16 inches long, 10 inches wide and 9 inches deep, outside measurement. They are bound with heavy strap iron, making them very serviceable and long-lived. One of these boxes is shown in Fig. 1. The figures on the end denote

Figs. 1, 2 and 3. Box Truck for Shop Use.

weight of box. All boxes are marked this way for convenience in weighing, and their weight will vary from six to nine pounds.

The truck shown in Figs. 1, 2, and 3 is made in the factory for our own use only. The frame is made of seasoned oak, bolted together with ¼-inch bolts. The center piece or handle is 4 feet long, 2 inches wide, and 1¼ inch thick. The side pieces are 3 feet long, 1½ inch wide, and 1 inch thick. The frame is 12 inches wide, at top and 11 inches at bottom. The bottom of the frame is 2½ inches square, and through this is run a ½-inch bolt which serves as an axle for the wheels. The wheels are ordinary cast iron wheels, 1¼ inch wide by 4 inches diameter.

The iron work shown on the trucks is all hand-forged. The hook shown fastened to the center piece is also hand-forged, and is so made that it will lie back against the frame as shown in Fig. 2, and when the truck nose is shoved under a box, a quick jerk causes the hook to drop into position shown in Fig. 1.

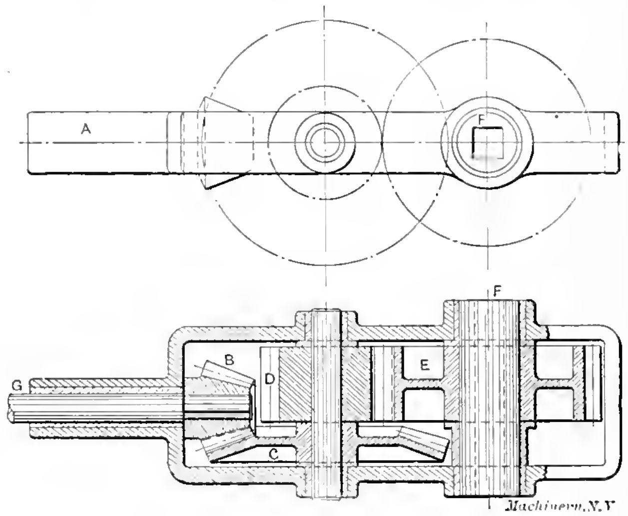
Holes are drilled through the center brace at various heights so that the hook may be placed in proper position for different sized boxes. A small cotter pin is used to keep the hook in whatever hole it is placed.

Reference to Fig. 1 will show that when the hook is in position to hold a box, there is a projection pointing to the rear so placed that the hook can be lifted out of the box with the foot. With very little practice, boys learn to handle boxes full of brass fittings quickly and easily without touching a hand to them. ETHAN VIALL.

Decatur, Ill.

RIGHT-ANGLE POWER HEAD FOR DRILLING AND REAMING HOLES.

The accompanying cut illustrates a right-angle power head which is used principally for drilling and reaming holes in locations where it is impossible to use the regular tools. Especially is the tool found very valuable where traction engines, locomotives, or cars are being repaired. It is often found that the pneumatic drill, or the electric drill, are too



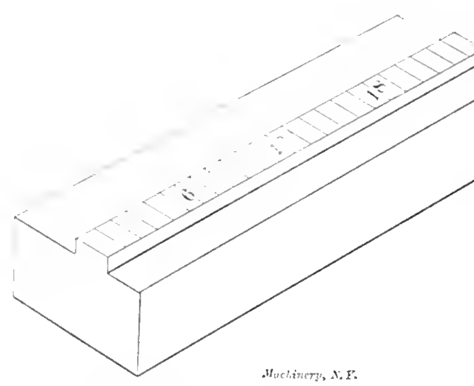
Right-angle Power Head.

large to be used, because of the lack of room, and the only tool that can be used is a ratchet. This power head requires less room than the ratchet. The drill or reamer fits into one end of the square socket *F*, and a small feed screw in the other. This socket is formed in a steel sleeve, which is keyed to the spur gear *E*, having 26 teeth, 5 pitch, and 1¾-inch face. The spur gear *E* is driven by the steel pinion *D*, having 14 teeth. On the same shaft with the pinion *D*, the steel bevel gear *C* is fastened. This gear has 36 teeth, 6 pitch, and 1¼-inch face. The main driving pinion *B* is made of hard brass, and it has 12 teeth. This pinion is keyed to the stub shaft *G*, which is attached to a flexible driving shaft. The shaft *G* can, of course, be driven in other ways if more convenient. The head frame *A* is made of cast iron, and each bearing is bushed with bronze. I believe that most shops will find this power head to be a valuable tool.

Denver, Col. T. B. BURNITE.

GRADUATING ON THE PLANER.

While the planer might not be considered the tool best adapted for graduating, I will describe a case in which I found it both accurate and quick. I had a number of drawn steel bars, from 4 to 12 inches long, to be graduated in sixths of an inch, as shown in the sketch. No miller was available, and the job was marked "rush." The 18-inch planer had a



Steel Bar which was graduated on the Planer.

double threaded cross feed screw with a 1/3-inch lead, and was driven through a 32-tooth ratchet wheel, so I set the feed to move 16 teeth at a time, which gave me a movement of 1/6 inch for every stroke. Putting the vise on the planer, and grinding a V-point tool, completed the preliminary arrangements. The bars were then put in the vise. The tool

was set to the proper depth and brought to the end of the work, after which it was only necessary to throw in the feed pawl and start the machine. The scales were cut at the rate of 5 inches per minute, which is very good time for an odd job. It was, of course, necessary to lift the tool on the return stroke.

DONALD A. HAMPSON.

Middletown, N. Y.

INDICATING FINISHED SURFACES—RECORDING CHANGES ON DRAWINGS.

The article by C. T. in the July, 1907, issue of MACHINERY, entitled Indicating Finished Surfaces, reminds me of a somewhat similar system of finishing marks which, to my mind, is simpler and fully as effective as the system mentioned by C. T., and which has also been in use for several years. In this system the various classes of finish are designated by number, as follows:

Finish No. 1 requires surfaces to be extremely smooth and accurate within a tolerance of ± 0.0005 inch.

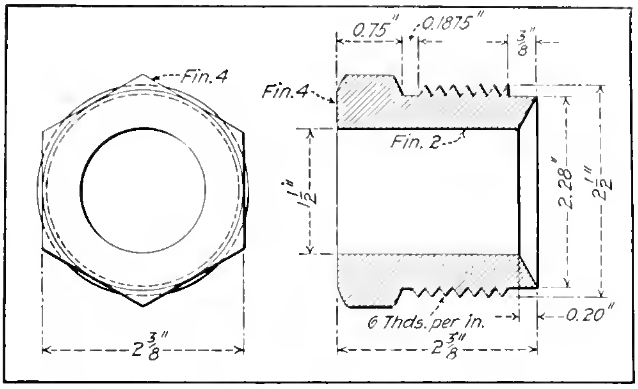


Fig. 1. System of Indicating Finished Surfaces, applied to a Drawing.

Finish No. 2 requires surfaces to be very smooth and accurate within a tolerance of ± 0.001 inch.

Finish No. 3 requires surfaces to be smooth and accurate within a tolerance of ± 0.003 inch.

Finish No. 4 requires surfaces to be accurate within a tolerance of ± 0.005 inch.

Finish No. 5 requires surfaces to be rough machined or filed to within a tolerance of ± 0.025 inch.

Finish No. 6 requires that castings or forgings be cleaned of all sand, scale, risers, fins, etc.; and that no thickness of

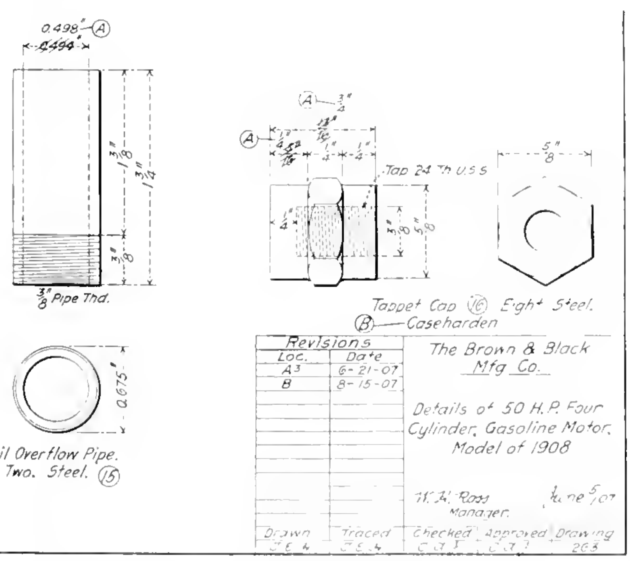


Fig. 2. Method of Recording Changes on a Drawing.

metal when ready to assemble shall differ from drawing dimensions more than ± 5 per cent.

All allowance for fit is to be made on the female parts. Male parts are to be made to the standard size.

With the above system, used on drawings as indicated in Fig. 1, work can be laid out to any degree of accuracy required and the workman readily knows between what limits of accuracy he must make any dimension. In cases where the piece can be made satisfactorily with one grade of finish all over, a note may be added to the name, etc., of the piece on the drawing to that effect. For example, the specification: Washer—Finish No. 4, attached to the drawing of a washer would indicate that no dimension need be worked closer than ± 0.005 inch to the specified sizes.

The recording of changes or revisions made on drawings of any kind is of the greatest importance, and Fig. 2 illustrates

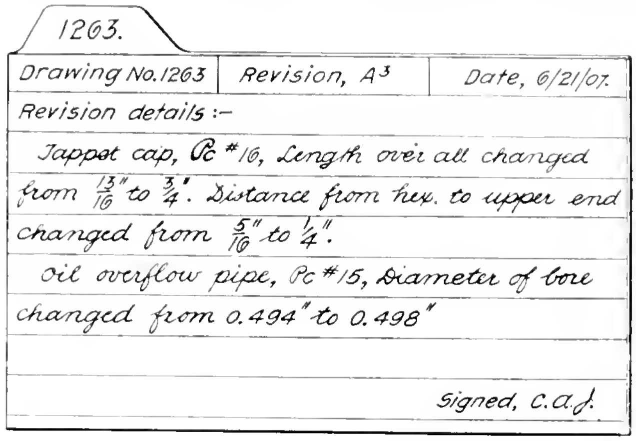


Fig. 3. Card System with Complete Record of all Revisions.

a very satisfactory method of recording changes on a drawing. The columns headed Revisions show the location on the drawing of dimensions revised and also the date when the revisions were made. The small figure at the right of the letter of revision in the column indicates how many places on the drawing the revision affects. For instance, the revision A^3 affects the drawing in three places, while *B* affects it in only one place, as shown. It is a matter of opinion as to how to remove the old dimension and place the new dimension in its place, but, personally, I very much prefer that the old dimension be merely crossed out and the new dimension be shown above it, as in Fig. 2.

It is advisable, on account of its simplicity and the possibility for ready reference, that a separate file of revision records for each type of machine being manufactured be kept. A card system, of some such form as shown in Fig. 3, is preferred by the writer, because its flexibility allows for sufficient expansion to cover all details concerning any revision that may be made in any drawing. The cards in the revision file are indexed by the drawing numbers, and are arranged in their several indexed spaces in the alphabetical order in which the revisions were made. By the above method a complete record of all changes, on any piece, shown on any drawing and belonging to any machine, can be kept in compact form and in condition for immediate reference at any time.

W. E. C.

FORMULAS FOR MILLING END MILLS AND CLUTCHES.

In the following the writer has shown the method by which a formula is arrived at for the correct setting of the index head of a milling machine for milling the teeth on the ends of end mills, on the sides of side or straddle milling cutters, etc. A formula is also deduced for the setting of the index head when milling the teeth of clutches.

Referring first to the question of end mills, let it be assumed that the number of teeth, and the angle of the angular cutter with which the teeth are to be milled are given. The angle sought is the one to which to set the index head of the milling machine. In Fig. 1 the problem is shown diagrammatically, the cutter angle *ADB*, and the number of teeth, *n*, being given, while the angle to which the index head is to be set (which is to be determined) is *BEC*. In order to simplify the calculations, assume the radius of the end mill to equal 1. Evidently, the length of the radius has no influence on the final result, or on our formula, anyway. The angle *BCM* represents the angle of one tooth of the end mill. Now, produce *CM* to *A* and draw *AB*. The line *CE* represents the bottom of the tooth, and the plane in which the angle of

the cutter for milling the teeth must be measured, is at right angles to CE, or in the plane BD (lower view of Fig. 1).

We can now arrive at the following equation:

$$\text{Angle } ACB = \frac{360 \text{ deg.}}{n}$$

$$\tan \frac{360 \text{ deg.}}{n} = \tan ACB = \frac{AB}{BC}$$

But BC = radius of end mill = 1, and consequently

$$\tan \frac{360 \text{ deg.}}{n} = AB \qquad (1)$$

The triangle ABD, shown at the right in Fig. 1, is in a

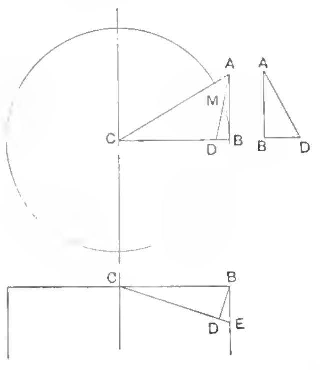


Fig. 1. Deriving Formula for setting Head for cutting End Mills.

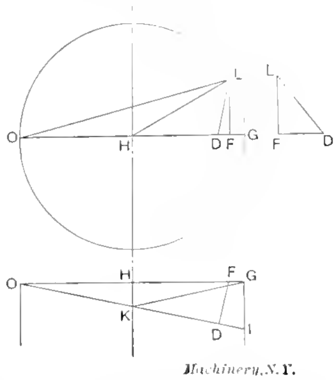


Fig. 2. Deriving Formula for setting Head for cutting Clutches.

plane perpendicular to the bottom CE of the tooth, the angle ADB being the cutter angle, as mentioned. Then

$$BD = AB \times \cot ADB = \tan \frac{360 \text{ deg.}}{n} \times \cot ADB \qquad (2)$$

The line BD, however, also lies in the plane containing the right triangle CDB. We have, therefore,

$$\cos CBD = \frac{BD}{BC} \qquad (3)$$

But BC = radius of end mill = 1, and consequently, from (2) and (3):

$$\cos CBD = BD = \tan \frac{360 \text{ deg.}}{n} \times \cot ADB \qquad (4)$$

The angle CBD equals the angle BEC, or the angle to which to set the index head; therefore,

$$\cos BEC = \tan \frac{360 \text{ deg.}}{n} \times \cot ADB, \text{ or, expressed in words:}$$

The cosine of the angle to which to set the index head equals the tangent of the tooth angle multiplied by the cotangent of the angle of the cutter by which the teeth are cut.

[This formula, expressed in words, was contributed by Mr. George Porter to MACHINERY, April, 1904, but the derivation was not given in Mr. Porter's article. For table see MACHINERY Data Sheet, May, 1904.—EDITOR.]

Clutches, in order to fit into one another, must have the bottom and top of the teeth inclined at corresponding angles, as shown by lines KG and KI in Fig. 2. Assume that the number of teeth n and the cutter angle LDF are given, and that the radius $HG = 1$. The angle LHG = 360 degrees divided by the number of teeth. Draw LF through L perpendicular to OG. The line KI represents the bottom of the tooth. Produce KI to O. The plane in which the angle of the cutter for milling the teeth must be measured, is perpendicular to OI. Assume, therefore, that the angle is measured in a plane FD (see lower view of Fig. 2). Angle $LHG = \frac{360 \text{ deg.}}{n}$.

$$LF = \sin LHG \times HL = \sin \frac{360 \text{ deg.}}{n}$$

The triangle LFD, shown at the right in Fig. 2, is in a plane perpendicular to the bottom KI of the tooth, or perpendicular to OI, the angle LDF being the cutter angle, as mentioned. Then $FD = LF \times \cot LDF = \sin \frac{360 \text{ deg.}}{n} \times \cot LDF$.

But FD also lies in the plane containing the right triangle ODF. Therefore,

$$HF = \cos LHF \times HL = \cos \frac{360 \text{ deg.}}{n}$$

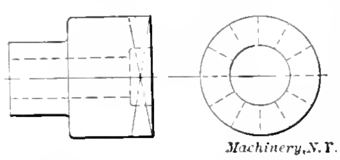
$$OH = 1.$$

$$OF = OH + \cos \frac{360 \text{ deg.}}{n} = 1 + \cos \frac{360 \text{ deg.}}{n}$$

$$\cos OFD = \frac{FD}{1 + \cos \frac{360 \text{ deg.}}{n}} = \frac{\sin \frac{360 \text{ deg.}}{n} \times \cot \text{cutter angle}}{1 + \cos \frac{360 \text{ deg.}}{n}}$$

The angle OFD equals the angle OIG, or the angle to set the index head. Therefore the previous formula expressed

TABLE OF ANGLES TO WHICH TO SET HEAD-STOCK OF MILLING MACHINE WHEN CUTTING CLUTCHES WITH ANGULAR CUTTERS.



The cosine of the angle to which the milling machine index head is set, equals the sine of the tooth angle multiplied by the cotangent of the cutter angle, divided by the cosine of the tooth angle plus 1.

No. of Teeth.	Angle of Cutter. 60°	70°	80°	No. of Teeth.	Angle of Cutter. 60°	70°	80°
5	....	....	82° 12′	18	84° 9′	86° 19′	88° 13′
6	....	77° 52′	84° 9′	19	84° 30′	86° 31′	88° 19′
7	73° 50′	79° 54′	85° 10′	20	84° 46′	86° 42′	88° 24′
8	76° 10′	81° 20′	85° 48′	21	85° 1′	86° 51′	88° 29′
9	77° 52′	82° 23′	86° 19′	22	85° 13′	87°	88° 33′
10	79° 12′	83° 13′	86° 43′	23	85° 27′	87° 8′	88° 37′
11	80° 14′	83° 54′	87° 4′	24	85° 38′	87° 15′	88° 40′
12	81° 6′	84° 24′	87° 18′	25	85° 49′	87° 22′	88° 43′
13	81° 49′	84° 51′	87° 30′	26	85° 59′	87° 28′	88° 46′
14	82° 26′	85° 12′	87° 42′	27	86° 8′	87° 34′	88° 50′
15	82° 57′	85° 34′	87° 51′	28	86° 16′	87° 39′	88° 52′
16	83° 24′	85° 51′	87° 59′	29	86° 24′	87° 44′	88° 54′
17	83° 48′	86° 6′	88° 7′	30	86° 31′	87° 48′	88° 56′

in words, reads: *The cosine of the angle to which to set the index head, when cutting clutches, equals the sine of the tooth angle multiplied by the cotangent of the cutter angle, all divided by the cosine of the tooth angle plus 1.*

The accompanying table gives the angles for setting the index head when cutting clutches, figured from the formula given. IRVING BANWELL.

Belvidere, Ill.

TO CALCULATE THE SIDE OF AN INSCRIBED POLYGON.

Sometimes we do not have our tables handy, and in such a case it is advantageous to know how to construct one, or to calculate a quantity for ourselves. Take, for instance, the length of the side of an inscribed polygon of any number of sides, which increases in geometrical proportion by two, as in the series 4, 8, 16, 32, 64, etc. To solve this problem we can start with the fact that when the radius is unity, the side of the inscribed square will be $\sqrt{2} = 1.4142$. Then the values of the other terms of the series will be as follows:

$$4 = \sqrt{2} = 1.4142$$

$$8 = \sqrt{2 - \sqrt{2}} = \sqrt{2 - 1.4142} = \sqrt{0.5858} = 0.7654$$

$$16 = \sqrt{2 - \sqrt{2 + \sqrt{2}}} = \sqrt{2 - \sqrt{2 + 1.4142}} =$$
$$\sqrt{2 - \sqrt{3.4142}} = \sqrt{2 - 1.8477} = \sqrt{0.1523} = 0.3902$$

and so on, the signs always commencing with minus and then alternating with minus and plus. ROBERT GRIMSHAW.

Hanover, Germany.

IMITATIONS OF AMERICAN MACHINE TOOLS.

The complete and painstaking imitations of American machinery, which a number of German firms are now engaged in manufacturing, is a matter which must sooner or later be considered as a factor having more or less effect on the extent of American foreign trade. It has fallen to the lot of the writer to be in a position where this practice is under his constant and direct observation, and he believes the time has come when a word must be uttered for the benefit, or at least, information, of the people who have spent time, study and money in perfecting and patenting their ideas. Not only is the manufacturer concerned in this subject, but the firms that handle American machinery abroad stand to lose considerable, should there be found no method of checking this piracy.

Almost invariably, before a new machine can be successfully sold in Europe, there must be considerable sums of money spent in advertising and demonstrating, and, as only a short time elapses before one or more of these "Nachahmen" firms has the matter under consideration, it generally happens that about the time the American machine is meeting the approval it deserves, there is quietly insinuated on the market, a "made in Germany" article, which, as far as appearance is concerned, might have been the issue of the same parentage. However, some small amount of comfort can be derived from a consideration of the results.

In one case in which I was personally interested, an American automatic was purchased by a Berlin firm, and a German imitation was installed beside it on the same work. The German machine had the advantage of national prejudice, but I was proud to find that the weekly output was 15 per cent in favor of the American article. The fault in this case was with the spindle, which was not properly scraped in, and in consequence heated frequently.

A friend of mine was once traveling through China. He had a pair of duck trousers which had seen service in the Philippines, and he decided to order a more presentable pair to wear when returning home. So he took them to a Chinese tailor and gave him orders to make another pair exactly like the sample. He received them in due time, and the practical example of the Chinaman's ability to make a perfect copy of a given article, as demonstrated by the work done on those duck trousers, left an impression which nothing could remove. John Lee had faithfully reproduced every detail, the most striking of which was a fair-sized hole, which in the case of both the original and the copy could only be hidden when the wearer assumed a position of rest.

So also is the case here, but I believe the idea in so faithfully copying every detail and not adding any improvements is because of the danger they incur of making something which will not run.

An acquaintance of mine here, a Pennsylvania Dutchman, owner of a small shop, was once in need of a grinding machine. He was visited by one of these "plagiarists" and received an offer of a "made in Germany" grinder at a few dollars reduction in price. A superficial inspection of the machine convinced my friend that it was made in the image of a well-known American design, but a point he almost immediately noticed was that while one center was ground to a 60 degree angle the other was finished at a much blunter angle.

This startled my friend and he pointed out the difference. The maker answered, "Yes, but that is nothing to complain about. Why should a little difference in angle be of any account? The machine is the same as your American grinder." "Yes," answered my friend, "but if you have exercised the same judgment in copying the machine as you have in the centers (which is of the most vital importance), I guess I'll look somewhere else for a grinder. I wouldn't take your machine as a gift."

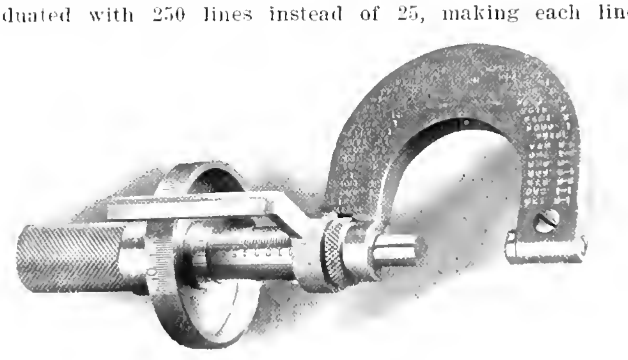
A striking case of so-called improvements was in evidence at the Automobile Show recently held in Berlin. A firm whose business is almost exclusively the copying of the well-known Cleveland automatic, had a machine on exhibition made after the design of the new 3-hole automatic recently brought out in Cleveland. Now, as is well known, the feature of the regular Cleveland automatic is the differential feed through adjustable cams and friction disks.

The 3-hole machine is a special machine designed with a view to cheapness, positive feed and speed, and adaptability for a great range of work. This German concern copied the construction of the machine made necessary because of the changed feed, and then in addition put in the friction feed, etc. The result is a hybrid that is neither ornamental nor useful. The feed is neither regular nor positive, as was demonstrated by the trouble they had in attempting to use a geometric die head. On account of the trouble they had in keeping the feed regular, the die would sometimes open too soon and at other times not at all. However, the natural desire to save a few dollars which actuates most buyers of machinery, often prevents the sale of the original article, and for this reason the writer believes something should be done by American manufacturers, if possible, to correct the evil. DAVID R. MILLINGTON.

Berlin, Germany.

MICROMETER ATTACHMENT FOR READING TEN-THOUSANDTHS.

The accompanying half-tone illustration shows an attachment for micrometers which I designed and made for reading in tenths of thousandths. With very little fitting it is interchangeable for 1, 2 or 3-inch B. & S. micrometers. The idea is simple, as can be seen by the illustration. The diameter of the thimble was increased 3 to 1 by a disk which is graduated with 250 lines instead of 25, making each line



Micrometer with Attachment.

represent 0.0001 inch instead of 0.001 inch. A piece of steel was then turned up and bored and cut away so as to form the index blade and a shell to clasp the micrometer frame, the whole thing being made in one piece. The thimble disk being just a good wringing fit, it can be easily adjusted 0 to 0. The attachment can be removed when fine measuring is not required. P. L. L. YORGENSEN.

Hartford, Conn.

METHOD OF TRUING UP OILSTONES.

There seem to be a great many mechanics who do not know how to true up their oilstones. Every now and then you will see a man spoil a good stone by trying to grind it true on the emery wheel, which usually cracks the stone into several pieces, or checks it with fine cracks which sometimes are almost invisible to the naked eye. My method of truing up an oilstone may not be new to all, but I know from experience that there are many who do not know about it. Take a piece of planed cast iron, and cover the machined surface with loose emery mixed with water. Then place the oilstone upon this surface and grind it true. This can be quickly done if water is used with the emery, as water is much better than oil for this purpose. I have trued up many kinds of stones in this manner, from a coarse India oilstone, to a fine Swaty razor-hone. Stones with special shapes may be formed by planing a groove of the desired shape into a cast iron block, and then drawing the stone back and forth through this groove, using emery and water as before. Those who try this method of truing up an oilstone will find the results satisfactory, and stones which are much worn and useless, can be made almost as good as new. J. J. VOELCKER.

Decatur, Ill.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

DESCRIBING A CIRCLE AROUND A DRILLED HOLE.

Occasionally it is required to describe a circle about a small drilled hole, the method in vogue being to do this with dividers and a ball center. In the absence of the latter, the dividers can be used by putting a sharp prick punch mark in a buckshot, inserting one leg of the dividers firmly in this mark, and proceeding as usual. DONALD A. HAMPSON.

Middletown, N. Y.

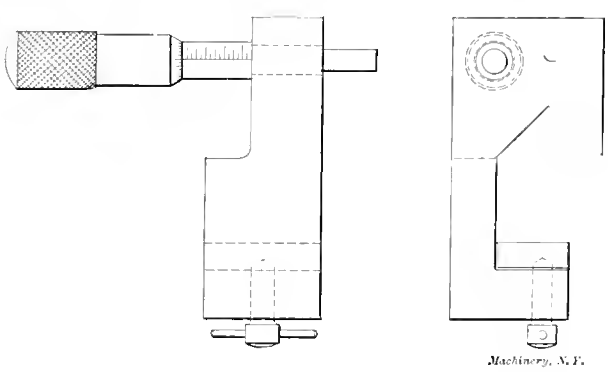
A TIME-SAVING DRAFTING KINK.

A great saving in time, which even well systematized drafting rooms seem to overlook, can be effected by putting one or two tracers to work cutting up a quantity of standard sizes of tracing cloth, drawing the border lines around them, stamping them with the standard marking, simply leaving out the name of the piece, date, and draftsman's initials, which, of course, are filled in when the tracing is made. This saves every man going and cutting up a piece of tracing cloth each time he is to make a tracing. It makes it very convenient for the tracers as they can get the size sheet they want, tack it down, and trace in the drawing right away, without bothering with cutting to size, measuring the outline, and putting on the borders and title stamp. This plan also saves a lot of waste of tracing cloth. F. L. ENGEL.

New Britain, Conn.

MICROMETER STOP FOR THE LATHE.

The micrometer stop shown herewith is used on the engine lathe for obtaining accurate movements of the lathe carrriage. It consists of a micrometer head, which can be purchased from any micrometer manufacturer, and a machine steel

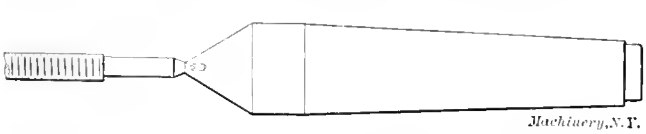


body which is bored to fit the micrometer head. This tool is clamped on the front way of the lathe bed, and when the jaw of the micrometer is against the lathe carrriage, it can easily be adjusted to the thousandth of an inch. Of course, care should be taken not to bump the carriage against the micrometer. J. L. MARSHALL.

Dayton, O.

TURNING AND THREADING NEEDLE POINTS FOR CARBURETERS.

The accompanying cut shows a little kink which saved time and trouble in the shop where I am employed. We were turning and threading needle points for large engine carbureters. These were made from brass rods 5/16 inch in diame-

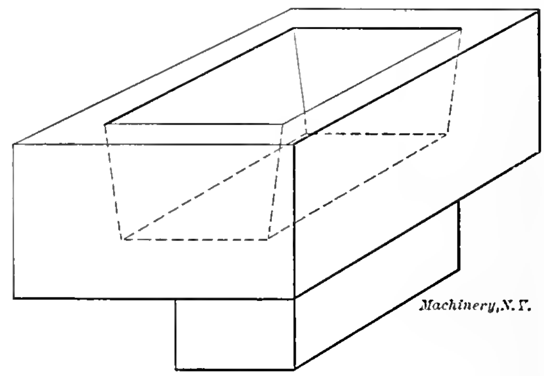


ter, by 4⅞ inches long. The rod was first held in a small chuck and beveled on one end. It was then pulled out a little over 4⅞ inches, and we were then ready for turning and threading the piece. In order to be able to get a support for the pointed end, we drilled a center hole in the tail-stock center of the lathe, and placed the rod with its 60-degree beveled end in the tail center, as shown in the cut. By this means it was possible for us to turn and thread the needle points without much trouble. J. D. COE.

Lansing, Mich.

BABBITT RIVETING BLOCK.

Some time ago one of the boys told me he was tired hunting up new pieces of babbitt or lead to rivet on, so I fixed up a "wrinkle" that helped him out finely. I asked the patternmaker to make a pattern for a little box, as shown in the accompanying cut, and from it got a half dozen castings. The lug on the bottom makes it convenient to hold in the vise. The

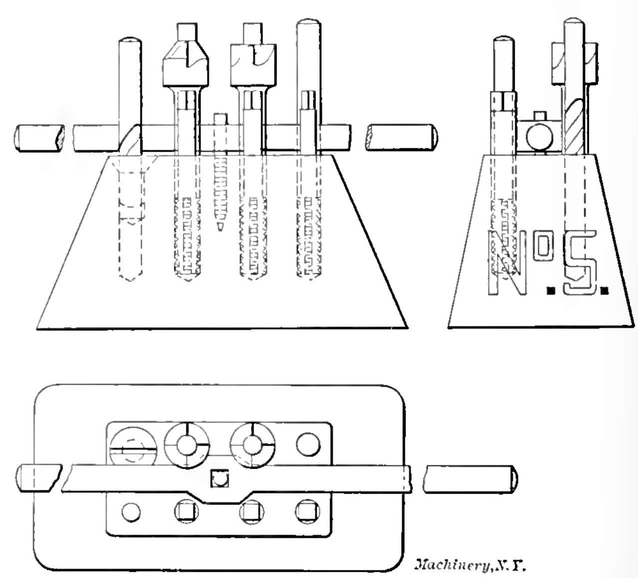


hollow top is poured full of babbitt (or lead), thus forming a soft anvil that lasts much longer than a plain piece of babbitt, as it is supported on all sides by hard metal which prevents the mushroom effect. When the babbitt gets so battered up that it cannot be used longer, we hold the block in the flame a few moments until it melts, and then pour the babbitt over again. The scheme saves time and babbitt, *i. e.*, money. C. H. RAMSEY.

Paterson, N. J.

BLOCK FOR HOLDING TAPS AND TAP DRILLS.

The accompanying cut shows a block which has proved very handy in our shop. It is intended for holding the three taps in the set, one tap drill, one full size diameter drill, one counterbore, one counter-sink, and a tap wrench. By having the tool-room provided with blocks such as these, when a man wants taps and drills or counterbores for a certain job, he simply asks for block number so and so, and he receives then



the block with all the accompanying tools. There is a great deal of time saved as compared with such systems where the man first has to ask for the taps, and then for the tap drill, and finally for the counterbore and counter-sink. Such methods in a shop tool-room ought to be considered obsolete. Tools belonging together should be kept together, and the best way for doing this is undoubtedly by using some kind of a block similar to that shown in the cut. F. RATTEK.

Brighton, Mass.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

THE GRIDLEY MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE.

The following paragraphs and the accompanying engravings describe and illustrate a new multiple spindle automatic screw machine, the invention of Mr. G. O. Gridley; it is built by the Windsor Machine Co., of Windsor, Vt., maker of the Gridley automatic turret lathe.

In the principle of its action (see Fig. 4), this tool follows the same plan as other commercially successful machines of its type. It is provided with an indexing head, carrying a number of revolving spindles. Each of these has a chuck and feeding collet for holding and handling the stock, of which there are as many bars as there are spindles—in this case, four. A tool-slide is provided, with a place for a tool opposite each work spindle, with means for feeding the tools simultaneously toward the head. Cross-feeding tool-holders for forming and cutting off are also provided, operating on the bar whose spindle is in position opposite it at the time. The spindle head is indexed periodically to bring each bar of stock in turn opposite each of the tools in the tool-holder, and in position to be formed and cut off as well, these operations all taking place simultaneously on different bars of stock. Thus a completed piece of work—turned, threaded, formed and cut off—is produced for each indexing of the spindle head.

The time required to complete a piece of work is the time required for the longest operation, plus the time consumed in the so-called "idle" movements. Sometimes, as in the turning operation in Fig. 4, a long operation may be split in two, thus materially increasing the output per day. All the other operations, except the longest, are, of course, working at less than the maximum feed of which they are capable, so that conditions are favorable to good work.

Mechanism by which the Machine is Operated.

The mechanism used to accomplish these various movements will be best understood by referring to the rear view of the machine, Fig. 2, in connection with Fig. 1.

The revolving head has a stem or shank solid with it, on which is mounted the "turret" or tool slide. This latter is guided in alignment with the work spindles by a fork having a carefully fitted bearing on the tie-piece D.

Driving pulley E is keyed to a shaft which passes through the hollow shank to the rear of the head, where it carries a gear meshing with the driving gears of the spindles, which are thus rotated continuously in the same direction, without provision for stopping or reversing. (See also Fig. 5.)

The various movements of the machine are all controlled by a cam-shaft F, at the rear of the machine. This cam-shaft may be driven at either of two speeds. One of them, that for feeding the tools, is obtained from spindle driving pulley E, through a double worm reduction and the quick change gear mechanism in the gear box. For the rapid movements, constant speed pulley G is connected by a friction clutch with the worm-shaft J, by which the cam-shaft F is revolved. When this is done, the worm-shaft runs ahead of the slow movement given it by its connection with the spindle, a ratchet mechanism being provided for this purpose. The throwing in of this fast motion is effected by clutch lever K, operated by adjustable dogs on disk L. By adjusting these dogs, the rapid and feeding movements of the cam-shaft may be made to occupy their proper respective portions of the complete cycle.

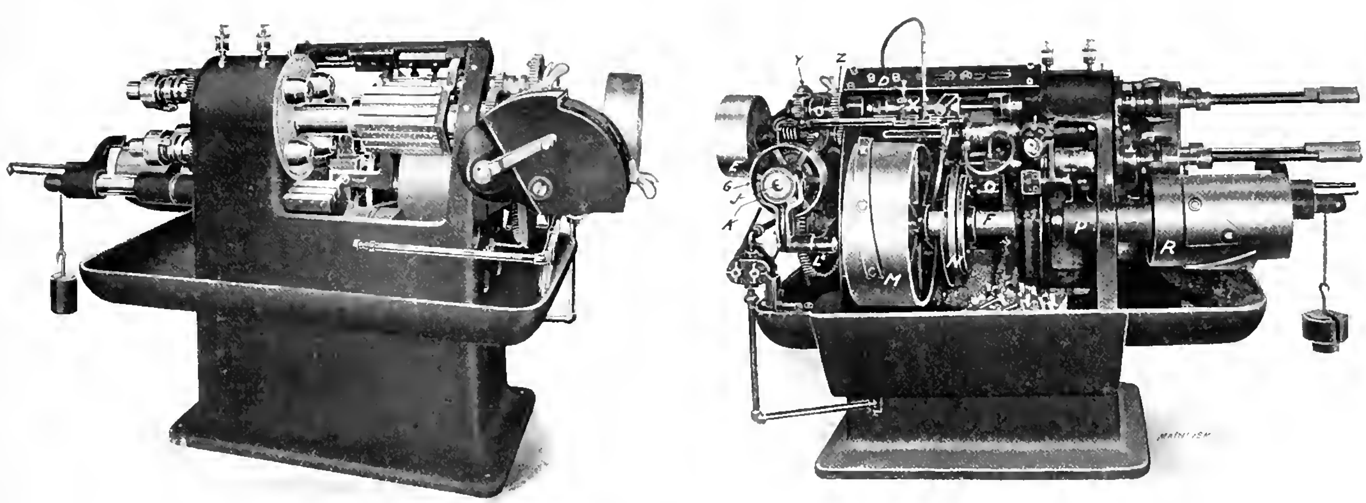
The longitudinal feed cam M acts on a roll at the rear of the tool-slide. Three cam-plates are furnished, having a 2-, 4- and 6-inch throw, respectively, of which the proper one for the length of the work in any given case is used. This cam, of course, advances all the tools on the slide simultaneously. This movement is positive for both advance and return, no springs being used.

The forming and cutting-off tools are mounted on pivoted holders, which are rocked toward and away from the work by positively acting face-cams on either side of disk N. Cutting-off tool-holder O also carries the stock-stop, which is presented to the work spindle opposite it just before feeding commences, after the preceding piece has been cut off.

Indexing arm P is the next member on cam-shaft F. This carries a cam which withdraws the revolving head lock bolt Q. It also carries a roll which engages slots in the inner face of the revolving head, the combination working on the plan of the Geneva stop motion, which is the standard mechanism for indexing heavy parts with a maximum of rapidity and a minimum of shock.

Last in order, at the outer end of the shaft, come the cams for operating the rod feed and chucks. These cams are mounted on drum R. The stock is fed forward by the usual feed tube and gripping collet, operated by a weight to give the required rapidity of action. The feeding movement for each spindle takes place when it is in the lower rear position.

The threading tool, tap or die, is mounted on spindle X, opposite the upper rear position of the work spindle. Spindle X is connected with the main driving shaft by either of gears Y or Z, depending on the position of the clutch between them. In beginning the threading operation, gear Y is clutched to spindle X, which is thus revolved at a slightly slower speed than the work. The threading tool is then pressed against the work by a cam, and the threading proceeds at a suitable surface speed. When the proper length has been threaded, a trip is released which throws the clutch to engage gear Z, which drives the tap or die faster than the work, thus screwing it off.



Figs. 1 and 2. Front and Rear Views of the Gridley Multiple Spindle Automatic Screw Machine.

Cycle of Operations.

The writer saw the machine in operation, making the hexhead cap screw shown at *e* in Fig. 4. The making of this screw will be readily understood, with the preceding description of the mechanism in mind.

We will follow the movements of one of the four bars of stock, starting with it in the front lower position, fed to length, as shown at *a*. When the tool-slide is fed forward, the tool opposite this position (a turner similar to that shown in Fig. 7) takes the cut at the end of the bar as shown at *b*,

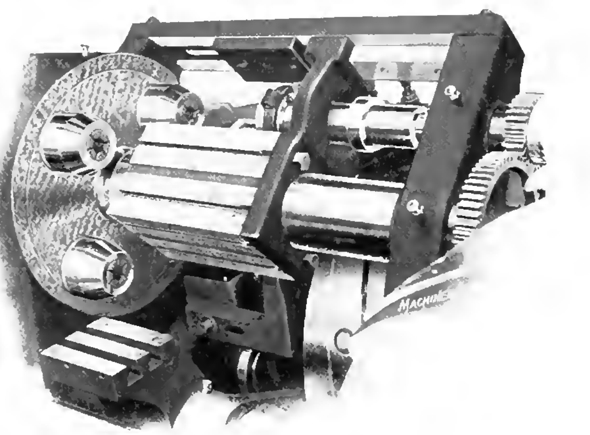


Fig. 3. Detail View of Spindle Head and Tool-slide.

while the forming tool necks the stock. At the completion of this cut the quick movement of the cam-shaft is thrown in, drawing back the tool, revolving the head, and bringing the tools up again. The bar of stock we are following is now in the front upper position where a second tool completes the turning operation, as shown at *c*. Dividing the turning into two operations increases the output, as previously explained. The head is now again indexed, and this spindle is brought opposite the threading die, which is slowly threaded on to the proper length by the mechanism previously described, and then threaded off again, without requiring the reversal of the spindle. The work, now in the condition shown at *d*, is next

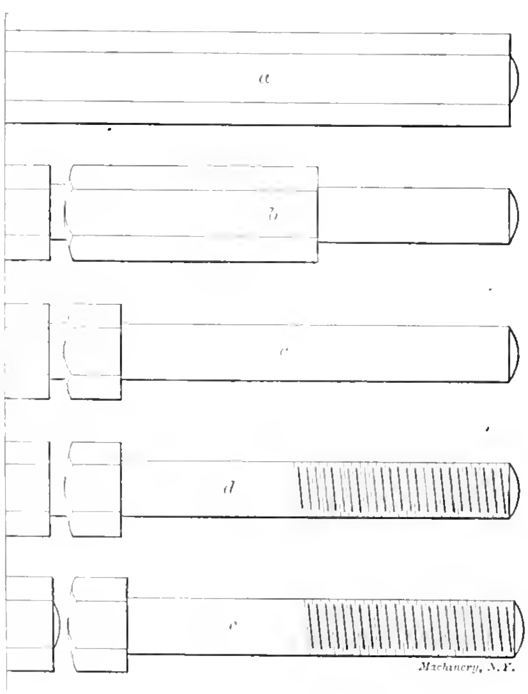


Fig. 4. Cycle of Operations on Hexagon Head Cap Screw.

brought down to the lower rear position, where it is cut off as shown at *e*. Immediately after it is severed from the bar, the cut-off tool recedes, bringing the stop into line, and the stock is fed forward to it while the other tools are being withdrawn from the bars on which they have been operating.

The Central Theme of the Design.

From the preceding description, it will be seen that the mechanism of this machine is simple, ingenious and effective, and therefore worthy of study. The chief interest in the design, however, centers about a definite constructive principle, which is the foundation on which the tool is built. This idea can be best understood by referring to Fig. 5, which shows the machine partly disassembled.

The prime difficulty in practically applying the multiple spindle scheme, is that of indefinitely preserving the alignment of the spindles with the tools. Fine workmanship may have established correct conditions at the start, but a little wear throws the parts out of line, and it is practically impossible to provide adjustments which will return them again to their proper place.

The reason for the existence of this particular multiple spindle automatic screw machine is seen in the construction of the head, shown disassembled on the floor in Fig. 5. It will be seen that this is a rigid casting, solid with the shank which carries the tool-slide. This shank has a bearing in the frame at the right. This is different from the usual construction, in which the comparatively short length of a large diameter head is depended on to preserve the alignment. It will be easily seen that a considerable wear of the bearing surface would have to take place before the head could "wobble" out of line, guided in parallelism as it is by the long shank.

Besides this, the tool-slide is mounted directly on the shank and moves with it, should the head get out of line. This is

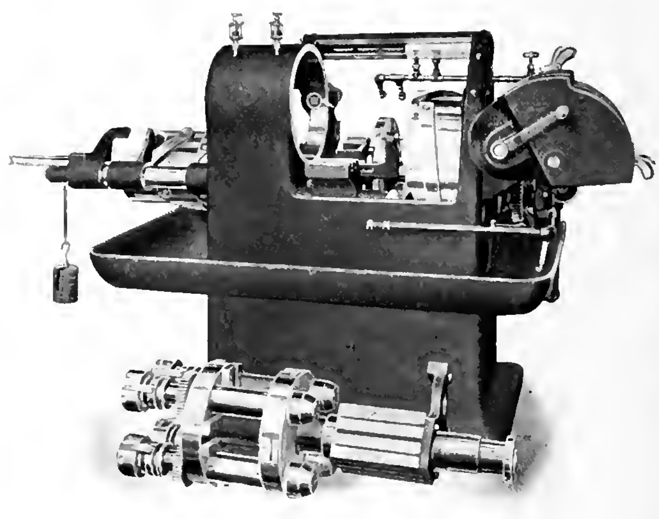


Fig. 5. The Machine Partially Disassembled, showing the General Scheme of the Design.

not the case with the usual construction, in which the head and the slide are separately supported by the base of the machine, each free to wear out of line or be mis-adjusted, without reference to the other. The value of this arrangement will be at once appreciated.

Preserving the Alignment.

Another radical step has been taken by Mr. Gridley to preserve the alignment of the spindles with the tool-slide as long as possible. This will be best understood by referring to Fig. 6, which shows an axial section through the head and one of the spindles. It will be seen that spindle *T* revolves in a bushing *U* of "Lumen" metal—solid and absolutely unadjustable. This is directly opposed to common practice, which provides elaborate adjustable boxes for the work spindles, with means for taking up the wear as fast as it occurs. The plan in this machine is to give the spindle a bearing of unusual area, in the best metal obtainable, with a fit as nearly perfect to begin with as the expert machinist can produce. With the low pressure per square inch to which such a bearing is subjected, and with the high-grade materials used, the expectation is that long continued use will be required to show anything more than negligible wear. The contention is, that where adjustments are furnished, adjustments will be required, for the parts will be continually getting out of their proper position, by working loose or by being tampered with by ignorant operators. We are believers in the correctness of this idea of carefully fitted, non-adjustable bearing of great area, and recommend it to the consideration of machine designers in cases like this, where the unit pressure can be

brought very low. Incidentally, the construction of the machine is greatly simplified, though this is not the purpose of the design.

If the time ever comes that the spindle wears loose, the old bushing *U* is removed and a new one inserted—a simple and satisfactory way of keeping the machine in good condition. There are two or three other points that may be mentioned in connection with this matter of permanency of alignment. The same plan of non-adjustability, careful fitting and large bearing area has been followed in the case of the bearing of the tool-slide on the shank of the spindle head, and the advantages of the construction apply here with equal force. Note also that the spindles are driven by gears *V* (see Fig. 6) flush with the end of the bearing, so that the lateral thrust is not multiplied by a lever action, as is the case when they are located at a considerable distance from the bearing. Being gear driven, the lateral thrust is, of course, less, anyway, than would be the case with belt-driven spindles.

It will be seen that the form of tool-slide used is an important factor in the matter of preserving the alignment. In the first place, the tools do not overhang at all—see the turning tool in Fig. 7, for instance. Besides this, the surface by which the slide is guided (the bearing of the fork on tie-piece *D*) is of a much greater diameter than the circle which contains the axes of the tool spindles, so that even if there were looseness here, it would be diminished instead of multiplied at the tool point. In the same way, the locking of the spindle head takes place on a large diameter.

The form of tool-slide used (identical with that of the Gridley single spindle turret lathe) has also the advantage of allowing the use of multiple tools at the same station to take cuts on different diameters, for instance, or to turn and drill simultaneously.

Points of Interest in the Mechanism.

Referring to the description of the mechanism, it will be remembered that the rapid movement of the cam-shaft is driven from a constant speed pulley, while the feeding movement is derived from the pulley which drives the spindles. This is as it should be. The rapid movements invariably take place at the fastest speed possible, if the speed of pulley *G* is properly selected; and since the feeding movement is con-

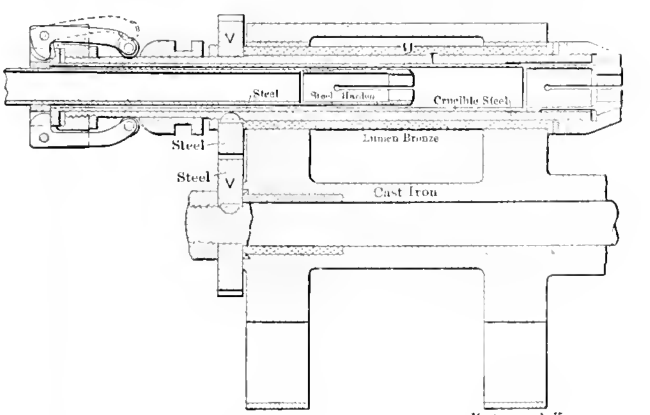


Fig. 6. Axial Section through Spindle Head and Spindle.

nected with the spindle, a given combination of gearing gives a definite feed in turns per inch, no matter what the speed of the spindle. This condition is the same as in the case of the lathe, and is the proper arrangement for any turning machine.

In the five months or more during which this machine has been in use, the value of the quick change mechanism for the feed has been steadily impressing itself on the minds of those who have used it. The machine may be set up with the tools properly adjusted for the work, without reference to the feeds; then, when the machine is started, the operator begins with a fine feed, gradually increasing it until the thickest chip is reached that the tool will stand. If a hard lot of steel is met with, the feed is lowered; if the tool appears to be taking it easy, the feed is increased. These adjustments would seldom be made if it were necessary each time to stop the machine and alter a set of change gears.

As previously noted, there are three cams furnished for the tool slide movement, giving 2, 4 and 6 inches of travel respectively. There are two handles on the feed box. When the lower one of these is set in that one of its three positions which is marked to agree with the cam which is being used, the adjustment of the upper handle will give a certain definite range of feeds, *viz.:* 75, 100, 125, 150, 175 and 200 turns per inch. Other feeds can, of course, be obtained by using other combinations of handle position. These handles operate two shifting idler and gear cone mechanisms, arranged in series.

The threading mechanism is an attractive one. This operation is made entirely independent of the others, by the way

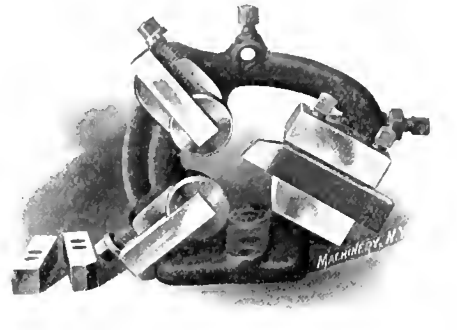


Fig. 7. Type of Turning Tool Used.

in which the die or tap is made to thread on or off by changing its feed relatively to that of the work, which remains unaltered. Left-handed tools are not required for turning and drilling operations, and the die has been threaded off by the time the other operations are completed, it not being necessary to wait for the return motion of the tool-slide to accomplish this.

Rigidity and Simplicity.

It will be seen that the central idea of the design of the head and tool-slide has resulted in a very rigid construction of the frame of the machine. (See Fig. 5.) The frame is all one piece, tied together at the top, so that all the strain of the feeding pressure is taken care of practically in simple tension, no bending action taking place. Above all, it should be noted, in this particular, that the bearing surfaces are free from cramping strains, the action of the feed-cam *M*, directly in back of the tool-slide, being an important item in this respect.

In the details of its mechanism, also, the machine has a noticeable simplicity and ruggedness. This is best seen in the rear view, Fig. 2. The members of the operating mechanism are strong, simple and few. There is nothing to get out of order, and everything is in sight. Strange to say, there are actually fewer parts in the tool than in one of the builders' single spindle machines.

The machine described above will take stock up to 1¼ inch in diameter, and will turn up to 6 inches in length. It weighs about 4,500 pounds.

MOTOR DRIVE MECHANISMS FOR LE BLOND LATHES AND MILLING MACHINES.

We show herewith a series of ten half-tone and line engravings, illustrating the solution of the motor drive problem for lathes and milling machines, arrived at by the R. K. Le Blond Machine Tool Co., 4605 Eastern Ave., Cincinnati, Ohio. These figures are particularly valuable as illustrating a consistent and systematic series of five designs, following the same general principles, but modified to suit the particular conditions under which they are used.

General Features of the Motor Drive Problem.

It is perhaps not necessary to say much about the comparative advantages of motor *versus* belt drive in connection with this line of machines, except as the general excellence of the design in this case enhances the points in which the motor drive appears to an advantage over its competitor. A greater number of speeds for a given range is obtainable with either the constant speed or variable speed motor drives than is ordinarily obtained by the cone pulley and back gear method. The advantage of this is evident. If it is not pos-

sible to run the work within 12 or 20 per cent of the speed at which the chip ought to be taken, it is evident that there is a waste of that amount constantly going on as long as the machine is in operation. There are also the well understood advantages of greater flexibility in arrangement of the machinery owing to the absence of line-shafts and counter-shafts; avoidance of transmission losses due to improperly designed and cared for belt and shaft transmissions; and avoidance of

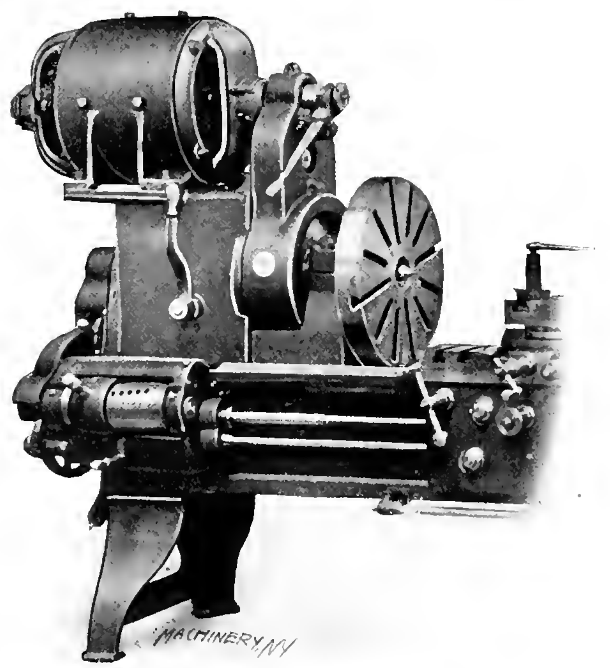


Fig. 1. Variable Speed Motor with Double Back Geared 20-inch Lathe.

the expense of running the whole system of shafts and belts for the sake of a comparatively few tools during slack times or long overtime work.

There are a number of factors entering into the design of motor drives for machine tools. There is, first of all, the question of the electrical system used—whether direct current single voltage, direct current multiple voltage, or alternating

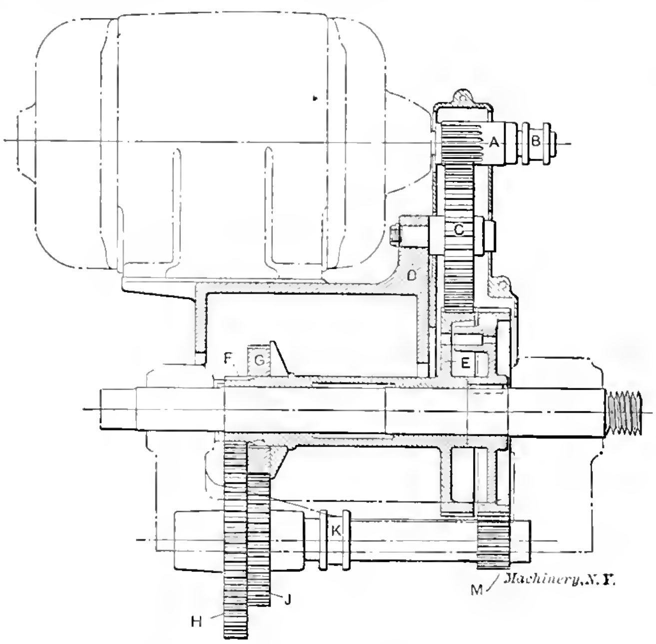


Fig. 2. Diagram of the Drive of the Lathe shown in Fig. 1.

current. With this matter, however, the machine tool designer has nothing to do, except as the system adopted requires the use of a constant speed or multiple speed motor. The arrangement of the gearing is vitally dependent on this question, as many more mechanical speed changes will have to be provided in the first case than in the second. Besides these electrical considerations, there are others which relate to the handiness, durability and efficiency of the mechanism. It should have as few parts as possible, consistent with the number of speeds it is desirable to furnish; changes should be quickly made without stopping the motor; the motion should be positive, and the parts should be strong and durable. In cases where a lot of mechanical changes are to be provided for, it is also an advantage to be able to change from one speed to another without going through all the intermediate steps. In other words, the control should be "selective."

Since provision is made in the Le Blond lathe for threading without reversing the spindle, no mechanical device for this is necessary. On the rare occasions when it might be necessary to run the spindle backward, the motor may be reversed, if electrical provisions are made for this. This simplifies the d sign greatly.

Lathe Driving Mechanism for Variable Speed Motor.

The problem evidently divides itself into two sections—those of providing mechanisms for variable speed, and constant speed motors, respectively. We will first consider the case of the variable speed motor. For lathes, the speed ratio should be from 40 to 1 up, depending on the size, if the lathe is to be used for the ordinary wide range of work. The most useful and satisfactory range of speed obtainable in variable speed motors is seldom much over 3½ to 1; so for small and medium-sized lathes it is evidently necessary to provide three mechanically-obtained speeds, each about three and one-half

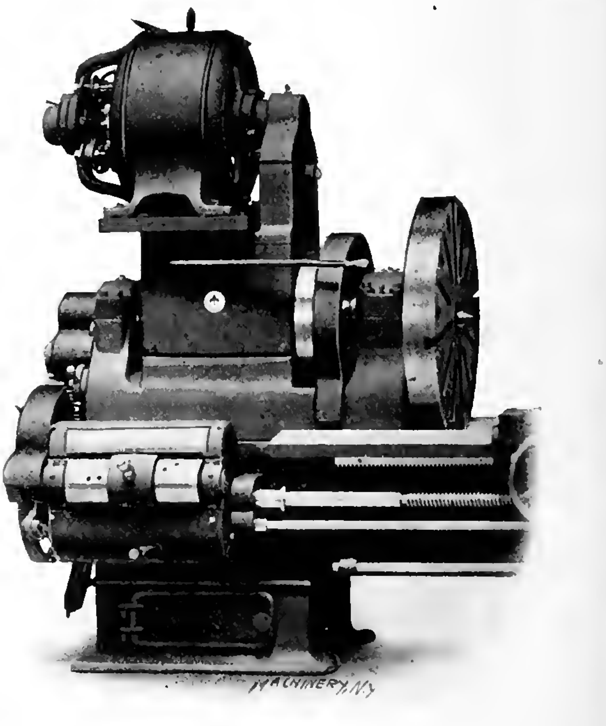


Fig. 3. Variable Speed Motor for 24-inch Lathe requiring Greater Speed Range than in the Case of Fig. 1.

times as rapid as its predecessor. This is done in the case of the 20-inch lathe shown in Fig. 1, by the driving mechanism shown diagrammatically in Fig. 2. The motor is mounted on a casing *D*, which surrounds the head-stock, and is bolted to it on each side. It is so arranged that practically no change has to be made in the head-stock from the form used for the ordinary cone-driven machine. It is only necessary to finish off the pads to which this casing is bolted. The back gear shaft and supports and other mechanism are unchanged, the back gear being shown below the spindle in Fig. 2 merely for clearness. In arranging casing *D* for different makes of motors, the upper part to which the motor is bolted may be readily changed to suit, or an adapter may be used here to connect the motor with the casing, as shown later in Fig. 4. No other alteration is necessary to fit the device to motors of different makes.

On the extended shaft of the motor is carried a driving pinion *A*, which is clutched to the armature shaft or released from it at will, by a clutch mechanism contained with it, operated by the lever shown in Fig. 1. This clutch, though compact, is very powerful, and is self-adjusting. It may be used for stopping the machine independently of the motor, serving the purpose of a belt shifter. Pinion *A* meshes with

a rawhide intermediate gear C, carried by a stud held in casing D. C drives a large gear E which is a part of a sleeve running loosely on the spindle, attachable to it at will through the main spindle driving gear and the usual lock bolt. This

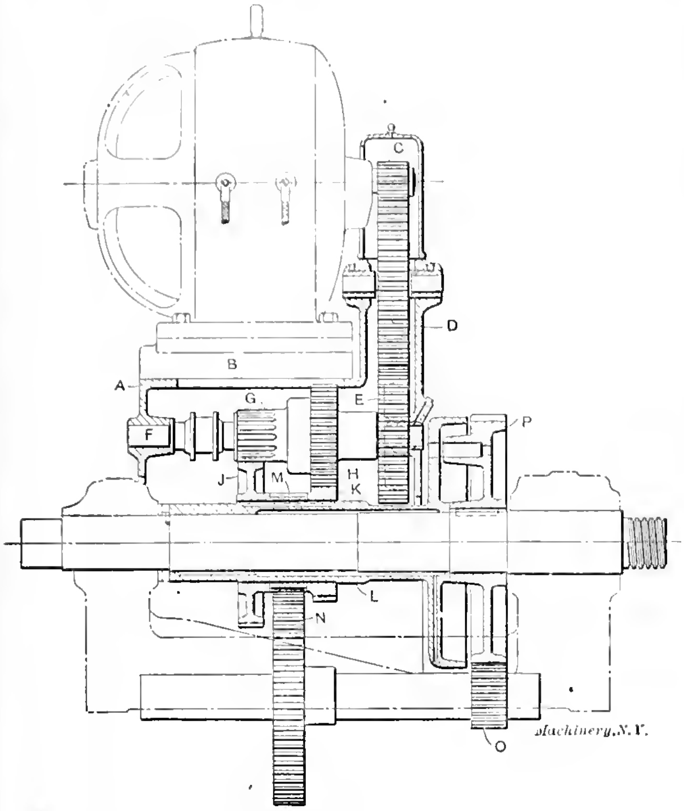


Fig. 4. Diagram of the Drive shown in Fig. 3, showing how the Four Mechanical Changes are obtained.

gives the highest speed. Two slower speeds are obtained through gears F and G, the former integral with the sleeve and the latter keyed to it. These mesh with gears H and J on the back gear quill, to which either one may be clutched by the vertical lever shown at the front of the head-stock.

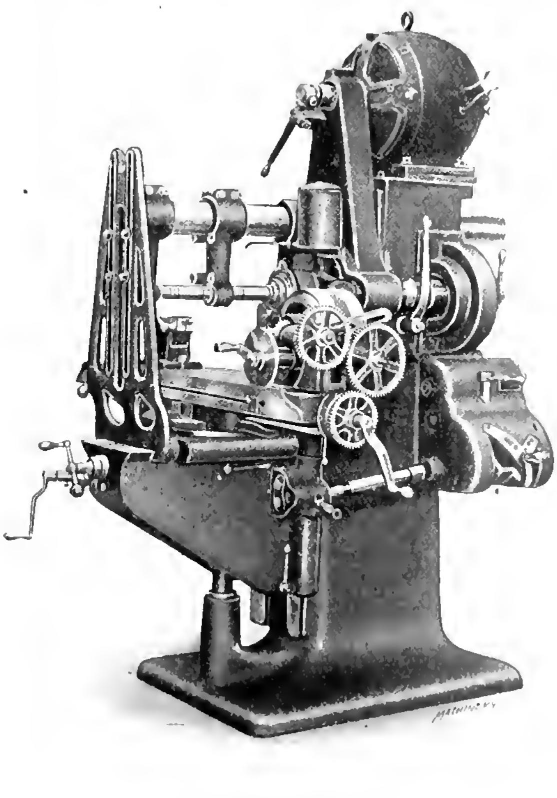


Fig. 5. Variable Speed Motor Drive for Milling Machine

This lever shifts collar K, which operates a double friction of the well-known form used on the builders' double-feed lathe and millers. This design of clutch is simple, durable, strong and compact, and is self-adjusting. Pinion M, at the right of the back gear quill, meshes with the main spindle gear as usual. Three speeds are thus provided for, one direct from E when the bolt lock is engaged, and the other two through gears F or G when the back gears are used.

It will be seen that the mechanism is unusually simple, requires a minimum alteration from the old style belt and cone arrangement, and has the required flexibility in the matter of adapting itself to motors of various makes and sizes.

In Fig. 3 is shown a larger lathe, the 24-inch size in this case, in which the ratio of 40 to 1 is too small to cover the range of speeds desired. Four changes, each in about the ratio of 3.2 to 1 with its predecessor, have to be provided for in this case, giving a total range of 90 to 1 in the speeds, when a 3 to 1 variation is used for the motor.

The arrangement of the gearing will be understood by referring to Fig. 4. In this instance the motor is not directly mounted on the gear casing A, there being an adapting plate B between them whose lower surface fits the casing, and whose upper surface and thickness are altered to agree with the requirements of the motor. The driving pinion C is keyed directly to the motor shaft, since provision is made elsewhere

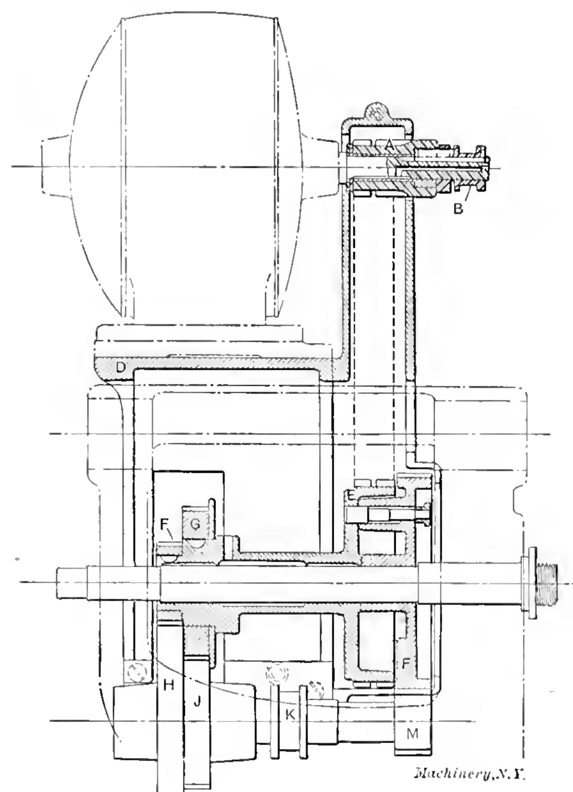


Fig. 6. Diagram of the Arrangement shown in Fig. 5 Compare with Fig. 2.

in the mechanism for disconnecting the drive without stopping the motor. Pinion C meshes with intermediate rawhide gear D as in the previous case, which in turn drives gear E, which is keyed to an intermediate shaft F, journaled at either end of the gear casing above the spindle.

The way in which the four speeds are obtained is readily seen. Sleeve L may be connected directly to the spindle by engaging the lock bolt in spindle gear P with the flange attached to the sleeve. When so connected, two speeds are available by shifting the horizontal clutch lever shown in Fig. 3, which engages either G or H with shaft F as may be desired. When sleeve L is free of spindle gear P and the back gearing is thrown in through M, N, O and P, there are two more speeds available, depending on whether G or H is clutched to shaft F. This gives four speeds in all. When the clutch lever is set on the central position, the motor is disconnected from the spindle. One advantage of this combination of double friction clutch and variable speed motor, is the fact that a total speed range of 9 to 1 can be obtained in 40 gradations, without stopping the lathe or shifting any positively acting connection.

Adapting the Miller to Variable Speed Motor Drive.

The problem of driving the milling machine from a variable speed motor is essentially the same as for the lathe. The only

changes in the conditions of the problem are those introduced by the interference of the over-hanging arm, which prevents the use of direct gearing between the motor and the spindle. The design adopted, shown in Figs. 5 and 6, should be compared with Figs. 1 and 2, the schemes being identical in every way. The change consists in connecting the motor spindle pinion *A* with the spindle sleeve gear *E* by a Morse chain instead of by an intermediate gear, otherwise the mechanism is the same. Similar reference letters refer to similar parts in Figs. 2 and 6. A casing *D* is fastened over the milling machine column in about the same way as it is for the lathe, very little change having to be made from the belt-driven arrangement. In the instance shown, an adapter is used between this casing and the motor. The back gear and motor pinion clutch lever are clearly shown in Fig. 5.

Lathe Driving Mechanism for Constant Speed Motors.

For the constant speed motor a much greater number of mechanical changes has to be provided than in the previous cases. The arrangement adopted for lathes by the builders is that shown in Figs. 7 and 8. The motor used in this particular case is of the alternating current type, though the

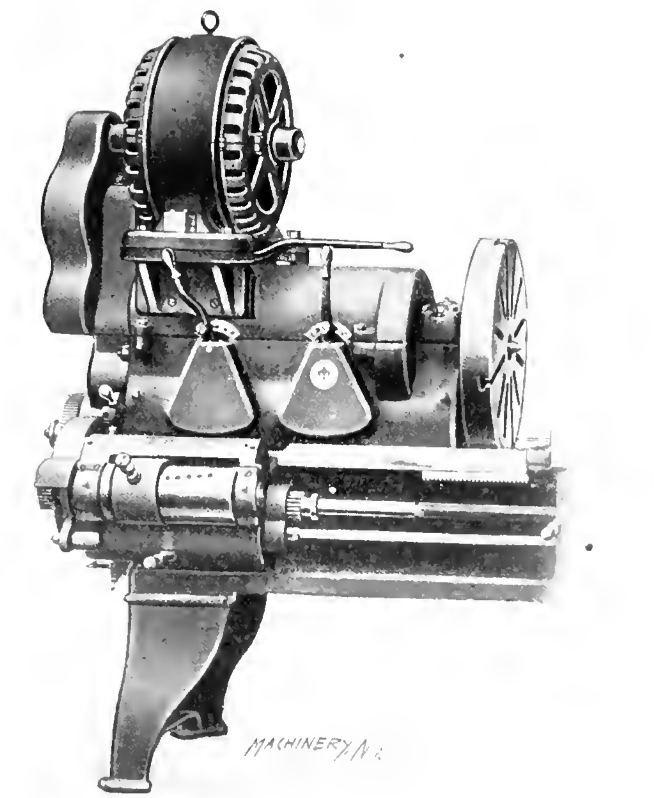


Fig 7. Lathe driven by Constant Speed Motor, with Eighteen Mechanical Speed Changes.

mechanical arrangements would be the same of course with a direct current constant speed machine. The motor pinion *A* is connected to gear *C* on shaft *D* by an intermediate rawhide gear *B* (see Fig. 8). Either one of pinions *E* and *F* may be clutched to shaft *D* as required, so that sleeve *G*, which runs loosely in the spindle, may be driven at either of two speeds, through either *E* to *H*, or through *F* to *J*. Gears *K* and *L*, which form a unit, are keyed to the second intermediate shaft *M*, and may be shifted longitudinally so that *K* engages with *H* as shown, or so that *L* engages with *J*. Gears *Q*, *R* and *S* are all keyed to the lathe spindle. *Q* is permanently in mesh with gear *N*, which runs loosely on shaft *M*. Gears *O* and *P*, which form a unit, are keyed to shaft *M* and may be shifted longitudinally, so that *P* meshes with *S* as shown, or so that *O* meshes with *R*, or so that the clutch teeth on the face of *O* engage those on the face of *N*, thus connecting the spindle of shaft *M* to *N* and *O*.

It will thus be seen that twelve changes are obtained—two by the double clutch between pinions *E* and *F*, multiplied by two depending on the longitudinal position of gears *K* and *L*, multiplied by the three changes depending on the longitudinal position of gears *O* and *P*, giving twelve in all. The various operating levers are shown in Fig. 7. The horizontal lever operates the clutch for pinions *E* and *F*, and is used when in the central position for stopping the machine independently of the motor. The two vertical levers are for shifting the sliding gears, the one on the left operating *K* and *L* and the one on the right, *O* and *P*.

The machine shown in Fig. 7 has 18 changes, instead of the 12 shown in the diagram. This is effected by having a third

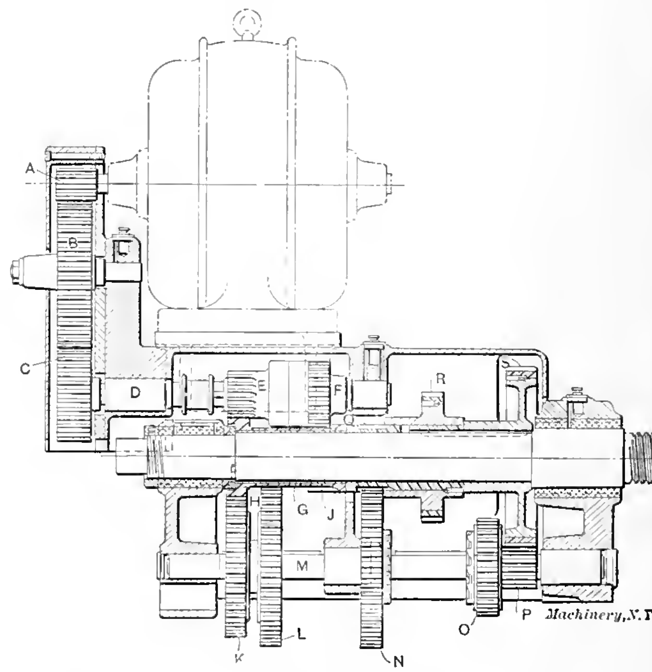


Fig. 8. Diagram of Drive Similar to that of Fig. 7, but giving only Twelve Speed Changes.

gear between *K* and *L* with a corresponding mate for it on sleeve *G*, thus adding six new speeds to the combination. For a 20-inch lathe, these 18 speeds give a total velocity ratio of about 30 to 1, ranging from 9.8 to 300 revolutions per minute in geometrical progression, having a uniform increment of $22\frac{1}{2}$ per cent.

Constant Speed Motor Drive for the Miller.

This arrangement, modified to meet the conditions of the milling machine, is shown in Figs. 9 and 10. The arrange-

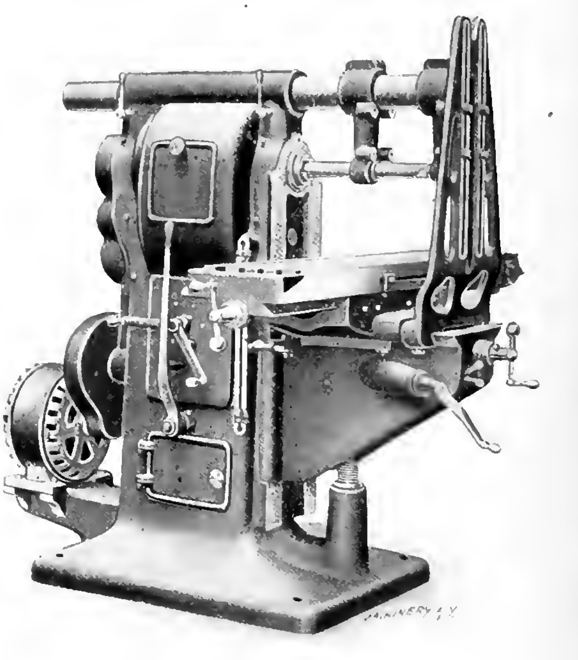


Fig. 9 Constant Speed Motor-driven Miller with Eighteen Speed Changes.

ment of the gearing can be best understood from the line engraving. In this case the column of the machine is designed specially for the mechanism used instead of having it carried by an attached casing. This is necessary, as in Fig. 7, owing to the increased amount of mechanism required.

The motor is mounted on a bracket at the rear of the base of the column, the bracket being designed for the particular motor used, so as to bring the motor pinion A to the right position to mesh with the driving gear C on shaft D.

It will be seen that this arrangement corresponds to the 18-speed modification of the mechanism shown in Fig. 8. Similar gears and parts in Figs. 8 and 10 have the same reference letters.

The 18 speeds are obtained as follows: Two changes depend on the position of clutch fork U, which engages either one of pinions E and F to shaft D. These two speeds are multiplied by the three obtained from the three possible positions of sliding gears, K, L and V, which may be made to engage with either one of gears H, J and W. The six speeds thus obtained are multiplied by three, obtained from the three different positions possible for sliding gears O and P, which may be shifted so that P engages with S, O with R, or so that gear N meshing with Q is clutched to shaft X.

The arrangement shown in Figs. 7, 8, 9 and 10 is applicable to belt drive as well as to motor drive, the only change necessary being the substitution of a single speed pulley in place of the motor. This has the well-known advantages over the cone pulley drive of constant power at all speeds, and practically constant cutting pressure available at the point of the tool within the range of the lathe, whatever the diameter of the work. The ease of obtaining the changes is also

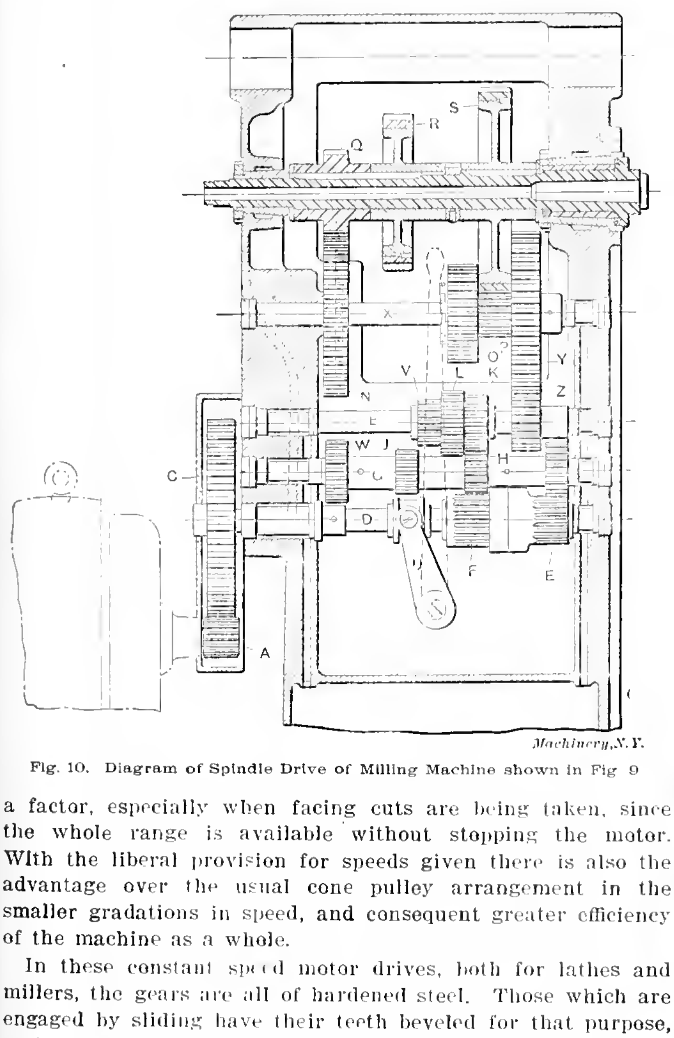


Fig. 10. Diagram of Spindle Drive of Milling Machine shown in Fig 9

a factor, especially when facing cuts are being taken, since the whole range is available without stopping the motor. With the liberal provision for speeds given there is also the advantage over the usual cone pulley arrangement in the smaller gradations in speed, and consequent greater efficiency of the machine as a whole.

In these constant speed motor drives, both for lathes and millers, the gears are all of hardened steel. Those which are engaged by sliding have their teeth beveled for that purpose, as is the practice followed in automobile construction.

Suitable speed plates are provided for each case, with graphical representations of the position of the various levers used, and consecutive tables of the speeds corresponding with those positions. The use of the clutch lever in each of the above designs will be found particularly advantageous in stopping the machine. It avoids the necessity for stopping and starting the heavy, rapidly revolving armature every time it is desired to arrest the motion of the spindle. The whole problem seems to be worked out in a very logical and satisfactory way.

CHICAGO BENCH MILLER WITH COLUMN.

The well-known Chicago hand miller, made by the Chicago Machine Tool Co., of Chicago, Ill., is here shown adapted as a bench machine to the needs of manufacturers of such articles as guns, sewing machines, typewriters, locks, electrical and other work where short milling and slitting cuts are required in pieces of which large quantities are turned out.

The overhanging arm and vertical attachment supplied with the larger machine have been omitted; otherwise the design is about the same. The counter-shaft and the machine itself are equipped with dust-proof, self-oiling boxes, which require filling but once in nine months or thereabouts. This provision adds materially to the life and accuracy of the spindle. The machine may be mounted on the bench or on a special column provided for it, as shown in the engraving. The counter-shaft has two speeds, giving six spindle speeds to the machine.

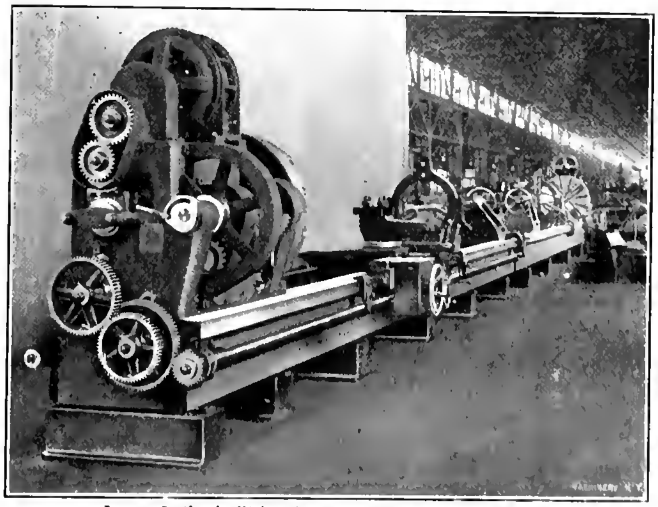
Chicago Bench Miller with Column.

The table feed is 9 inches, with a cross movement of $2\frac{1}{2}$ inches. The vertical movement of the knee is $4\frac{1}{4}$ inches. The spindle is bored to No. 9 B. & S. taper, and is fitted with a sleeve to receive a draw-in collet.

Hill, Clarke & Co., Inc., Boston, Mass., are the agents for these machines.

LARGE SPECIAL POND LATHE.

The lathe shown in the accompanying cut is, as far as length goes, one of the largest ever built in this country. It is intended for turning long propeller shafts, and work of a



Large Lathe built by the Pond Machine Tool Works

similar character, and is to be used at the Mare Island Navy Yard, for which it has been built by the Pond Machine Tool Works, Plainfield, N. J., branch of the Niles-Bement-Pond Co.

This lathe is designated as a 48-inch forge lathe, and is provided with two head-stocks, one mounted at each end of

the bed, and with two carriages and two tail-stocks, the latter normally placed at the middle of the bed, thus making in general two complete lathes. This duplex arrangement is plainly exhibited in the cut, where the heads, steady-rests, carriages and tail-stocks are shown in place. The bed of the machine is 77 feet long, and is made in three sections. The lead-screw on the one side of the machine not shown in the cut, runs for the full length of the bed, and is threaded for a length of 72 feet. On the side of the bed shown is another lead-screw, which, however, only runs half the length of the bed. The long lead-screw presents an interesting example in screw cutting. This screw was cut in an engine lathe. After turning and cutting the thread on a section of shafting, as long as could be handled in the longest lathe in the shop, a second section was welded onto the portion already finished, and then this portion was turned, and the thread cut on same. Several sections were thus welded on until the required length of lead-screw was obtained. The finished portion of the screw, while threading a new portion in this manner, was supported in a steady-rest, instead of being supported on the tail-center, as would have been the case with work that would not have been too long to be held between the centers in the lathe. The machine is driven by alternating-current motors, placed over the head-stocks, as shown in the cut.

THE ROCKFORD ROUTING MACHINE FOR KEY-SLOTS IN SPINDLE.

We show in Figs. 1 and 2 a novel and interesting adaptation of a 20-inch drill press, to the special work of routing the key-slots made in spindles, sleeves, etc., for forcing from their seats the taper shank of the various tools held in them. The drill press shown is one of the line manufactured by the

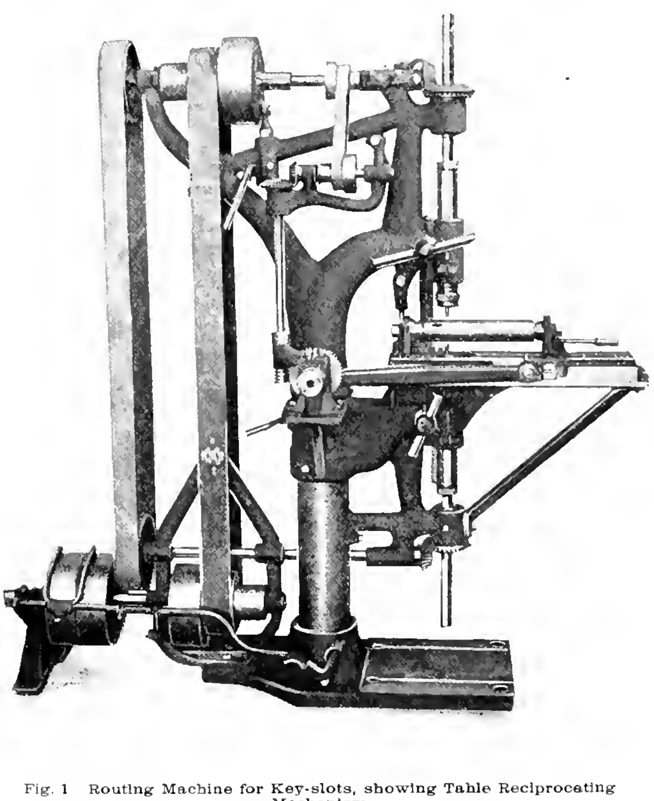


Fig. 1 Routing Machine for Key-slots, showing Table Reciprocating Mechanism.

Rockford Drilling Machine Co., of Rockford, Ill., and the rearrangement of it for this special work was done in the shop of the builders for their own use.

A bed with longitudinal ways, supported by a brace, is used in place of the usual circular table. This bed carries a slide which is attached, as shown in Fig. 1, to a connecting-rod operated by an adjustable crank-pin in the face of a worm gear, carried by a bracket at the side of the column. This worm gear (through suitable belts, cones and bevel gears) is operated from the horizontal shaft at the top of the machine, as shown. By this means a continuous reciprocating movement of suitable length for the length of slot desired is given to the table. The work is held on the table by any suitable means. In the case shown, a pair of stepped centers are used, these being adapted to holding the various sleeves used in the line of drilling machines manufactured by the builders. Spindles and irregular work can be held in any suitable holders or fixtures.

The routing is done by rose or end mills, held in draw-in chucks in both of two spindles, one of which is the regular drill spindle of the machine, while the other is a supplementary one, in line with the main spindle, but below the table. This provision for two spindles and two mills allows the slot to be worked through from two sides at a time, thus increasing the output. The lower spindle is driven by bevel gears from a horizontal shaft, belted as shown to the horizontal shaft at the top, so that both spindles revolve at

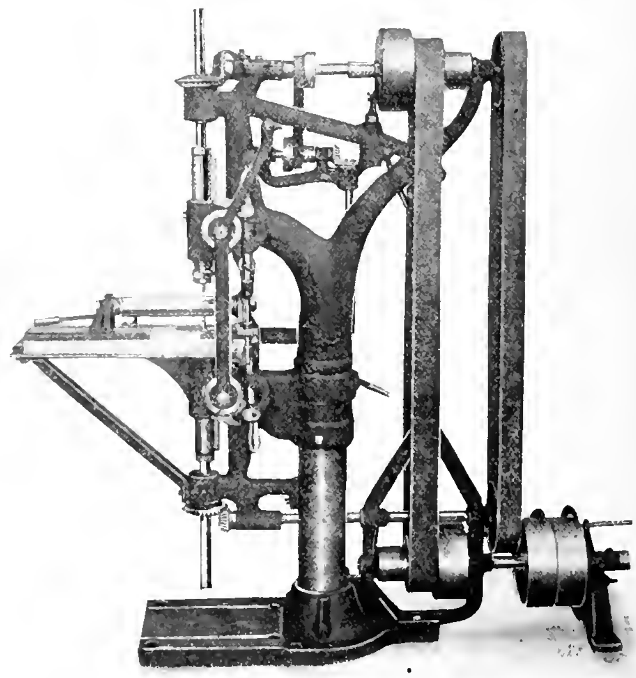


Fig. 2. Right Side of the Routing Mechine, showing Feeding Motion for Mill Spindles.

the same speed, whatever the position of the driving belt on the cone pulleys. The driving mechanism has been strengthened throughout for the use of larger shafts and wider belts and pulley faces.

The feed mechanism is best seen in Fig. 2, which shows the other side of the machine. Each spindle is advanced by a rack and pinion arrangement as usual, operated by worm-wheels. The worm driving each worm-wheel is supported in a pivoted holder, and provided with a knock-out arrangement with automatic stop so that each spindle may be fed to depth and thrown out independently of the other. The vertical shaft which operates the feed worms through the universal joints is rotated by a ratchet mechanism, actuated by the reciprocating motion of the work slide.

The operation of the machine is now clear. The continuous rotation of the worm-driven crank, in Fig. 1, reciprocates the work through a stroke of the required length for the slot desired. At the end of each stroke the ratchet mechanism, in Fig. 2, operates the feed, sinking the mills a little deeper into the work at each reversal. This is continued until the slot has been entirely cut through into the center hole.

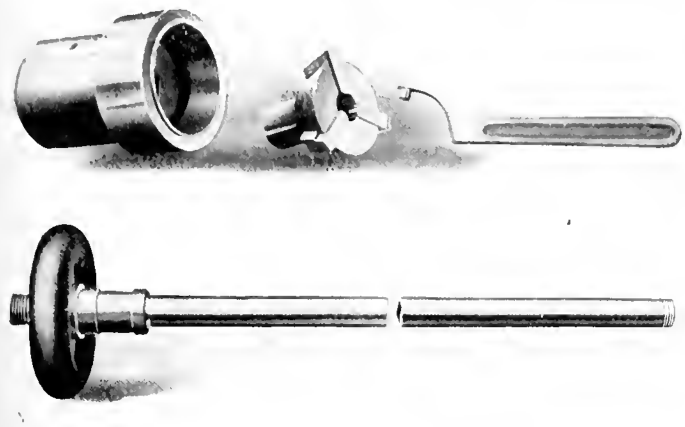
The machine is said to answer the purpose very well, doing the work accurately and quickly. It affords a distinct improvement both in quality and time, as compared to the old method of drilling a number of holes to form the slot, which is finished by chipping or broaching out the stock that is left. The arrangement shown was rather hastily designed for immediate use, but the builders are prepared to furnish it for the market in a more neatly designed form.

ADJUSTABLE COLLET WITH DRAW-IN ATTACHMENT.

In the accompanying cut we show an adaptation of the collet made by the Adjustable Collet Co., of Cleveland, Ohio, to the draw-in arrangement as used for spring chucks of the

usual construction. It consists, as may be seen, of a hood threaded directly to the nose of the lathe spindle, an adjustable collet fitted into the hood, and a threaded tube with hand wheel for tightening the collet on the work, from the rear end of the spindle. The directness of attachment of the device, with the carefulness with which it is fitted, insures the true running of the attachment.

The great advantage of this arrangement is the fact that it does away with the bother of changing from one size to



Adjustable Collet Co.'s Chuck with Draw-in Attachment.

another of the old-style draw-in spring collet, replacing a full set of them; the jaws of the adjustable collet grip any diameter of stock within its range. It may be provided with plain jaws for bar stock, or with step jaws for castings, collars, etc., and for stock that is larger in diameter than the passing capacity of the spindle. These tools are built to fit any size or make of lathe, of the engine, speed or turret design.

VAN NORMAN PLAIN MILLING MACHINE.

The Waltham Watch Tool Company, of Springfield, Mass., has recently added to its line of machine tools two milling machines of the plain manufacturing type. They have been placed on the market to meet the demand for accurately made, small manufacturing millers, such as are required in

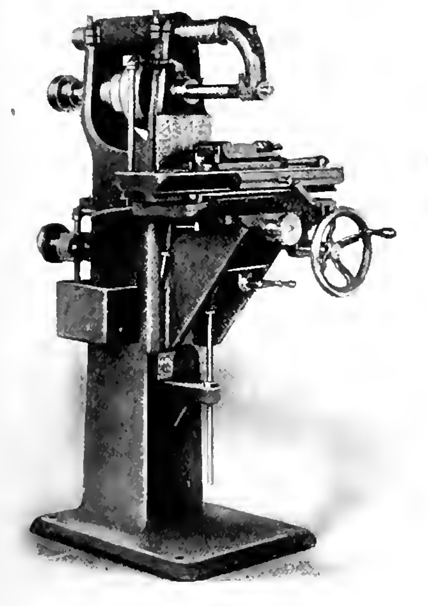


Fig. 1. No. A Van Norman Plain Milling Machine.

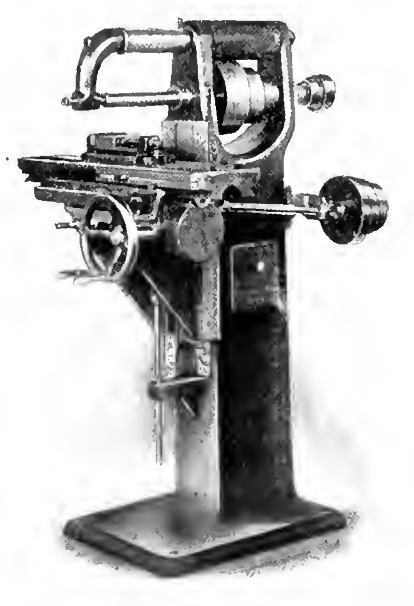


Fig. 2. No. AA Machine of the Same Type.

the interchangeable manufacture of sewing machines, typewriters, electrical apparatus, etc. Proper attention has been paid to the matter of giving them the stiffness required for using cutters of high speed steel, while at the same time sacrificing nothing in the way of ease and handiness in operation.

The No. A machine, shown in Fig. 1, has a table with an automatic feed by means of a vertical rack and pinion, with a quick return operated by a conveniently placed hand wheel; this gives 3 inches table movement to a revolution of the wheel. The table of the No. AA machine (see Fig. 2) which is somewhat similar to that designed for No. A, but is of somewhat larger dimensions, is operated by means of a revolving nut and stationary screw. While feeding automatically, the screw is locked; when it is desired to stop it, the locking device on the screw can be instantly released, when the latter may be operated by hand. A quick return is furnished, as in the case of the smaller machine.

Attention is called to the design and fitting of the spindle. The bearings, both front and rear, are of cone form, and adjustment for wear is accomplished by one pair of take-up nuts at the rear. The spindle pulley is of ample diameter and width for the required driving power. The carriage and table are made with wide and long bearing surfaces, carefully fitted to insure rigidity. Ample provision is made for the use of oil in cutting operations, an oil tank with pump being attached at the side of the machine, while suitable channels in both table and carriage are furnished to return the oil after it has been applied to the cutter.

The feed of the table in the No. A machine is 13 inches. The table is 24 inches long by 7 inches wide. The spindle cone has three steps for a 2½-inch belt, the largest diameter being 7½ inches. The machine weighs about 850 pounds.

In the No. AA machine, the length of the feed is 18 inches, the area of the table 28 by 8 inches, the width of the belt 2¾ inches, and the largest diameter 8 inches. The weight of this machine is 950 pounds. In both cases the cross feed is 5 inches, and the vertical movement of the knee 14 inches.

NO. 3 WALKER SURFACE GRINDER.

We herewith show half-tones and line engravings descriptive of a surface grinder recently placed on the market by the Walker Grinder Co., of Worcester, Mass. The machine is intended for commercial work in the grinding of hardened steel, and soft stock as well, and can be used for roughing and finishing flat surfaces on castings and forgings of all kinds. It will thus be seen that it has a range of usefulness beyond the ordinary tool-room sphere to which the surface grinding machine is generally restricted. It is rigid enough to take cuts varying from 0.0005 inch or less up to 0.015 or 0.020 inch in depth, with a cross feed ranging from zero to 1/10 inch wide. The machine has three especially notable features—an adjustable tension belt drive, an improved method of guiding and supporting the sliding wheel column, and a new noiseless friction clutch reversing mechanism. These and other interesting details will be understood after a study of the accompanying engravings and descriptive matter.

The base of the grinder is of the usual T form; one section of it supports the bed for the work table, while the rearward extension carries a base on which the wheel housing slides. These two parts of the bed are made separate in order to provide for the extended bearing of the wheel housing, which is a feature of the machine. The wheel column bed *B* (see Figs. 2 and 3) has projecting horns, carrying the guiding surfaces on its top in through an opening in the side of the work table bed *C*. The wheel column *E* also has its ways extended on the front of projecting horns, which enter the same opening in bed *C* and bear on the extended guides of *B*. It will thus be seen that the wheel *D* has a support directly under it throughout practically the whole range of its cross travel. The two parts, *B* and *C*, of the bed are tied together by a bolt *G* as shown, which thus makes the base one solid casting, so far as vibration is concerned.

Column *E*, wheel slide *F*, and the wheel with the attached parts, together weigh something over 300 pounds, which is much more than sufficient for the heaviest feed that could possibly be borne by the wheel. Since it is thus possible to depend on the weight of the column, the ways provided for

it on base B are of the V type, commonly used for lathe carriages.

The movement of the column is controlled by cross feed screw T, operated by a hand-wheel at the front of the bed. The gear driving the table rack, and some parts of the reversing mechanisms are pivoted about the axis of the screw T, but they are entirely separate from it. The wheel slide F is guided on sliding surfaces within the double column. It is adjusted vertically by the hand-wheel H, which may be

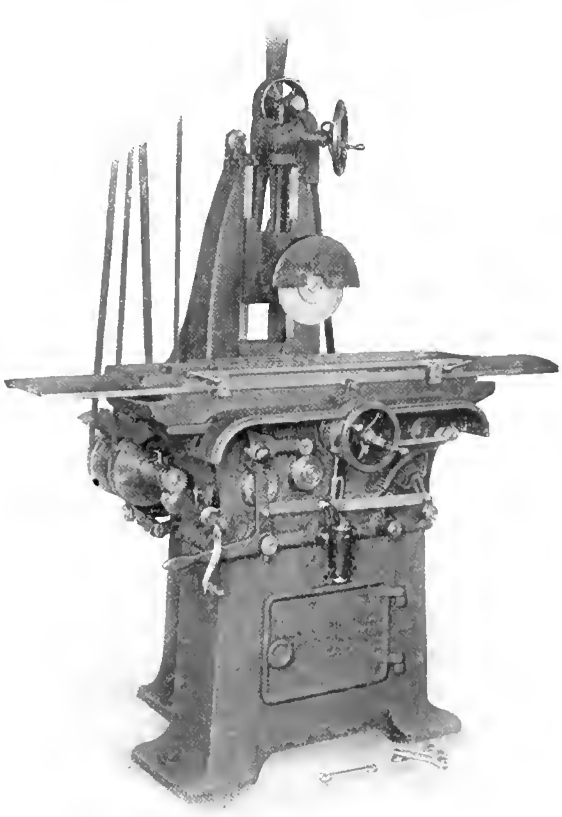


Fig. 1. The Walker Surface Grinder.

swiveled to any convenient angle to suit the position of the operator. Being counterweighted, there is no danger of its dropping down against the slack of the vertical adjusting screw. This also makes it as easy to raise the slide as to lower it, the motion being equally free in each direction. The wheel spindle is hardened and ground, and runs in hard bronze ring-oiling boxes, adjustable for wear. The end play is taken up by an adjustable cap at the rear of the spindle.

The arrangement of the belt drive can be followed from line drawing Fig. 3, and the rear view of the machine, Fig. 2. Drum A at the base of the machine is connected with the counter-shaft by the pulley and belt shown, and drives a belt J, which passes up over a pulley at the top of the wheel column and down around the driving pulley K on the spindle. (See the small detail at the left of Fig. 3.) From here the belt passes up over an idler L in the wheel slide, and back down to the drum again. It will be noted that the belt enters and leaves pulleys K and L vertically, so that there is no disturbance in the tension of the belt as the slide is moved up or down. Pulley M at the top of the column is carried by a slide, adjustable vertically by a screw and slide for maintaining the proper tension of the belt. As about 5 or 6 inches of stretch are provided for, an endless belt may be used, which will not need re-cementing until after long continued use.

The work table N is provided with liberal guiding surfaces, and has a roll oiling device which is identical with the standard arrangement applied to planer ways. The table receives its reciprocating movement from a rack and gear in the same way as does a planer. This gearing is connected to a pair of friction clutches, contained within the forward and reverse driving pulleys seen at the left of the machine in Fig. 1. The friction clutches contained within these pulleys are of durable construction, with a large area of contact surface, and are very simply constructed as well. By the use of a screw driver and wrench, they may be easily adjusted when adjustment is required, yet not so easily that they will be constantly tampered with by an unskilled operator. The use of friction clutches in place of the usual positive toothed clutches for driving the table, is considered by the builder to be a great improvement. The reversal is effected accurately, but with an entire absence of the shock noticeable with the older arrangment.

Reversing dogs O and O (see Fig. 4) are clamped in a T slot on the front of the table. These dogs engage the upper end of reversing lever P, whose lower end carries a roller operating the spring plunger Q, of the usual design in such mechanisms, whose function is to prevent the reversing lever from stopping on dead center. As lever P is thrown over alternately in each direction, it strikes contact screws on swinging bar R which operates clutch lever S. This latter is directly connected with the clutch mechanism. The table movement may be manually operated by the crank and pinion shaft at the left side of the base. The pinions are slipped out of engagement when the hand movement is not in use. Reversing dogs O may be thrown out of the way when desired, to allow the tool to run beyond its regular movement without altering their adjustment.

An automatic cross feed is provided, acting on screw T. Reversing lever P is connected by a link as shown to toothed sector U. This link may be adjusted in the slots of both P and U (as shown only in Fig. 1) to vary the amount of swinging movement given to the latter as each reverse movement takes place. This adjustment serves to vary the automatic cross feed. Sector U meshes with a pinion rotating the feed crank V, which thus receives a movement of con-

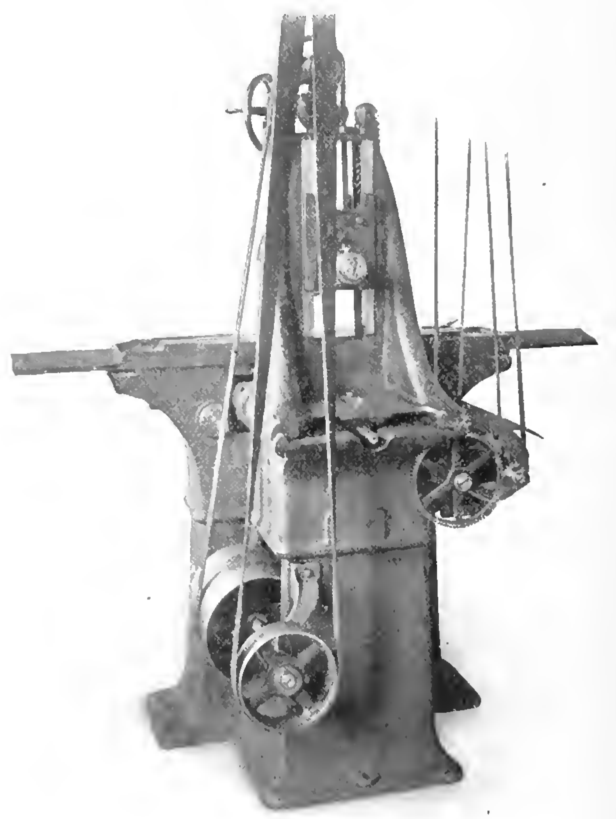


Fig. 2. Rear View of the Grinder, showing Extension of Wheel Column Ways under Work Table.

siderable amplitude on either side of the dead center, so that the connecting-rod W, to which it is attached, is given a forward and backward movement at each reversal. This connecting-rod has rack teeth cut in it, engaging with a pinion X (see Fig. 3) operating the ratchet feed mechanism of the cross feed screw. The ratchet may be made to feed either in or out, by shifting the operating pawl in the same way as is customary for planer feed mechanisms.

Means are provided for stopping the reciprocating movement of the work table at any point in the automatic cross

feed. The upper end of clutch lever S carries a projecting arm, so shaped as to engage with an abutment on stop lever Y. This lever is normally held in its upward position by the support of a collar on stop rod Z; this stop rod can be operated by adjustable dogs on the wheel column E. When the column has reached the desired point in the cross movement, given by the automatic cross feed, the adjustable

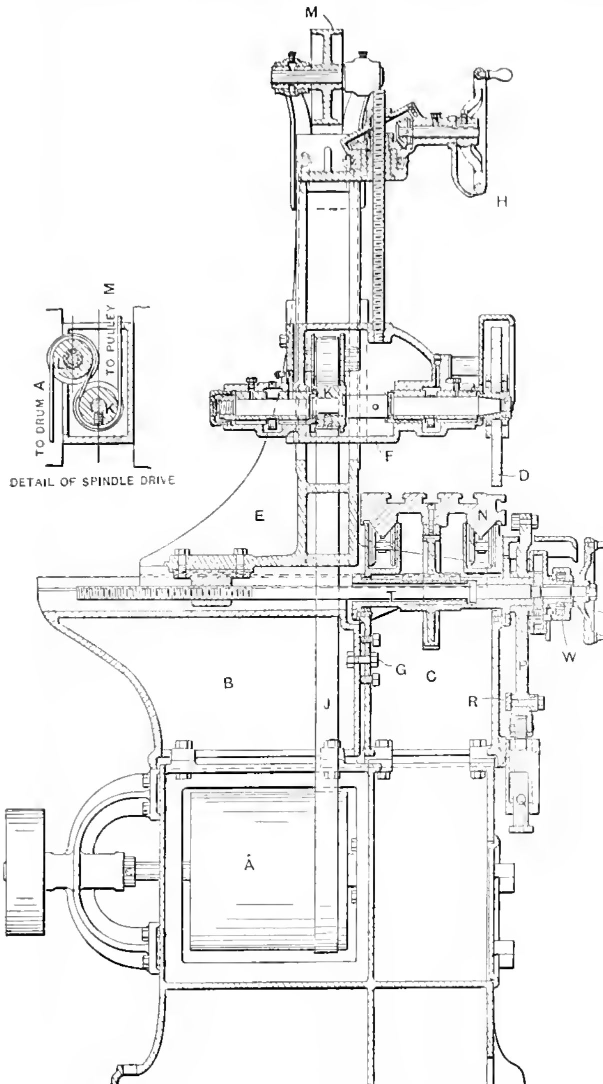


Fig. 3. Vertical Section showing General Design of Walker Grinder

dog shifts stop rod Z, allowing stop lever Y to drop from its position on the collar until its abutment rests on the upper end of reversing lever S. As the next reversal takes place, the two engaging surfaces of Y and S strike, stopping the movement of S in mid-position where both of the friction clutches are disengaged, so that the movement of the table is arrested. The adjustable dogs on the wheel column which

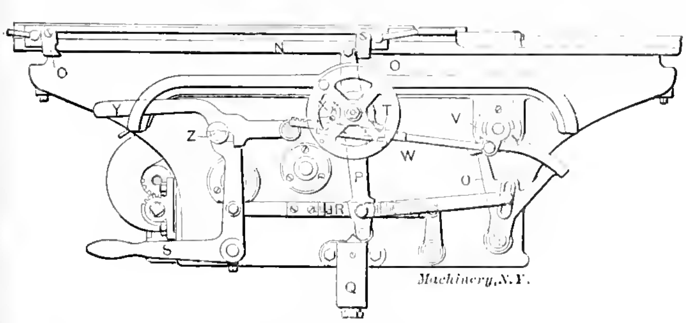


Fig. 4. The Reversing and Automatic Cross-feeding Mechanism

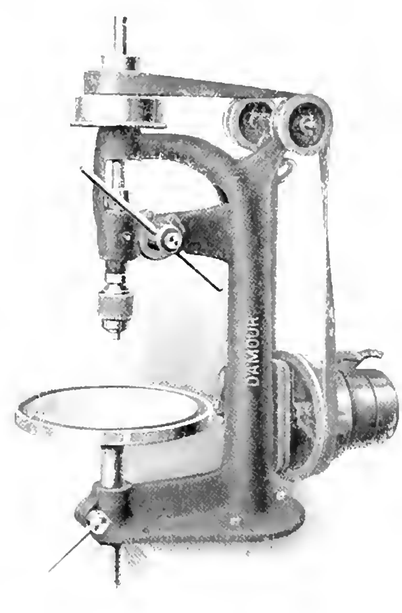
govern this movement are so arranged as to be positively operative, at the extremes of travel of the cross movement, so that there is no danger of the power feed being forced beyond the range of movement provided. This avoids the possibility of damage to the mechanism from this cause.

Three speeds are provided for the grinding wheel, obtained from a pair of cones in the overhead works. It is thought best to place the speed change here, since the only reason for altering it is to accommodate the change in diameter of the wheels as they wear down. If the speed change is made too easy, there would be danger of the operators experimenting with it after it had been set for the proper rate. It can still be easily changed when there is really need for it.

The machine is arranged to carry grinding wheels 10 inches in diameter and 5/8 inch wide. The grinder can be furnished with a magnetic chuck built integrally with the platen, or if desired, a special magnetic chuck 26½ inches long can be used. The grinder can also be provided with an individual exhausting system for the dust, and can be arranged for motor drive if the purchaser desires. The length of the stroke of the table is 30 inches, the cross feed is 8 inches, and the vertical adjustment is 10½ inches. The net weight of the tool is about 1,700 pounds.

D'AMOUR SENSITIVE DRILL PRESS.

This little tool, shown in the accompanying half-tone as a bench machine, may also be furnished with a column for use on the floor. It is built by the Charles Ramsey Company, 135th Street and Willow Avenue, New York. The spindle is of open hearth steel and is entirely relieved of belting strain, besides being counterbalanced by a weight inside of the frame, making it extremely sensitive to the touch. It is also provided with means for taking up wear and lost motion. The feed is by rack and pinion. The adjustable stop is of new design, applied directly to the pinion instead of to the top of the spindle, thus doing away with the tendency to spring the frame of the machine, making it possible to drill or counterbore more nearly to exact depth.



D'Amour Drill Press arranged as a Bench Machine.

The spindle is driven by either of two speeds, obtained from the cone pulleys shown. The counter-shaft pulleys are carried by a bracket which has vertical adjustment, and acts as a belt tightener. An endless belt is provided for the machine. The fact that the counter-shaft is attached to the machine makes the trouble and expense of properly installing it very small. The spindle and counter-shaft pulleys are of unusually large diameter, giving greater belt speed and a more powerful drive than is usual with drills of this size and type.

The greatest distance from the spindle to the table is 8 inches, and from the center of the spindle to the frame, 6 inches. The table has a vertical adjustment of 5 inches, that of the spindle is 2 inches. The drill capacity of the machine is from zero to 5/16 inch diameter. The weight without column is 60 pounds; with column, 120 pounds.

MANVILLE CAM CUTTING MACHINE.

It has always seemed strange that no machine tool has been placed on the market, carefully and consistently designed for the purpose of making cams, one of the commonest and most vital machine parts used in a wide range of automatic machinery. The various forms of cams have almost invariably been cut on attachments to the lathe or milling machine. Many of these attachments are very ingenious, and work in a way that is quite satisfactory, but they have the lack of convenience and productive power that almost invariably at-

tends the use of such special contrivances. Barring a machine for cylindrical cams which was built some years ago and had a comparatively limited sale, the one we illustrate in Figs. 1 to 4 is, so far as we know, the first distinctive cam cutting machine to be placed on the market. Its construction is rigid and convenient, and ingenious enough to repay a study of the half-tones and line engravings we show herewith.

As may be seen, the machine consists essentially of a bed on which are mounted two heads—one for the cam and one for the former—while between them is mounted a spindle on a swinging frame, one end of which carries the former roll, while the other carries the cutter which does the milling. It will be seen that the machine is for the variety of cams known as plate cams, in which the guiding surface is formed on the outer periphery of the disk. It will also, of course, form what are known as face cams, in which a cam slot is milled in the face of a disk. These two forms constitute by far the larger part of the cams in common use. The only other type frequently met with being the barrel or cylindrical variety.

Head-stock *A* (see Figs. 3 and 4) carries a heavy face-plate to which the work is clamped. This face-plate is cast solid with a rugged, large diameter spindle, which carries the driving head at its rear end. Similarly, foot-stock *C*, which has also a limited adjustment on the bed, has a face-plate for the former or master cam, and is driven by gear *D*. Both *B* and *D* mesh with pinions on driving shaft *E*, which runs the length of the bed and rotates the two face-plates in unison. It receives its motion through the quick change gear mechanism shown, giving a suitable range of feeds, which can be quickly altered to suit the changed conditions as the mill approaches the center or recedes from it. This feed may be thrown out instantly, or reversed as well, all the controlling handles being within easy reach. It may be manually operated by hand-wheel *F*. Driving gears *B* and *D* are split, and may be adjusted to take up all back lash, so that assurance is given that the work and the former revolve in absolute unison.

The swinging frame *G*, which carries the mill *H* and the forming roll *J*, is pivoted at the back of the machine near the base, and is normally under the influence of weight *K*, acting through rock shaft *L* and arm *M*, so that the former roll *J* is pressed firmly down against the periphery of the forming cam on the face-plate of tail-stock *C*. As this forming cam revolves, it is evident that frame *G* will swing in and out, giving mill *H* the proper motion to duplicate in the work the contour of the former. The mill is driven from cone pulley *N* through the bevel gears and the vertical shaft *O*, contained within the swinging frame *G*. The various speeds provided by the cone pulley, and the provision for reversing the movement, gives a wide range of adaptability to different sizes and designs of milling cutters.

Hand-wheel *P*, mounted on the back of the swinging frame, acts through the worm and worm sector *Q* on a pivoted bar *T*, which is notched to bear against a pin in *Q*. When this pin is in the notch and the hand-wheel is rotated in the direction shown, the pressure of *Q* against *T* forces the frame *G* back, lifting the weight and raising the roller *J* from the former. This provision is made for changing the work, removing the cutter and for similar adjustments. When hand-wheel *P* is rotated in the other direction and the roll is again brought back to the former, the continued movement of the hand-wheel withdraws the pin in *Q* from the notch in *T*, allowing the latter to drop to the position shown by the dotted lines. The frame is then absolutely free to follow the contour of the forming cam under the influence of the weight.

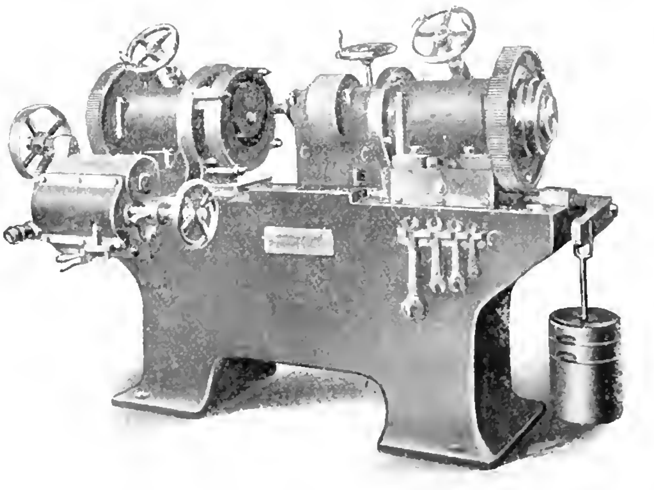


Fig. 1. The Manville Machine for cutting Plate and Face Cams.

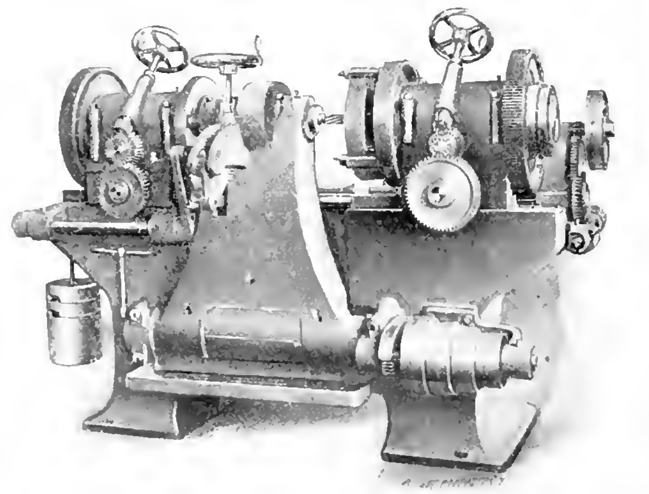


Fig 2. Rear View of Cam Cutting Machine, showing Spindle and Forming Roll Support.

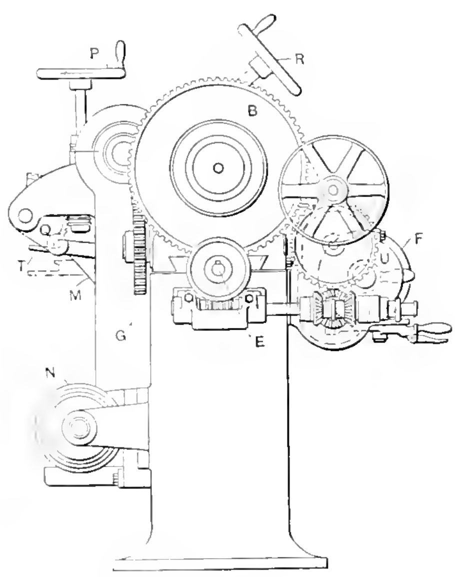


Fig. 3. End View of Machine.

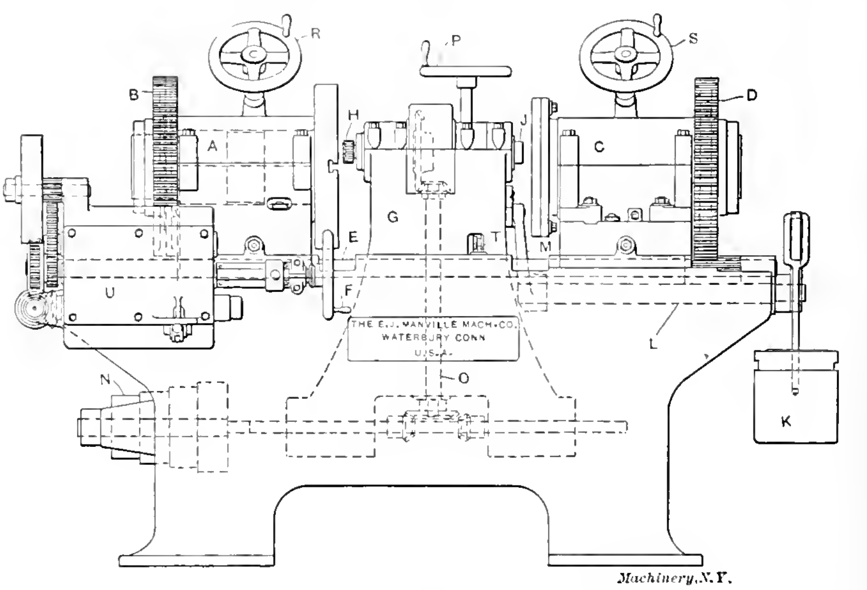


Fig. 4. Front View, showing Driving Connections for Spindle and Rotary Feed Motion.

When it is desired again to raise it from the work, bar T is brought into position by hand, easily done from the front of the machine, while the hand-wheel is operated as before.

The convenience of the arrangement of the machine will at once be appreciated. The longitudinal adjustment of heads A and C can be effected from the front by hand-wheels R and S. These heads are firmly clamped in their position by handles projecting from the front of the machine. Hand-wheel R is used, of course, in feeding the mill H to depth when cutting face cams. If desired, it is possible to follow an outline scribed on a cam without using a former at all. Under such conditions, swinging bar T is thrown into engagement with the pin in Q, and hand-wheel P is used to feed the mill out or in, in following the contour, while the work is revolved by the left hand, controlling hand-wheel F. Provision thus seems to have been made for about all the requirements likely to be met with in a machine for this work. The stiffness and cutting power of the machine should evidently be considerable, to judge from the general design, and the swinging member is so rugged, and supported so firmly, that all rocking and twisting strains are avoided. This stiffness and rigidity result from the use of separate spindles for the work and former, and the placing of the milling cutter and forming roll between them.

The machine is built by the E. J. Manville Machine Co., of Waterbury, Conn. It is the result of the requirements of their own business, which includes the designing and building of automatic machinery of all kinds, particularly that for bending wire into intricate shapes. Such machinery is largely dependent on the use of cams. To indicate the applicability of cam driving mechanism for such machinery, mention may be made of that used in making the well-known De Long hook and eye, built by this firm. The cams of this machine are run at the rate of 250 revolutions per minute, producing 250 perfect hooks per minute. These same machines were operated at a speed above 300 per minute, but at this rate it was found necessary to use an air blast to assist the finished product in dropping from the machine fast enough to prevent it from clogging up.

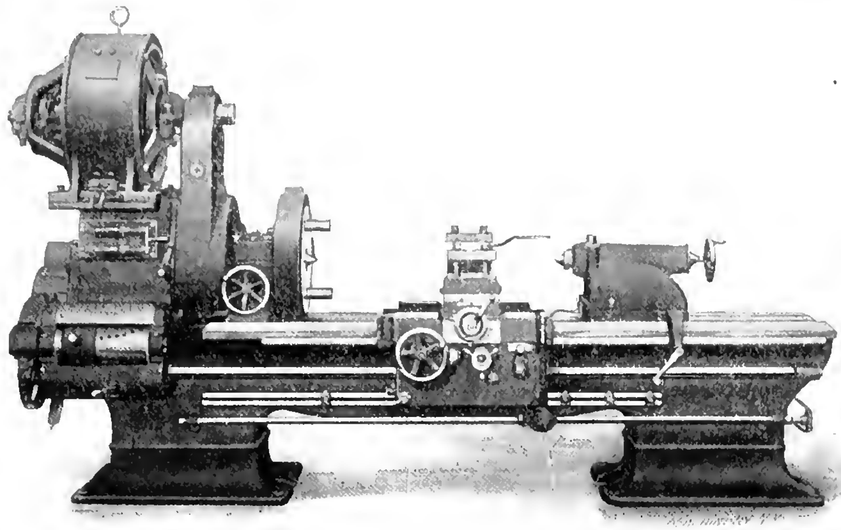
LE BLOND HIGH-SPEED ENGINE AND REDUCING LATHE.

Two new modifications of their regular design of engine lathes have been developed by the R. K. LeBlond Machine Tool Co., 4605 Eastern Avenue, Cincinnati, Ohio. The change consists in re-designing the bed, head-stock, foot-stock, and carriage to withstand the greater strains they are expected to carry, and involves a corresponding re-designing of the spindle drive and feed mechanism.

For the belt-driven, high-speed engine lathe, a 3-step cone pulley is provided for a 5½-inch belt. This cone may be connected directly with the spindle, or geared to it through quadruple back gearing, from which two changes are obtained by the regular LeBlond double friction back gear, while the other two changes are obtained by the endwise shifting of a double pinion on the back gear shaft, which may be made to engage with either the spindle gear or with teeth on the periphery of the face-plate. When a double speed counter-shaft is used, 30 speeds are thus provided for, ranging from 7.6 to 250 revolutions per minute. With the reducing lathe, the drive is practically the same, except that the machine is always back-geared, and the double-speed counter-shaft is not required. This gives 12 speeds, ranging from 11.2 to 143 revolutions per minute. The reducing lathe is especially designed for heavy cuts in steel castings and forgings.

When the machine is motor driven, a variable speed motor is used, mounted as shown in the illustration, which represents the reducing lathe. The controller is operated from a handle on the carriage, connected by gearing, chain and sprocket with the controller shaft at the back of the machine. The motor may be stopped and started by this handle, or the machine may be stopped and started independently of the heavy, rapidly revolving armature shaft by the friction clutch provided between the armature shaft and the driving pinion mounted on it.

The apron on this lathe has steel gears throughout, is of a semi-box construction in which all the shafts and studs are supported at both ends. The rear bearing acts as a rib, to connect the ends of the apron. The tail-stock is of improved design, reinforced to withstand heavy strains, with improved and effective methods of clamping the spindle to the body, and the body to the bed. The turning and screw cutting feeds are obtained by the standard Le Blond quick change device, giving 33 threads and feeds, including the 11½ pipe thread, without removing a gear. The range of threads is from 1 to 24, and the feeds are four times the threads. A series of stops are provided in the T-slot at the front of the bed behind the apron. These may be set for the shoulders on the work, so they will stop the carriage successively as each point is reached.



Le Blond Motor-driven High speed Reducing Lathe.

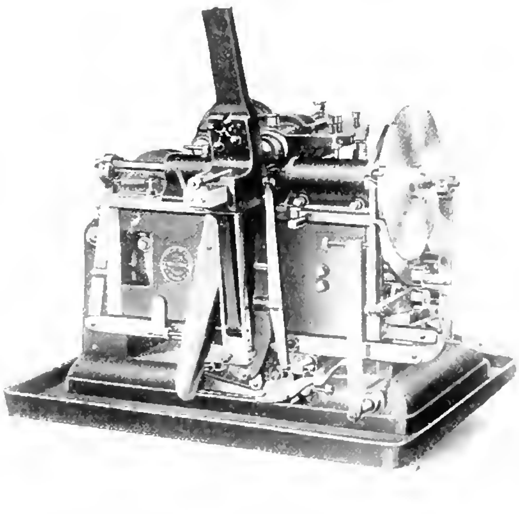
The engine lathe is provided with compound rest and power angular feed. The reducing lathe is ordinarily provided with a carriage of special construction, in which the lead-screw and threading mechanism are omitted, and double tool-posts are provided, one in front of the work and one in back, so that a double chip may be used for great reductions in diameter. The strong spindle drive and feed connections permit the removal of great quantities of chips by this method.

WALTHAM AUTOMATIC PRECISION GEAR AND PINION CUTTER.

We illustrate in the accompanying half-tone a highly developed form of automatic gear and pinion cutter, intended for small work on gears such as are used in instruments, typewriters, clocks, recording devices, etc. An especially interesting feature of the machine is the magazine feed provided for pinion blanks. When this is used, the machine is entirely automatic in all its movements. At the conclusion of the last cut on the work the holding centers are separated, the cut pinion ejected, a new blank is brought by the carrier from the magazine to the centers, the centers are clamped to the blank, and the cutter is again brought into position to take its first cut on the new work.

Provision is made in this machine for taking either one, two or three cuts through each tooth space. The cutter spindle is lifted while the return stroke of the work slide is being made, thus allowing the indexing to be done without loss of time, and preventing damage to the work by the cutter dragging back through it. The stroke of the work slide is adjustable, and the head- and foot-stocks can be shifted so that either long or short work can be accommodated. When

used as a hand-fed machine, the magazine is removed. The machine is then adapted to the cutting of small gears in stacks, as well as to the cutting of pinions.

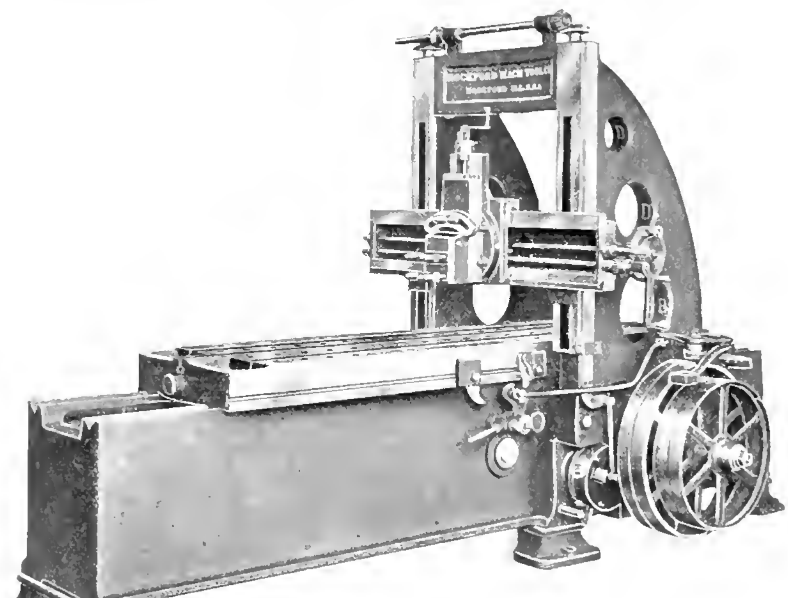


A Precision Gear or Pinion Cutter in which the Work may be automatically fed to the Machine.

This tool is built by the Waltham Machine Works, Waltham, Mass., and is similar to the smaller size shown on page 361, (Engineering edition) of this same issue, that one being also a three-cut machine.

ROCKFORD HEAVY PATTERN PLANER.

The accompanying half-tone shows the first of a new line of heavy pattern planers which the Rockford Machine Tool Co., of Rockford, Ill., is bringing out. The machine shown has a capacity for work 24 inches wide by 24 inches high, and has a 6-foot bed. Among the salient features of the machine is double gearing inside of the bed for transmitting the motion from the pulley shaft (which carries two pinions) through two intermediate gears, one each side of the bull wheel, to the large pinion which drives the latter. This feature ensures long life, and gives great power to the machine. All the gears in the drive are inside the bed, between the bearings, so they are protected from accident and falling

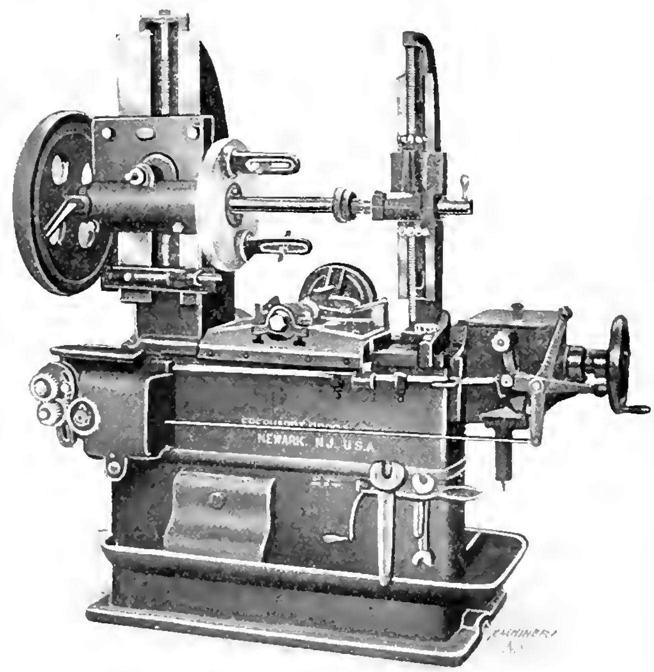


The Rockford Heavy Pattern Planer.

chips. All the bearings in the bed are bored and bushed and fitted with efficient self-oiling devices. The feed friction is of the double releasing type, and will not heat even when on short stroke, though furnishing a powerful feed to the tool when taking heavy cuts. The feed range is from 0.016 inch to 0.750 inch per stroke. At a cutting speed of 30 feet per minute, the drive is so proportioned that the return of the platen is 95 feet per minute. The machine weighs 7,100 pounds.

EBERHARDT BROS. NO. 3 AUTOMATIC GEAR-CUTTER.

The accompanying half-tone shows the new No. 3 size of the line of automatic gear-cutting machines built by Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J. This new size has a capacity for work 36 inches in diameter and



A New Member of the Eberhardt Bros.' Line of Automatic Spur Gear Cutters.

10 inches face. It will cut 4 diametral pitch in cast iron (or 5 diametral pitch in steel) in one cut at a fast rate of feed. It will, of course, cut larger teeth if a stocking cut is taken first.

The mechanism of this machine, which is designed for cutting spur gears only, is similar to the rest of the line brought out by this firm, embodying the positive indexing mechanism, the spur gear drive for the cutting spindle, the long cutter carriage with the spindle in the center of its length, and the provision for putting the feed screw under tension instead of under compression during the cutting action. It will be noticed that the 10-inch width of face which is within the capacity of the machine, is unusually long, allowing several gears to be cut at a time. This is made possible by the design of the machine, which permits the cutter slide to run past the column to some extent, thus adding considerable to the effective feed of the cutter.

A convenient feature is the arrangement of the controlling handles. These are all on the front side, or near the hand-wheel at the end of the machine, so that the operator, in setting, has control of all the movements without changing his position. The hand-wheel has a clutch and spring to keep it automatically disengaged during the running of the machine.

The equipment regularly furnished includes an indicator for setting the cutter central, change gears for cutting all numbers of teeth from 10 to 100, and all from 100 to 400, excepting prime numbers, and many higher numbers, change gears for feed and speed changes, face-plate with jacks and drivers for fastening and driving the work, a work arbor with collars and stepped flanges, a cutter arbor of the removable type, oil cup and fittings, and counter-shaft. The counter-shaft is of the tight and loose pulley pattern, and is

ring oiling, special provision being made for lubricating the loose pulley bushing. Other members of this line of gear cutters were illustrated in the November, 1906, and the June, 1907, issues of MACHINERY.

NEW LINE OF HEAVY NEW HAVEN LATHES.

In Fig. 1 is shown an example of one of a line of heavy pattern engine lathes which the New Haven Mfg. Co., of New Haven, Conn., is placing on the market. Aside from the general strength of the design, of which considerable may be understood from a study of the engraving, there are a number of interesting points connected with the details of the mechanism, particularly with reference to the feed changing device and the taper turning attachment.

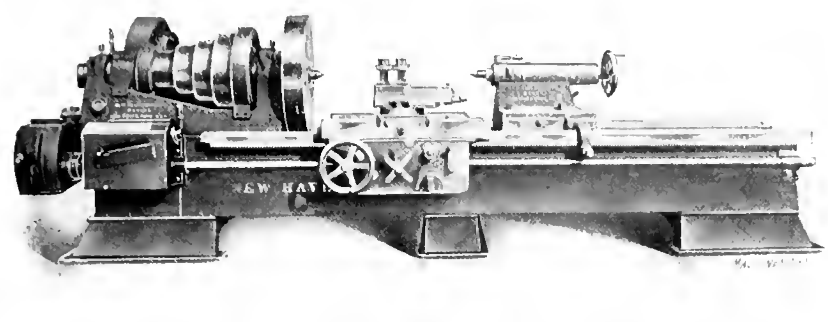


Fig. 1. Heavy 28-inch New Haven Lathe.

The speed changing box at the front of the head-stock is of the design which we have described before (see the New Tools of the Month in the August, 1904, issue of MACHINERY), giving seven changes of speed. This number is quadrupled by the supplementary feed box at the end of the head-stock, whose mechanism is shown in Fig. 3, removed from the casing which encloses it when in place on the machine. Stud *A* carries the gear which receives the motion from the lathe spindle. About it is pivoted a rocking frame *B*, carrying pivots *C* and *C*, which each carry a pair of gears driven by the central pinion on *A*. Gear *D* is mounted on an extension of the shaft of the main feed box *E*. This gear may be made to engage with either one of the two gears on each of the two pivots *C* and *C* by the operation of handle *F*. Shifting *F* longitudinally brings gear *D* opposite the outer or inner gear

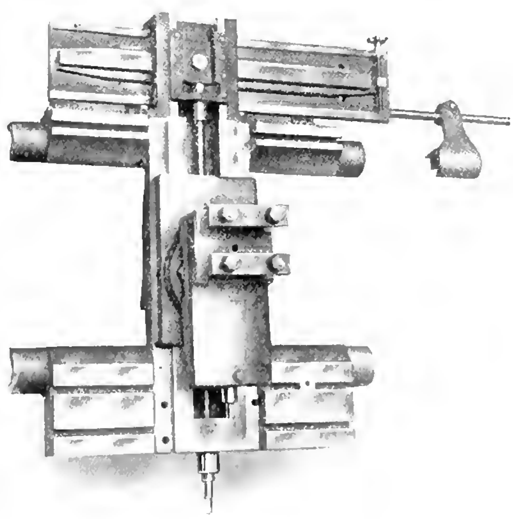


Fig. 2. Plan View of Taper Attachment.

on stud *C*. Shifting it vertically, by means of the connecting links *G*, rocks frame *B* to bring either the upper or lower gears on *C* into mesh with *D*. Four changes are thus provided for.

The design of the taper attachment is shown in Fig. 2. The taper bar is carried by a table, sliding in brackets attached to the back side of the carriage, and always in place. When it is desired to turn tapers, a clamp, which is fastened to the bed of the lathe, is tightened down on the rod which connects it with the table. The cross feed screw is connected by a tapered pin with the sleeve at the front of the slide which locates it so far as endwise movement is concerned. When this tapered pin is removed, and the clamp is tightened down on the rod, the attachment is ready for action. The tapered swivel bar is graduated at one end to read in degrees, and the other in inches per foot. A fine adjustment is provided for it by the screw and hand nut shown.

STURTEVANT HIGH-SPEED LARGE VOLUME FAN.

The original Sturtevant fan, invented over half a century ago by B. F. Sturtevant, was for high pressures and small

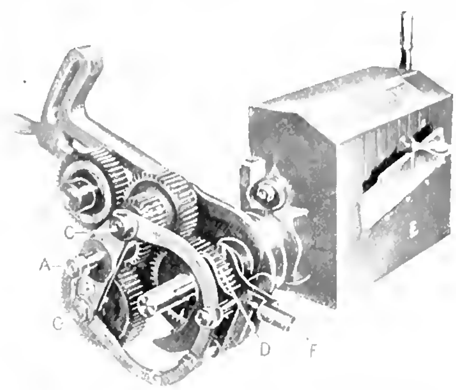
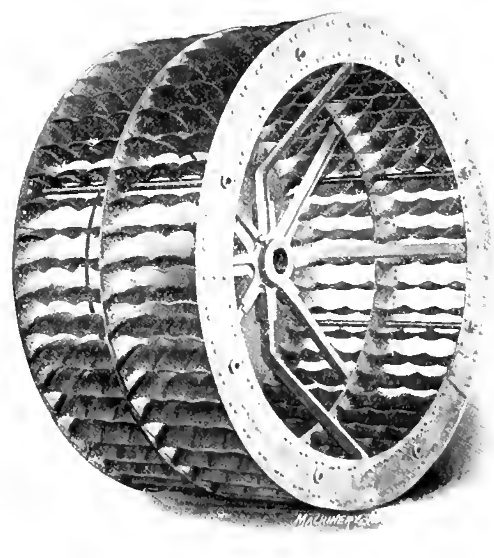


Fig. 3. Detail of Mechanism for Quadrupling the Number of Feeds obtained in the Feed Box.

volumes. It was intended particularly for exhausting the dust produced by the buffing wheel, in smoothing the soles of shoes. At that time it was thought necessary to use small pipes and maintain a high velocity throughout an exhausting system, and as the inventor naturally designed this fan for a pulley drive at the high rotative speeds existing in shoe factories, planing mills, etc., where the device was used, the



Design of Runner for Sturtevant High-speed, Large Volume Fan.

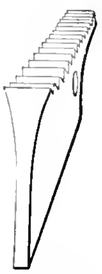
form of fan he developed had 24 or more blades, curved, and with a depth equal to about 1/8 the diameter of the wheel, which was very narrow. This was, and still is, the proper form for such service, where the volume required is small as compared with the velocity. Further study of the problem showed that there was a wide field for fans giving a large volume of air at low velocity. In many cases it is desirable to connect steam engines directly to the shaft, making the speed of the fan much lower than had previously been used. These and other considerations necessitated wider and fewer blades, giving the larger volume at lower velocity. At the same time the proportion of blade area to the volume was practically the same as in the type of wheel originally designed.

The B. F. Sturtevant Co., of Hyde Park, Mass., has recently added to these types a form intended for high speed and large volumes. Requirements of this kind have only been met with

in the past few years, with the growing use of the steam turbine and the electric motor. Still keeping the proportion of blade area to volume the same as in the previous types, the natural way to attain the desired result under the new conditions was to widen the wheel to give the increased volume, at the same time making the blades more numerous and considerably shallower, thus providing a large inlet area. In practice, slight changes in construction were found advisable to increase the efficiency and to reduce eddy currents and other obnoxious features. One of these improvements consists in making the floats for the high speed, large volume wheels with several cup-shaped cavities or spoons, as shown in the illustration. This prevents the air which enters the pockets from slipping along the length of the float, constraining it to enter and leave in a radial plane. The form of runner shown in the illustration is being regularly furnished by the makers for high speed, large volume service.

SIMONDS SCREW SLOTTING HACK-SAWS.

The Simonds File Co. of Fitchburg, Mass., is manufacturing extra thick, concaved hack-saw blades in sets of four, for the special purpose of slotting odd screw heads for tool and repair work. The general outline of one of these blades is shown in the accompanying line cut. The thickening of the width at the toothed edge gives the blade a clearance which allows it to be easily worked by hand, even on the widest size of the set, which is 0.109 inch thick. The other three saws are 0.083, 0.065 and 0.049 inch thick, respectively. These screw slotting blades, though they have been in the market but a short time, have already met with cordial appreciation on the part of tool makers, repair men and others, who have occasional jobs of screw slotting to do, which have hitherto been done in a patched up way with thin hack-saw blades, or on the milling machine with a milling cutter, at a considerable expense of time and labor.



Machinery,N.Y.

Wide-face Hack-saw Blade.

HENDERSHOT SHAFT COUPLING.

This device, which is being placed on the market by Manning, Maxwell & Moore, Inc., 85-87-89 Liberty Street, New York, embodies novel features of construction which gives it great usefulness and effectiveness. The design can be easily understood from Figs. 1 and 2, of which the first shows it assembled, and the second separated into its component parts.

It is made in two complete halves, each half consisting of a body and a split tapered bushing, the latter bored to fit the shaft and turned to fit the tapered hole in the body of the coupling. The two bodies, which form the flanges of the coupling, are provided with interlocking lugs on their faces, which take the torsional strain of the transmission, the bolts being required only for compressing the sleeve on the shaft. A turned ledge on the face of one flange fits a turned recess on the face of the other, thus serving to keep the shafts concentric with each other and in correct alignment.

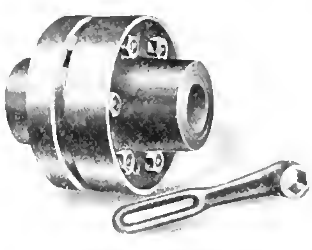


Fig. 1. Hendershot Shaft Coupling, Assembled.

Among the advantages of this construction are the following: The two parts of the coupling may each be assembled on its own shaft while they are on the floor, before being hoisted into place, thus facilitating the work of erection. Owing to the fact that two taper bushings are used instead of one, differences in diameter of the two shafts are taken care of without the slightest difficulty. The transmission of the turning moment by interlocking lugs instead of by the bolts, relieves them of a large share of the strain; though, in accordance with the plan of making this coupling unusually strong, even greater bolt area than usual is provided. The tapered bushings are made quite thin, while the hubs are proportionally large, thus obtaining great strength and holding power with the application of comparatively little force in clamping.

It will be seen that this device is, in use, simply two positive interlocking couplings of the old style, presenting, with the improved design, the advantages of not requiring to be accurately fitted to the shafts, driven on them, or have key-

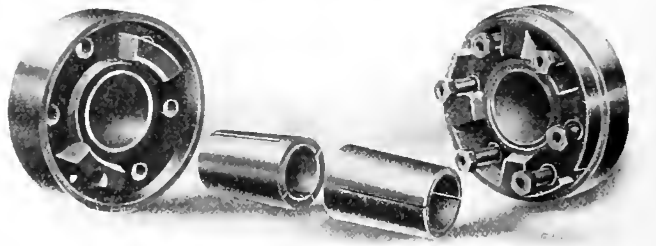
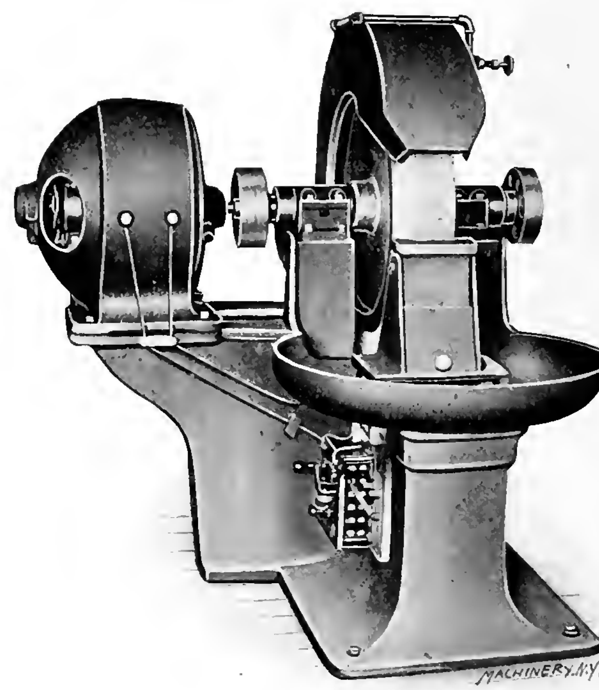


Fig 2. The Construction of the Coupling, as shown by the Component Parts.

ways cut in the latter. The coupling is easily taken apart by screwing two bolts into holes tapped in the shell for that purpose. Each complete set is put together on a test bar and inspected before it leaves the factory.

BRIDGEPORT DROP APRON TOOL GRINDER.

The principal peculiarity of the tool grinder shown in the engraving is the fact that the rim of the bowl which surrounds the wheel stand has been made considerably lower than is usually the case. The reason for this construction is to be found in the necessity for grinding tools much larger and



Tool Grinder with Low Bowl or Apron, for Grinding Long-shanked Lathe or Planer Tools.

longer than was the case when the original designs of wet tool grinders were first brought out. The great size and length of these tools makes it almost impossible to grind them at the proper angles on grinding machines as ordinarily made with the high bowl or apron, it being impossible to lower the shank to an angle sufficient to give the proper bevel.

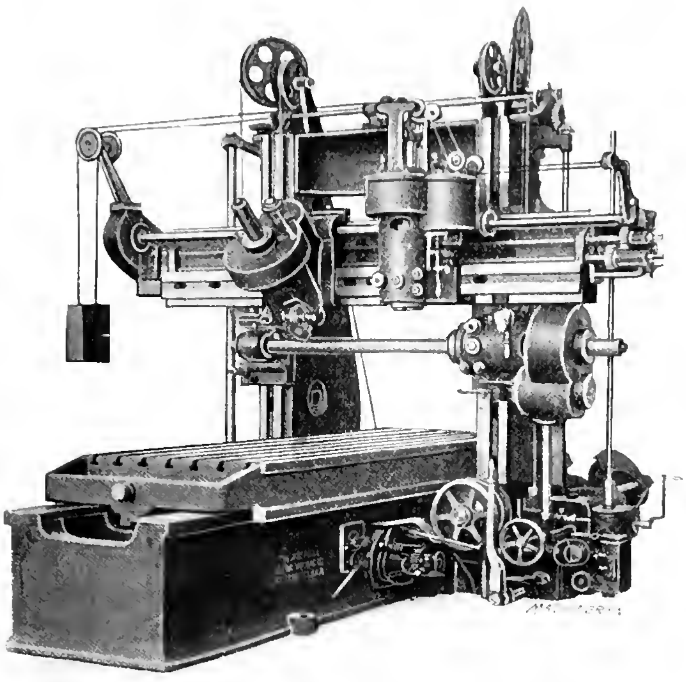
In its general construction, the tool is similar to other machines the builders brought out. The base forms a large water tank supplying the centrifugal pump, which forces a full stream of water to the wheel. The tool may be either belt or motor driven. When belt driven, it is equipped with tight and loose pulleys on the emery wheel spindle, with a self-locking belt shifter to hold the belt on the desired pulley. This shifter is within easy reach of the operator. When driven by a direct-current motor the motor is mounted on a substantial bracket, cast integrally with the base, as shown in the engraving. The armature spindle is then directly coupled to the wheel spindle. When arranged for an alternating-current motor, the motor is back geared to the wheel spindle, being mounted on a bracket similar to the one shown.

The device is made for a 36-inch wheel, with a 4-inch face, 20 by 21½ inches. The emery wheel should run about 425 or

450 revolutions per minute. The weight of the machine with motor is 2,600 pounds. It is built by the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.

INGERSOLL MILLING MACHINE WITH HORIZONTAL, VERTICAL, AND ANGULAR SPINDLES.

The milling machine shown in the accompanying half-tone was designed by its builders, the Ingersoll Milling Machine Co., Rockford, Ill., for milling the general run of work requiring the finishing of plane surfaces on the top, sides and ends. The angular spindle, shown in the cross rail, is a special provision for finishing the surfaces of inclined pillow blocks for gas engine frames.



An Ingersoll Miller with a Special Head for Facing Gas Engine Pillow Blocks.

Each of the two heads on the cross rail has an automatic reversible feed across the machine in either direction, each taking in the full width between the housings. The angular head may be readily removed, if it is not required for a considerable period of time, though it is not in the way of ordinary work when moved to the extreme end of the cross rail. When using the vertical heads, the horizontal arbor shown in place on the machine is removed. It can be seen that in finishing horizontal surfaces, either slabbing cuts or end mill cuts can be used.

It will be noticed that the horizontal head is at the operator's side of the machine instead of being mounted on the further cross-rail, as is common in machines of this kind. This makes it much more convenient for the operator in setting to proper depth of cut when using face mills. The horizontal spindle head, the cross-rail, and the spindle of the vertical head, are all counterbalanced to make the adjusting of the machine as easy as possible. The spindles are driven by spur gears cut from solid forgings, and are encased so that they can be packed in grease.

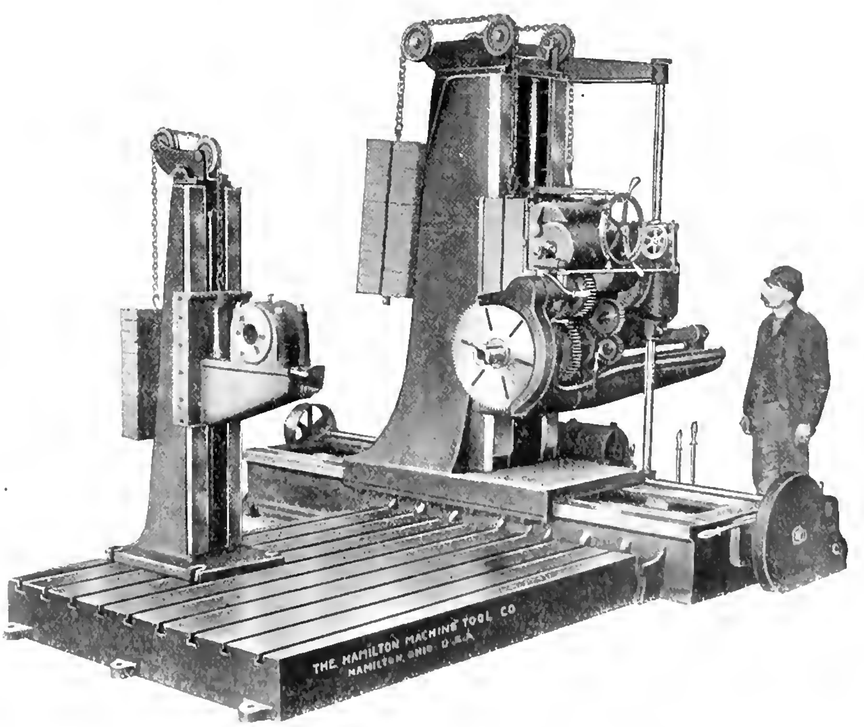
This machine is made in two standard sizes, 36 inches and 46 inches width, with any desired length of table. The positive table feed has eight changes for each cutter speed, giving a range of from ½ inch per minute up to 15 inches per minute. The quick power adjustment in either direction is about 30 feet per minute. The axial adjustment of the vertical spindle is 8 inches, that of the horizontal spindle being the same.

HAMILTON NO. 3 HORIZONTAL DRILLING, BORING, AND MILLING MACHINE.

The tool shown in the engraving is built by the Hamilton Machine Tool Co., Hamilton, Ohio. It is a drilling, boring and milling machine of heavy and rigid construction, characterized by a facility of adjustment and operation unusual in a machine of this size. It is particularly adapted to the handling of unwieldy pieces which are difficult or inconvenient to move. After these are once placed on the floor-plate, the spindle can be adjusted horizontally and vertically to perform different operations within its range, resulting in a saving of time and the obtaining of greater accuracy than by less improved methods of doing the work. The operations of drilling, boring and tapping, together with milling of slides, bearing surfaces and T-slots, can all be performed at one setting of the work.

In its general construction, the machine consists essentially of a floor-plate to which the work is fastened, combined withh a transverse bed along which a column may be adjusted or fed to any desired position within its range. The column carries the boring spindle in a slide on its face. An outboard support for the boring bar is also furnished, which is clamped in a suitable location on the floor-plate.

Power feeds and quick traverse movements in both directions are provided for the column on the bed, for the slide up and down the face of the column, and for the spindle in and out of its bearings in the slide. Graduations are provided for reading the various adjustments used for column slide and spindle, as well as for the adjustments of the outboard bearing, so that the matter of setting the machine for a given operation is a simple one. The spindle slide on the column is counterweighted, as also is the supplementary slide on the outboard bearing.



A Drilling, Boring, and Milling Machine of Rigid and Convenient Design.

The various spindle speeds and feeds are obtained from a single pulley running at constant speed, the changes being made by positive quick change mechanisms controlled by suitably placed levers. All the changes can be made while

the machine is in motion. There are eight changes for the feed of the column, slide and spindle, ranging between 0.0196 and 0.66 inch per revolution of the spindle for the column and slide, and from 0.001 to 0.033 inch per revolution for the longitudinal feed of the spindle. Positive quick change gearing with suitable levers provide for 16 spindle speeds in geometrical progression, ranging from 2 to 180 revolutions per minute. The mechanism for these changes is suitably enclosed and guarded, and the controlling handles are located within easy reach of the operator, as are those for the quick power movements. The single pulley drive makes the use of the motor drive a simple matter, it being merely necessary to replace the driving pulley with a constant speed motor.

The floor-plate, shown in the engraving, is 8 feet long by 6 feet wide and 10 inches thick. The area of this plate may be altered to suit the requirements of the purchaser. The traverse of the column on the bed is 72 inches; of the spindle slide on the column, 40 inches; and the longitudinal traverse of the spindle is 36 inches. The distance from the center of the spindle to the top of the floor-plate may be adjusted within the limits of 24 inches and 64 inches. The machine, as shown, weighs about 30,000 pounds.

HILBERT UNIVERSAL DRILLING TABLE.

The accompanying half-tone shows a device made by the Hilbert Machine Co., Cincinnati, Ohio, for increasing the range of usefulness of the ordinary drill press or radial drill. It is a universal attachment, permitting holes to be drilled at any angle in either of two planes, giving access to all sides of the work except the face upon which it is clamped.

The attachment consists of a circular table, pivoted at the center and capable of being swung to any angle about the axis perpendicular to its face, with provision for clamping to any desired position when it is obtained. The holder to

A Device for Presenting Work to the Drill Press at any Desired Angle.

which the table is pivoted is mounted on trunnions, carried by standards integral with the base, so that the work fastened to the table may also be adjusted about a horizontal axis. A worm-wheel sector with adjusting worm is provided for this motion, making it easy to handle heavy work with delicacy and certainty. When desired, for rapid adjustment the worm may be dropped out of mesh with the sector, and the table swung over by hand. Clamping mechanism is provided for this adjustment also. When used in connection with an ordinary drill press it will be seen that this device will perform many of the functions of the universal drill.

The base of the table is 14 x 14 inches, and the height from the horizontal clamping surface to the base is 22 inches. The table is 25 inch in diameter.

LANDIS STAY-BOLT CUTTER.

The Landis Machine Co., of Waynesboro, Pa., is building the stay-bolt cutter, illustrated in Fig. 1. The principal feature of this machine is the avoidance of the lead-screw, which has hitherto been considered necessary in stay-bolt threading machines to bring the thread of the stay-bolt to exactly the right pitch, so that it will match up with the holes in he boiler plates as tapped by the stay-bolt tap. If the pitch of the stay-bolt is not exactly proper, contiguous bolts in the boiler being of different pitches, the continuous threads produced by the tap will force the plates apart at different distances, thus straining both the plates and the bolts.

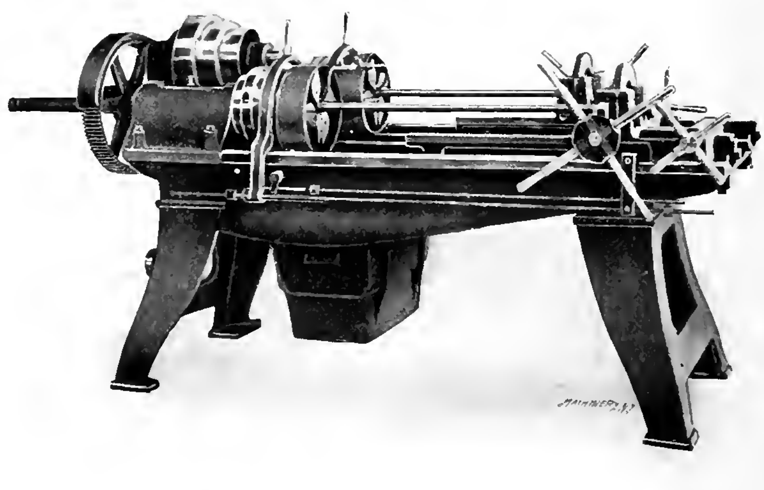


Fig. 1. Double Head Landis Stay-bolt Cutter.

The builders have adopted their regular form of chaser for this purpose, obtaining with its use, a high degree of accuracy without requiring the incorporation of a lead-screw in the machine. One of the chasers is shown in Fig. 2. As may be seen, the teeth are not hobbed, but milled. They are set in the head, tangent to the work, with the front ground at an angle so that the work only bears on the cutting edges for the first few teeth. The finished threads bear on the back of the cutting edge on the milled surface of the threads of the chaser. The work and the chaser together, thus furnish the lead-screw and nut for the machine. These chasers are carefully made, and very accurate results are secured. When a lead-screw and die are used, if they are not exactly the same pitch, the two work against each other, producing rough and torn threads.

Another advantage of the type of chasers shown is the fact that they are ground on the end only, and so may be sharpened repeatedly until the full length is used up. The end may also be ground at any angle to suit the material being worked on, it being possible to produce a curling chip, as with a lathe tool. The die never requires to be annealed, hobbed or retempered, consequently it is not subject to the changes which occur in rehobbing dies, and has a life far in excess of the old style type. The head in which it is mounted is arranged to swing the cutters apart or bring them together, so as to cover a wide range of diameters.

Fig. 2. Type of Chaser used in Landis Bolt Cutter.

The carriage of this machine has an adjustment vertically and sideways. The cutting strain is exactly central. The rack is provided with recesses between the teeth, so that it is impossible to clog them up with chips or scale, which are allowed to fall through into the base without interfering. The machine is built in single and double head arrangement in sizes up to 1½ inch diameter.

BRITISH INDUSTRIAL NOTES.

The previously mentioned downward tendency in British industrial returns continues, though not apparently at such a rate as to justify unduly pessimistic views. Here and there, slackness is pronounced; for instance, in Sunderland considerable distress prevails, as a consequence of the abnormal scarcity of ship-building orders, due to a number of causes, one being the high prices of ship-building material, another the high price of coal acting unfavorably on the shipping trade. In the Midlands, Wolverhampton has experienced several set-backs within recent years, due to the removal of large works to more favorable positions near the seaboard, the railway companies appearing unable, or unwilling, to assist—by reduced rates of carriage—in the retention of these businesses. Two works engaged in the manufacture of puddled iron, have just been sold, ostensibly on account of inability to meet competition, though an impression prevails in some quarters, that it is more in consequence of the pooling of financial interests. At the same time it is reported that the size of the large works formerly occupied by Daniel Lysaght & Co., who removed to Newport, South Wales, has been purchased by a London syndicate which will probably build new works, and Sir Alfred Hickman will entirely reorganize and equip the large steel smelting and rolling mill plant at the neighboring town of Bilston, electrical driving being adopted on a considerable scale.

Banks and Banking.

Though the subject of banking methods is not too often included in reports on engineering industry, the present financial troubles in the United States—sympathetically felt in other countries—may justify reference to an important paper on "A Decade of Bank Amalgamation," prominent points raised including the fact that since 1897 no fewer than eighty-five British banks have ceased to exist through amalgamations, a chief feature being the continued disappearance of the once powerful private banker. Tables given in relation to British joint stock banks, their assets and liabilities, show their great solidity. For every £100 of deposit liability the banks hold £30 in liquid assets, £17 in A1 investments, £62 is employed in making advances and discounting bills for the trading community, leaving only £9 in bank premises and cover for acceptances. In addition there is the guarantee of the uncalled capital which is equal to £24, or a total security of £142 for every £100 of deposit liability.

Franco-British Exhibition in 1908.

Considerable interest is being evinced in the Franco-British Exhibition to be held at Shepherd's Bush, London, in 1908. There appears some probability of a representative show of British and French machines and products. The buildings, etc., will cover forty acres.

Ship-building.

In ship-building, recent developments include the complete removal of Messrs. Yarrow from the Thames to the Clyde, which will take place immediately the last torpedo boat, now under construction, is completed. Operations, more particularly boiler-making, are now in progress at the new works. Messrs. Thorneycroft have practically removed all their naval works from Chiswick to Southampton, their latest production, which has just gone through its trials, being the turbine-driven destroyer *Tartar*, which in three runs, with and against the tide, attained the record speed of 35.95 knots. The *Ghurka*, another ocean-going turbine destroyer, built by Hawthorn, Leslie & Co., in her official six hours' trial attained an average speed of 33.91 knots. She proved her ability to steam a distance of 1,715 knots at a speed of 13½ knots without replenishing her fuel supply, which is considerably better than the Admiralty requirements. If supplementary oil tanks were fitted, she could steam 2,500 knots without taking on board more fuel.

Interesting Foundry Practice Development.

In foundry practice, a method, developed by Dr. Szekely, Sr., of 113 Clements Inn, London, of producing iron castings in metal molds shows interesting and suggestive results, there being practically no shrinkage. The molds are treated by a wash, and all castings produced are soft. We understand that Alfred Herbert, Ltd., Coventry, produces a number of its castings on these, or somewhat similar lines. Speaking broadly, more consistent attention than formerly is being devoted to the layout, equipment, and management of foundries, the British Foundrymen's Association being an active agent in the dissemination of information and suggestions calculated to improve the general status of the foundry, which, though essential to engineering, has never been as well recognized as its importance would naturally suggest.

Lifting and Conveying Machinery Sugar Machinery.

The manufacture of cranes and lifting and conveying appliances in general, has made substantial though unobtrusive progress of late years in this country. One of the most prominent concerns in Great Britain is that of Appleby's, Ltd., of Leicester and London, which by amalgamation with a Glasgow firm, and, more recently, with the Temperley Transporter Co., is now particularly well equipped for dealing with practically all branches of this important section. The building of the heavier traveling cranes, especially since the general adoption of electric driving, has often been dealt with by machine tool makers in conjunction with their regular output, but where such is still the case, the work is to all intents and purposes produced in a distinct shop or department. Iron and steel foundries, as well as ship-building yards, have contributed largely to the increased demand for powerful lifting appliances, while the general run of industries are increasingly alert as to the advantages obtainable from rapid internal transit of material. All the same, the number of plants concerned in this branch of work seems, to say the least, fully adequate to the demands made on their output.

In addition to other considerable orders, The Mirrlees-Watson Co. of Glasgow, has recently had placed in its hands the contract for the whole of the buildings and plant for a large sugar refining works in the State of Morelos, Mexico, the layout being such as will admit of easy extension. In the Glasgow district generally, things in the engineering and tool-making line are decidedly less brisk than for some time past.

Milling Machine Development—Yorkshire Tools.

In the way of milling machines, considerable advances have, within the last few years, been made by British manufacturers both as regards power provided—with proportionate stability—and ease of manipulation. This has taken place in all the branches of this class of tool from the heaviest and more simple forms, to those in which comprehensiveness of function for small and medium work is the leading characteristic. About eleven years ago (March, 1897) the writer contributed a short article to this journal, on Yorkshire tools, dealing with the phenomena of the extremely low priced tools which then formed the staple product of a number of makers in several districts. A number of Yorkshire friends obtained the impression that undue severity towards Yorkshire practice was evinced in the paper, though nothing was mentioned that could not easily be upheld, and full allowance was made for ruling conditions, and due credit given for wonderful value for price paid. However, the change in absolute value and accuracy of machine tools easily obtainable in Yorkshire during the last seven years or so, cannot be over emphasized. The amount spent in the most approved plant, organization, and design, must be enormous, and the result has more than justified the expenditure. Since the Paris Exposition of 1900, one firm alone—Dean, Smith & Grace, Ltd., Keighley, has at least trebled its turnover, having, since then, specialized on one form of machine tool only—lathes. On Japanese account alone, they have supplied over 250 lathes. The only tools built outside of lathes are special machines for their own use which cannot conveniently be obtained from other makers. The great majority of the lathes turned out are cone-driven and specially adapted for high-speed work, though all-gear-head machines are built to special order or to meet certain conditions. A line now being produced very successfully is that of four-jaw independent chucks, it very early being seen that the then commercially obtainable chucks were far from equal to the duty imposed by high-speed steel.

JAMES VOSE.

Manchester, Eng., December 31, 1907.

OPENING OF THE NEW ENGINEERS' CLUB BUILDING.

On the evening of January 11, more than 600 men of prominence in the engineering, architectural, and industrial world, met at the new Engineers' Club house in Philadelphia for a house-warming and reception. It probably was the largest and most representative gathering of engineers ever held in Philadelphia. The event marked the thirtieth anniversary of the club, which has had a long and creditable career.

The new club house, which is situated at No. 1317 Spruce Street, was formerly the residence of Mr. Charles Potts, a wealthy iron manufacturer. It was designed by Mr. Lewis Hickman on such broad lines that when the Engineers' Club purchased it, it was found to need little alteration to convert it into an ideal club house. The purchase price was $55,000, and $15,000 additional was spent in changes and furnishings.

Fig. 1. New Engineers' Club of Philadelphia

The building, which is of brownstone and four stories in height, has a frontage of 25 feet and a depth of 140 feet. At the right of a wide hall is a lounging and reception room 17x48 feet, fitted with two costly mantel pieces, one of solid onyx and the other of mahogany. In this room is a chandelier valued at several thousand dollars, which was imported by Mr. Potts from Turkey. Handsome mahogany tables and leather upholstered chairs make this room most comfortable and inviting.

The meeting hall is on the second floor in the front. This was two rooms which are now converted into one large room 24x48 feet. Here can be seated 200 persons, and it is the intention of the club to hold not only semi-monthly meetings of the club here, but also all business meetings. In the rear of the meeting room is a closet wherein can be installed the stereopticon apparatus when it is not in use. The room is lighted by electric lights hung close to the ceiling in front of the ceiling beams so that the rays of light do not dazzle the eyes of those seated in the auditorium.

The library, a room 17x34 feet, filled with books and periodicals, is on the second floor, at the rear of the meeting hall. The floor of this room is covered with cork carpet. Back of the library is a small room used temporarily by the officers, but which will eventually be used as a conversational corner. On the third floor are six comfortably furnished bedrooms for convenience of out-of-town members. On the fourth floor a room 17x67 feet is given over to a playroom, being equipped with pool tables, shuffle board, etc. There are also two bedrooms, a bath and committee room on this floor.

The Engineers' Club was founded December 17, 1877, at a gathering of twenty-one engineers at the home of Dr. Coleman Sellers. Fifty members were quickly enrolled, and the growth of the club has been going on steadily since. Some very notable papers have been contributed by its members. Of the original members who organized the club, there are only three surviving, these being Mr. Wilfred Lewis, Mr. Chas. A. Billin, and Mr. M. R. Muckle, Jr. The present membership is about 590. The recent growth has been rapid, about 124 new members having been enrolled within the past few months.

Fig. 2 Lounging Roome, Engineers' Club

Fig. 3. Meeting Hall, Second Floor, Engineers' Club.

The following are the officers: President, H. W. Spangler; vice-presidents, Washington Devereux, W. P. Dallett, Wm. Easby; secretary, Francis Head; treasurer, George T. Gwilliam.

* * *

THE MACHINERY CLUB, NEW YORK.

Plans for the new Machinery Club are practically mature at the present writing, and all the contracts for furnishing, equipment and decoration have been made. The Fulton Building, whose two upper floors, the twenty-first and twenty-second, the club is to occupy, is to be ready April 15, while the contracts are all called for completion on April 1, so there should be no delay in geting into the quarters as soon as the building is completed.

The architect's plans show a very elaborate and serviceable lay-out. The twenty-first floor will be occupied by the offices, hall, coat room, reception room, etc., and the main dining-room. This latter will be of sufficient size to accommodate 500 guests during the luncheon period, between 12:30 and 2 or 3 in the afternoon. In addition to this, there is, on this floor, a large grill-room and a bar. The top floor of the build-

ing, the twenty-second, is provided with a ladies' dining-room, a smoking-room and a number of private dining-rooms. Only a part of this story is housed in, the remainder being fitted up as a roof garden, to be used in pleasant weather. This should be an especially attractive feature, as the building is a lofty one near the water's edge, on the outskirts of the high building district, with unobstructed view in almost every direction. The kitchens are also on this floor, in the rear of the building.

As we have previously explained, the membership of this club is divided into three classes; resident members, suburban members and non-resident members. We are informed that over 500 membership applications have been accepted by the committee on membership, these being about equally divided between resident and non-resident members.

* * *

PERSONAL.

Walter B. Snow, publicity engineer, Boston, Mass., has been elected president of the alumni association of the Massachusetts Institute of Technology.

A. L. Roberts has entered the employ of Pawling & Harnischfeger, Milwaukee, as mechanical and designing engineer. Mr. Roberts was for eighteen years with the Morgan Engineering Company.

T. D. W. Moore, general manager of the Remington Arms Co., Ilion, N. Y., has resigned his position, and will be succeeded by Mr. Jerome Orcott, general manager of the Union Metallic Cartridge Co., Bridgeport, Conn., as general manager and superintendent.

Gorham C. Parker, formerly head of the selling department, Jacobs Mfg. Co., Hartford, Conn., has been made sales manager of the Wm. J. Smith Co., New Haven, Conn., manufacturer of adjustable reamers, automatic tools and special machinery.

George A. Gauthier, formerly chief draftsman and designer of the Universal Screw Machine Co., Hartford, Conn., has taken a position in Toronto, Canada, to design machinery for the Caldwell double-thread wood screw, which is being developed by Worth & Martin of that city.

D. G. Baker, who has been superintendent of the Remington Arms Co., Ilion, N. Y., for the last three years, has resigned that position, and will become one of the engineering firm of S. M. Green, Inc., Holyoke, Mass. Mr. Baker will remain in Ilion with the Remington Arms Co. as consulting engineer for some time.

H. F. Sanville, who has been for the past two years with Dodge & Day, engineers, of Philadelphia, joined the organization of Frank B. Gilbreth, general contractor, on the first of the year. Since completing his engineering education at Columbia University, in 1892, Mr. Sanville has had a very wide experience in engineering and construction, as well as in commercial lines. For the past four years he has been secretary of the Philadelphia section of the American Institute of Electrical Engineers.

A dinner was given by the American Museum of Safety Devices and Social Hygiene at the rooms of the Aldine Association, January 15, in honor of the decorations conferred by the French Republic upon Mr. Charles Kirchhoff, editor the *Iron Age*, Mr. T. Commerford Martin, editor *Electrical World*, and Rev. Percy Stickney Grant, rector Church of the Ascension. Mr. Elbert H. Gary, chairman of the U. S. Steel Corporation presided, and John La Farge, the eminent painter, conferred the decorations of Officier de L'Instruction Publique.

* * *

MEMORIAL SERVICE FOR LORD KELVIN.

An impressive memorial service in honor of Lord Kelvin, who died December 23, was held in the Engineering Societies Building, New York, Sunday, January 12, under the auspices of the American Institute of Electrical Engineers, assisted by representatives of the American Society of Mechanical Engineers, American Society of Civil Engineers, and other leading engineering societies of United States and Great Britain. The program included the reading of memorial resolutions by the secretary. These were adopted by a rising vote. President Stott of the American Institute of Electrical Engineers made appropriate introductory remarks, and introduced Prof. Elihu Thompson, whose subject was: "Lord Kelvin as an Electrical Engineer." He was followed by Prof. E. L. Nichols with the subject, "Lord Kelvin as a Scientist." Mr. G. G. Ward, vice-president of the Commercial Cables Co., spoke on the subject, "Lord Kelvin's Work in Submarine Telegraphy," and Rear Admiral Geo. W. Melville, U. S. N., treated of his work in naval engineering. To T. C. Martin was given the subject of Lord Kelvin's relation to the American Institute of Electrical Engineers. Mr. Ward's remarks were of much interest because of his intimate connection with submarine telegraphy, in which Lord Kelvin's most notable commercial success and widest fame were won. The mirror galvanometer, which was followed by his equally sensitive and more practical siphon recorder, are rated among the most remarkable instruments ever devised. The effects of inductance, reactance and capacity in very long submarine cables prohibits the use of strong electrical currents. The first cable laid in 1858 was ruined by disregard of Lord Kelvin's advice, the insulation being broken down by using too great battery power. The mirror galvanometer responds to impulses so feeble as to be almost inconceivable. It is asserted that a battery contained in the bowl of an ordinary clay pipe is sufficient to operate an ordinary ocean cable of 2,000 or 3,000 miles length.

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OBITUARY.

George V. Cresson, president of the George V. Cresson Co., Philadelphia, Pa., died at his country home near Philadelphia, January 18, at the age of 71.

Charles W. Martin, Jr., assistant general manager of Jenkins Bros., New York, died at his home in Bay Ridge, South Brooklyn, December 31, of pneumonia, following an attack of the grippe. Although Mr. Martin was only thirty-seven, he had been in the employ of Jenkins Bros. twenty-one years, having entered their employ when a boy of sixteen. He was one of the best known men in the power plant and railway supply fields and had a wide circle of friends. He leaves a wife and two children.

Matthias N. Forney, a well-known retired engineer, author, editor and publisher, died of paralysis January 14. He was born March 28, 1835, in Hanover, Pa. Mr. Forney displayed a marked taste for mechanics at an early age, and in 1852 entered the shop of Ross Winans as an apprentice to learn the building of locomotives. Following his apprenticeship in the shop and drafting-room was a period of varied mechanical and mercantile experience during which he was granted a patent in 1866 for the celebrated "Forney" tank locomotive, which was used for years on the elevated railways of New York City, and in large numbers by contractors, etc. In 1870 he became associate editor of the *Railroad Gazette*, and in 1873 brought out his celebrated Catechism of the Locomotive, which has had a large sale. He was later the editor and part owner of that Journal, severing his connection in 1883. In 1886 he bought the *American Railroad Journal* and Van Nostrand's *Engineering Magazine*, which were consolidated under the name *The Railroad and Engineering Journal*, later being changed to *American Engineer and Railroad Journal*, under which name it is still published. Mr. Forney was very active in the Master Mechanics' and Master Car Builders' Associations. He was married for the first time about one year ago.

DR. COLEMAN SELLERS.

The death of Dr. Coleman Sellers, at his home in Philadelphia, Pa., December 28, removed one whose ingenuity and taste did more, perhaps, than any of his contemporaries to make American machine tools the standard of excellence and efficiency the world over. He was born in Philadelphia, January 28, 1827. His early education included a course in the academy of Anthony Bolman, West Chester, Pa., from which he graduated at sixteen. To possibly benefit his health, which was not robust, he was advised to engage in agricultural pursuits for a year or so after graduation, but his tastes were too scientific and mechanical to long permit him to follow this prosaic occupation, but during this period his inventive

Dr. Coleman Sellers.

genius was displayed in the invention of a metal tooth hay-rake on wheels that anticipated by many years the modern implement.

At nineteen his brothers in Cincinnati gave him a position as draftsman in the Globe Rolling Mills in that city, and before he was twenty-one he was made superintendent and general manager of the mills. This fact of having gained a thorough insight into the manufacture of iron in less than two years, coupled with evident executive ability, early developed, speaks eloquently for his extraordinary talents. In 1851 at the age of twenty-four he was made foreman of Niles & Co., locomotive builders of Cincinnati, the founders of the present Niles Tool Works branch of the Niles-Bement Pond Co., at Hamilton, Ohio. Five years later he returned to his home city, Philadelphia, and became chief engineer of Wm. Sellers & Co., and later was made a member of the firm.

His inventive genius and skill as a designer soon put the Sellers machine tools, already well-known, in advance of competitors. Those were the days of piano legs, beading, fluting, scroll work and other *outré* architectural ornaments in machine design, now regarded as ridiculous, but then considered to be quite the proper thing. Young Sellers discarded the clumsy and inappropriate designs, and made shapely and well-proportioned forms which coupled with superior mechanical design throughout, easily made Sellers tools the best produced. He was the first to devise the scheme of rational design in proportioning shafting, hangers and pulleys for power transmission, thus revolutionizing the power transmission business which had grown up under the totally unsound and ungainly system of selling by the pound. The obvious effect of this practice, of course, was to make the power transmission parts as heavy as possible without particular regard to the stresses transmitted. In these days of copious half-tone illustration, it is interesting to know that Mr. Sellers was an "amateur" photographer who materially advanced the art by his experiments and practice. He took it up in 1858, having recognized its value for advertising machine tools.

Dr. Sellers was associated with Wm. Sellers & Co. for thirty years, resigning in 1886 to enter consulting engineering practice. In 1889 he was retained to assist in the power development of Niagara. It is of melancholy interest that Dr. Sellers and Lord Kelvin, both having been connected with the pioneer development of this great water-power, died only five days apart. Lord Kelvin, then Sir William Thompson, was chairman of the International Commission of five members appointed to develop the plan of power development, and Dr. Sellers was consulting engineer. He acted both as consulting engineer of the Cataract Construction Co. and as chief engineer and president of the Niagara Falls Power Co.; also as chief mechanical engineer of the Canadian Niagara Power Co. His work in the pioneer development of these great water powers would alone establish his standing as a great mechanical engineer of international renown. Besides the mechanical features of the dynamos, improvements in the shaft bearings and other details of the installation, his advice guided the company safely through the whole of the initial development, both as to the mechanical as well as the electrical features involved.

Dr. Sellers was a member of the leading engineering societies of the United States and Great Britain; he was a charter member of the American Society of Mechanical Engineers. At the time of his death he was associated in consulting work with S. Howard Rippey and H. W. Sellers, of Philadelphia, under the firm name of Sellers & Rippey, the practice being now continued by the junior partners.

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NEW BOOKS AND PAMPHLETS.

PROCEEDINGS OF THE TRAVELING ENGINEERS' ASSOCIATION; FIFTEENTH ANNUAL MEETING, CHICAGO, ILL., September 3-6, 1907. 340 pages, 6 x 9 inches. W. O. Thompson, secretary, Buffalo, N. Y.

PROCEEDINGS of the Twenty-seventh Annual Convention of the American Water Works Association, held at Toronto, Ontario, Canada, June 17-21, 1907. 527 pages, 6 x 9 inches. Published by the Secretary, J. M. Diven, 14 George St., Charleston, S. C.

COAL MINE ACCIDENTS, THEIR CAUSES AND PREVENTION. By Clarence Hall and Walter O. Snelling, with introduction by James A. Holmes. 22 pages, 6 x 9 inches. Published by the Department of the Interior, U. S. Geological Survey, Washington, D. C.

REPORT of the Proceedings of the Fifteenth Annual Convention of the International Railroad Master Blacksmiths' Association for 1907. 244 pages, 5¾ x 8¼ inches. Published by the association. A. L. Woodworth, Lima, Ohio, secretary.

AMERICAN SOCIETY OF TESTING MATERIALS; PROCEEDINGS OF THE 10TH ANNUAL MEETING, held at Atlantic City, N. J., June 20-22, 1907. 759 pages, 6 x 9 inches. Published by the society, Edgar Marburg, secretary-treasurer, University of Pennsylvania, Philadelphia, Pa.

Technical Literature, published by the Technical Literature Co., 220 Broadway, New York, has been changed in name to the *Engineering Digest*. This publication, as many of our readers doubtless know, is a review of the general engineering press, and is intended to give its busy readers a comprehensive idea of the best and most important current articles without the drudgery and time-consuming process of reading all the technical and trade publications.

BANKER'S MATURITY GUIDE AND HOLIDAY CALENDAR. 32 pages 5x6¾ inches, with thumb index. Compiled and published by Sperry & Morgan, Hartford, Conn. Price, 50 cents.

This convenient little work is a summary of the laws and customs in the United States and possessions, Canada, Cuba, and Mexico, governing days of grace, Saturday half-holidays, maturities of negotiable paper, legal rates of interest, etc. It should be of value to manufacturers and others generally doing business in the various states and countries represented.

THE STUB TOOTH GEAR. 24 pages, 6 x 9 inches, illustrated. Published by the Fellows Gear Shaper Co., Springfield, Vt., for free distribution to those interested.

This pamphlet describes in a very convincing fashion the merits of the involute gear tooth of shortened addendum and increased pressure angle, as exemplified in the "stub tooth" system introduced by the Fellows Gear Shaper Co. The subject is discussed very plainly, with a profusion of explanatory diagrams. It is stated that fully one-third of the cutters ordered from this firm, are now required by customers to be of the stub tooth form.

MACHINE DESIGN. By Charles L. Griffin. 186 pages, 6 x 9 inches. 82 line illustrations. Published by the American School of Correspondence, Chicago, Ill. Price $1.50.

This work is substantially the same as the well-known work on machine design published by Mr. Griffin some years ago. It is bound in red cloth binding, uniform with the edition of books on various mechanical and electrical subjects now being issued by the American School of Correspondence. As a simple and comprehensive work on machine design on the subjects treated it is one of the most clear and logical that we have ever examined. It is deservedly popular.

WM. DAWSON & SONS, LTD., Cannon House, Bream's Buildings, London, E. C., England, have sent us their little "red book" listing annual subscriptions to English and foreign magazines, newspapers, etc. This list of the principal daily, weekly, and monthly papers and magazines is arranged alphabetically, with subscription prices for a year, both for England and abroad. A classification follows enabling one to find at a glance all papers on a certain subject or science. The little book also includes a full list of the principal American, Canadian, Australian, Chinese, Japanese, French, German, Indian, etc., newspapers, there being in all 5,000 listed. Copies are sent to any address on application.

SPECIFICATIONS AND CONTRACTS. By J. A. S. Waddell, with Note on the Law of Contracts by John C. Wait. 174 pages, 6 x 9 inches. Published by the Engineering News Publishing Co., New York. Price $1.00.

This work is compiled from a series of lectures delivered by Dr. Waddell. It treats of specifications and gives examples for practice in specification writing, engineering contracts, examples for practice in contract writing, notes on the law of contracts. The work is one that will be highly appreciated by contractors, manufacturers and others having to execute contracts for engineering work. A study of its pages would often save some very costly mistakes. The book is one that we can recommend to all engaged in contract work.

ELECTRICAL POCKETBOOK FOR 1908. 247 pages, 4 x 6 inches, illustrated. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price sixpence, net.

This pocketbook is compiled on lines similar to the *Mechanical World* pocket diary, published by the same concern. It treats of the electrical units by the C. G. S. system, specific resistance, table of horse-power equivalents in volts and amperes, mechanical and electrical unit equivalents, electrical transmission of power, dynamos and motors, methods of distributing electrical energy, alternating and polyphase motors, alternating current generators, machine driving by electric motors, and in general contains a large amount of useful electrical data. Mathematical tables are also included, and about sixty blank pages for diary and memoranda.

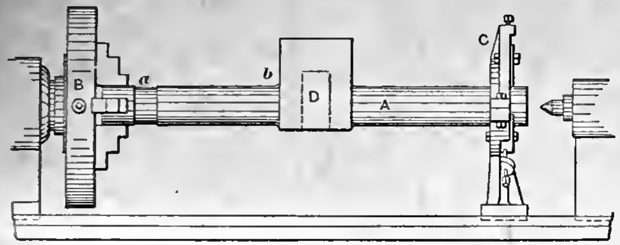
NEW BASIS OF CIVILIZATION. By Prof. Patten. Macmillan Co., New York. Price $1.00.

This book may seem at first thought to be a little out of our line, but it really treats of subjects in which every mechanic should be vitally interested. The author's idea is that the tremendous improvements in the production of wealth that have taken place in the past decades, are resulting in an economic change which is destined to

PUNCH PUNCH

SHOP OPERATION SHEET NO. 55.

Stanley Gould. MACHINERY, March, 1908.



To Rough Turn a Single-throw Crank-shaft Forging.

1. Place on the lathe spindle an independent four-jaw chuck *B*. Clamp center-rest *C* to the lathe bed at a point nearly the length of the forging *A* from the chuck.

2. Place the end of forging *A* in the jaws of the chuck *B* and clamp it, supporting the opposite end in the center-rest *C*. Lubricate the inner ends of the jaws. Prick punch center of forging. Adjust center rest jaws to bring this mark opposite tail center. Start the lathe. Hold a piece of chalk against the forging at *a*, and adjust chuck jaws until forging runs true.

3. Turn the space *a* long enough to take center-rest jaws.

4. Reverse the forging *A*, placing opposite end in chuck jaws, and space *a* in center-rest jaws. Adjust the chuck jaws as in Step 2.

5. Face end of forging to length. Drill and ream center. Bring up tail-stock center. Remove center-rest *C*. Turn a bearing for center-rest between chuck and crank, and close up to crank as at *b*, and adjust center-rest here.

6. Rough turn the end next to tail-stock, leaving from 1/16 to 1/8 inch, according to size of shaft, for finishing.

7. Change center-rest *C* to opposite side of crank. Rough turn shaft from crank to chuck.

8. Face both outsides of crank nearly to finish dimensions.

9. Change forging end for end, supporting tail-stock end in center-rest *C* jaws on turned part. Turn part previously held in chuck, face end to length, and drill and ream center. Remove forging from lathe.

10. Lay off that portion of the crank which is to be removed, as shown by the dotted lines at *D*. The vertical dotted lines should be equidistant from the sides of the crank, and the horizontal dotted line located so as to leave plenty of stock for the pin. Lay out rows of holes, inside these dotted lines, spaced so as to touch each other.

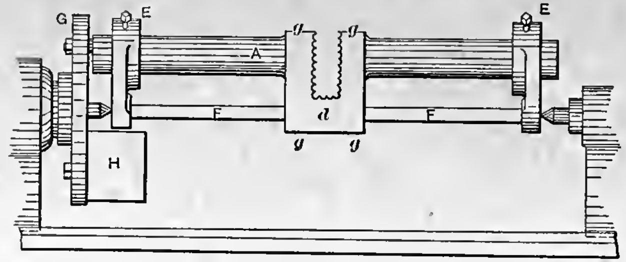
11. First drill each alternate hole, and then the remaining holes, the holes being drilled through the forging in both instances. Alternate holes are drilled first to prevent the drill from running into the hole next to it, as it would be apt to do if the holes were drilled in succession. After the holes have been drilled, remove the center piece with a hammer and chisel.

NOTE.—When the crank-shaft is large, the center piece can be removed with less trouble by drilling one row of holes along the horizontal dotted line, and then removing the center piece on the slotter, one cut being taken along each vertical dotted line.

PUNCH PUNCH

SHOP OPERATION SHEET NO. 56.

Stanley Gould. MACHINERY, March, 1908.



To Turn the Crank-pin of a Single-throw Crank-shaft Forging.

NOTE.—The crank-shaft is supposed to have been centered, the ends faced to the required length, and the shaft rough turned.

1. Select a pair of crank dogs or carriers *E* which are bored slightly smaller than the rough-turned shaft. Each of these dogs must be provided with a center upon which the work rotates when turning the crank-pin. The distance from these crank-pin centers to the center of the hole in the dog must equal the throw of the crank. Midway between each crank-pin center and the center of the crank dog hole, there is another center. These intermediate centers are used when turning the ends *g* of the crank.

2. Turn the ends of the shaft to fit the holes in the crank dogs *E*, and then place the dogs on the shaft as shown in the cut, allowing the ends of the shaft to project through the dogs as far as possible to make the work more rigid.

3. Put the crank-shaft in the lathe, using the crank-shaft centers. Locate the center of the crank-pin on one side of the crank. The distance from this center to the shaft will equal the throw of the crank, minus one-half the diameter of the shaft. Place the crank in a horizontal position, with the crank-pin center the same height from the lathe bed as the lathe centers. Measure the distance from the crank-pin center to the lathe bed, and then adjust each crank dog until the distance from the crank-pin center in the dog to the lathe bed is equal to this measurement. Fasten the crank dogs securely in place by tightening their set-screws.

4. Fit braces *F* between the crank dogs and the crank, to take the thrust of the lathe centers, and then shift the crank-shaft in the lathe, supporting it by the crank-pin centers. Move the crank-shaft until its centers are about the same height as the lathe centers, then caliper from the shaft to the lathe bed and see if the shaft is parallel with the bed. If it is not, one of the dogs must be readjusted.

5. Fasten a driver to the face-plate *G*, and a counterbalancing weight *H* opposite the crank-shaft.

6. Rough turn the inside faces of the crank to nearly finish dimensions. Rough turn crank-pin *d* until it is cylindrical.

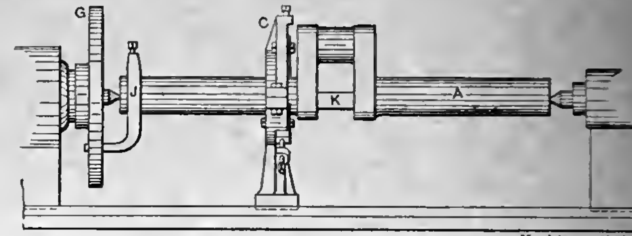
7. Finish inside faces of crank to dimensions, leaving fillets next to crank-pin. Finish crank-pin to finish dimensions.

8. Put the work on the intermediate centers in crank dogs *E*, and finish the ends *g* of the crank.

PUNCH PUNCH

SHOP OPERATION SHEET NO. 57.

Stanley Gould. MACHINERY, March, 1908.



To Turn the Main Bearings of a Single-throw Crank-shaft.

NOTE.—It is assumed that the main bearings and the outside faces of the crank have been rough turned, and the inside faces of the crank, and the crank-pin, have been finished. The work is supposed to have been left in the lathe on completion of the last operation, with the crank dogs and the braces, shown in the preceding operation, in place.

1. Remove the work from the lathe. Take off the crank dogs *E* and the braces. Put in place the block *K*, carefully fitted, so as to prevent springing the crank-shaft. Put the lathe dog *J* on the crank-shaft and clamp it. Put the shaft between the lathe centers, and the tail of the lathe dog in the slot in the face-plate *G*.

NOTE.—When turning a crank-shaft, unless it be one of very small size, a counterbalancing weight should be fastened to the face-plate. This weight should be placed on the face-plate near the point indicated in the illustration by the tail of the dog *J*. If the dog *J* fits loosely into the slot in the face-plate, the play should be taken up by inserting a wooden wedge.

2. Turn a space on the crank-shaft between the face-plate and the crank, and near the latter, removing as little stock as possible to true it. Clamp the center-rest *C* at this point, oil the jaws and adjust them.

3. Take a roughing cut over the part of the shaft between the crank and the tail-stock center 1/32 inch larger than the finish diameter. If the shaft runs considerably out of true, take two or more cuts, as may be necessary.

4. Take a finishing cut, using a broad, keen-edged tool and a coarse feed. The width of the tool's cutting edge, and the feed, will depend upon the rigidity of the work. Soda water used on the finishing cut will produce a smooth surface.

5. Take a finishing facing cut on the outside face of the crank, making the side of the crank the required width. As the inside face of the crank has been finished it will be necessary to work from this face.

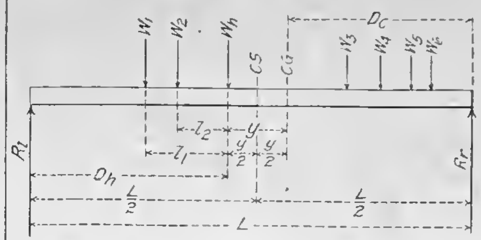
6. Turn the shaft end for end in the lathe, changing the lathe dog to the opposite end, putting a piece of copper under the set-screw to protect the finished surface. Adjust the center-rest jaws and oil their inner ends.

7. Repeat upon the rough-turned end of the crank-shaft the operations of turning described in steps 4 and 5.

NOTE.—As the stock between the sides of the crank was removed after the shaft was rough-turned, the shaft will very likely run somewhat out of true. Because of this, the turning operation described in step 2 is usually necessary.

I.—FORMULAS FOR MOVING LOADS.

Location for Maximum Moment.



CS denotes center of span.
CG denotes center of gravity of loads.
W_h denotes heaviest load adjacent to CG.
Let W = total load and M = moment.
For M a maximum place CS midway between W_h and CG and find M under W_h. For reactions, $R_l = \frac{WD_c}{L}$ and $R_r = W - R_l$. For maximum moment $M = R_l D_h - (W_1 l_1 + W_2 l_2)$, or since $D_c = D_h$, $M = \frac{WD_c^2}{L} - (W_1 l_1 + W_2 l_2)$.

Two Wheels Equally Loaded.

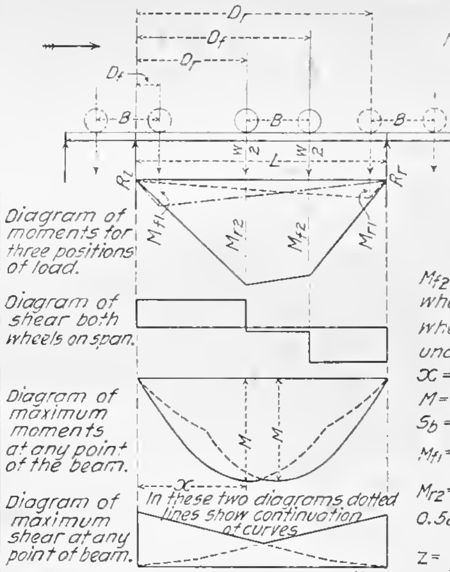


Diagram of moments for three positions of load.

Diagram of shear both wheels on span.

Diagram of maximum moments at any point of the beam.

Diagram of maximum shear at any point of beam.

For B = or exceeds 0.5858 L, $M = \frac{WL}{8}$ and $R_r = \frac{W}{L}(D_r + \frac{B}{2})$.

Notation: All values in inches and pounds. W = total load. $W/2$ = load on one wheel. L = length of span. B = wheel base. R_l = left reaction. R_r = right reaction. V = vertical shear = reaction nearest to the point under consideration. D_f = distance to front wheel, D_r = distance to rear wheel } the load coming on from the left. M_{f1} = moment under front wheel, one wheel on the span. M_{f2} = moment under front wheel with both wheels on the span. M_{r1} = moment under rear wheel, one wheel on the span. M_{r2} = moment under rear wheel, both wheels on the span. x = value of D_r for M_{r2} a maximum. M = maximum moment. Z = section modulus. S_b = stress due to bending.

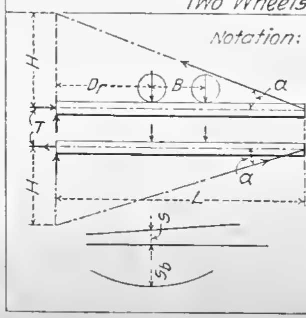
$M_{f1} = \frac{WD_f}{2L}(L - D_f)$. $M_{r1} = \frac{WD_r}{2L}(L - D_r)$. $M_{f2} = \frac{W}{L}(D_f - \frac{B}{2})(L - D_f)$.

$M_{r2} = \frac{WD_r}{L}(L - D_r - \frac{B}{2})$. For values of B less than 0.5858 L, $x = \frac{L}{2} - \frac{B}{4}$ and $M = \frac{WL}{4}(1 - \frac{B}{2L})^2$.

$Z = \frac{M}{S_b}$ or $S_b = \frac{M}{Z}$.

For both wheels on the span, $R_l = \frac{W}{L}(L - D_r - \frac{B}{2})$

Two Wheels Equally Loaded, Oblique Reaction.



Notation: Same as above with addition of; α = angle of the reaction with beam. A = cross sectional area of beam. T = thrust or pull due to oblique reaction. S = direct stress due to T (tension or compression).

$T = \frac{W}{H}(D_r + \frac{B}{2})$, or $T = \frac{W}{L}(D_r + \frac{B}{2}) \cot \alpha$.

$S = \frac{T}{A} = \frac{W}{HA}(D_r + \frac{B}{2})$, or $S = \frac{W}{LA}(D_r + \frac{B}{2}) \cot \alpha$.

M_{f2}, M_{r2}, x, M and S_b = same as above.

$S + S_b = W(\frac{D_r + \frac{1}{2}B}{HA} + \frac{D_r(L - D_r - \frac{1}{2}B)}{LZ})$, or

$S + S_b = \frac{W}{L}(\frac{(D_r + \frac{1}{2}B)\cot \alpha}{A} + \frac{D_r(L - D_r - \frac{1}{2}B)}{Z})$.

$S + S_b$ = a maximum when $D_r = \frac{LZ}{2HA} + \frac{L}{2} - \frac{B}{4} = \frac{Z}{2A}\cot \alpha + \frac{L}{2} - \frac{B}{4}$.

For light weight I-beams $\frac{Z}{A}$ = about $\frac{1}{3}$ depth of beam.

Contributed by John S. Myers.

II.—TABLES FOR SHEAR OR MOMENT. MOVING LOADS; TWO WHEELS EQUALLY LOADED.

Notation: W = total load on wheels. $\frac{1}{2}W$ = load on one wheel. L = length of span. B = wheel base. D = distance from support to point at which moment or shear is required. R = ratio of B to L = B/L. x = ratio of D to L = D/L. M = bending moment. S = vertical shear on beam which is also the reaction of the support nearest to the point under consideration. V_m and V_s are variables to be taken from tables.

Table giving values of V_m in formula $M = WLV_m$.

$R = \frac{B}{L}$	Values of D/L = x: 0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.375	0.40	0.425	0.45	0.475	0.50
0.0	0.0475	0.090	0.1275	0.16	0.1875	0.210	0.2275	0.2344	0.24	0.2442	0.2475	0.2494	0.250
0.1	0.0450	0.085	0.1200	0.15	0.1750	0.195	0.2100	0.2156	0.22	0.2231	0.2250	0.2256	0.225
0.2	0.0425	0.080	0.1125	0.14	0.1625	0.180	0.1925	0.1969	0.20	0.2019	0.2025	0.2019	0.200
0.3	0.0400	0.075	0.1050	0.13	0.1500	0.165	0.1750	0.1781	0.18	0.1806	0.1800	0.1781	0.175
0.4	0.0375	0.070	0.0975	0.12	0.1375	0.150	0.1575	0.1594	0.16	0.1594	0.1575	0.1544	0.150
0.5	0.0350	0.065	0.0900	0.11	0.1250	0.135	0.1400	0.1406	0.14	0.1381	0.1350	0.1306	0.125
0.6	0.0325	0.060	0.0825	0.10	0.1125	0.120	0.1225	0.1219	0.12	0.1222	0.1238	0.1247	0.125
0.7	0.0300	0.055	0.0750	0.09	0.1000	0.105	0.1138	0.1172	0.12	0.1222	0.1238	0.1247	0.125
0.8	0.0275	0.050	0.0675	0.08	0.0983	0.105	0.1138	0.1172	0.12	0.1222	0.1238	0.1247	0.125
0.9	0.0250	0.045	0.0638	0.08	0.0983	0.105	0.1138	0.1172	0.12	0.1222	0.1238	0.1247	0.125
1 or over	0.0238	0.045	0.0638	0.08	0.0983	0.105	0.1138	0.1172	0.12	0.1222	0.1238	0.1247	0.125
Values of D/L = x from other support	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.625	0.60	0.575	0.550	0.525	0.50

In the above the values enclosed by heavy lines are maximum

Table giving values of V_s in formula $S = WV_s$.

$R = \frac{B}{L}$	Values of D/L = x: 0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	$R = \frac{B}{L}$
0.0	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.0
0.1	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.1
0.2	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.2
0.3	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.3
0.4	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.4
0.5	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.25	0.5
0.6	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.275	0.25	0.6
0.7	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.325	0.30	0.275	0.25	0.7
0.8	0.60	0.55	0.50	0.45	0.40	0.375	0.35	0.325	0.30	0.275	0.25	0.8
0.9	0.55	0.50	0.45	0.425	0.40	0.375	0.35	0.325	0.30	0.275	0.25	0.9
1 or over	0.50	0.475	0.45	0.425	0.40	0.375	0.35	0.325	0.30	0.275	0.25	1 or over
Values of D/L = x from other support	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	

In both the above tables R = 0 indicates one wheel instead of two. When B = 0.5858 L the moment with one wheel in the center of span is equal to the maximum moment with both wheels on.

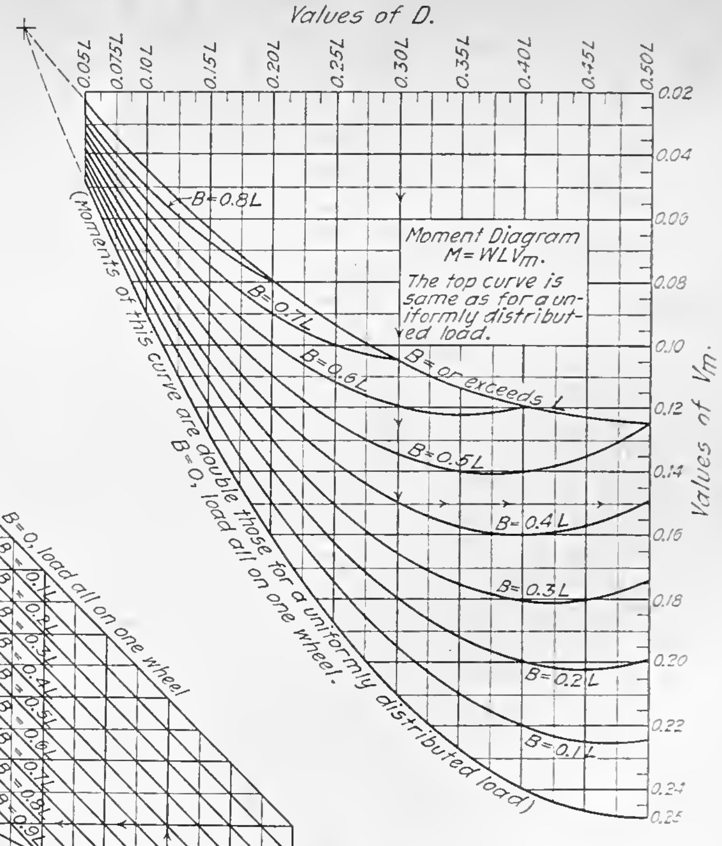
Contributed by John S. Myers.

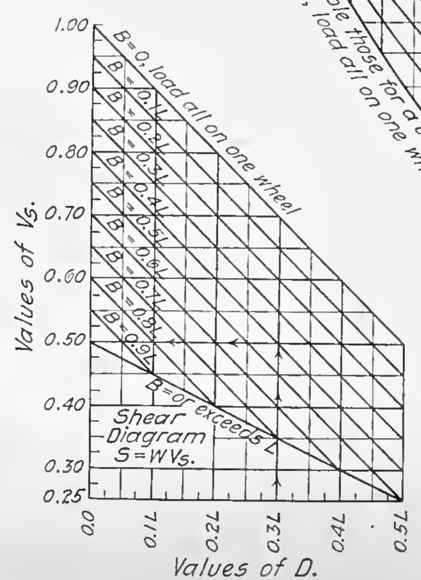
Payment will be made for all accepted matter.

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

III.—DIAGRAMS OF MOMENT AND SHEAR. MOVING LOADS; TWO WHEELS EQUALLY LOADED.

Notation: W = total load $\frac{1}{2}W$ = load on one wheel. B = wheel base. L = length of span. M = bending moment. S = vertical shear. D = distance from nearest support to point where moment or shear is required. V_m and V_s are variables to be taken from the diagrams. The shear is also the reaction at the nearest support.





Example: W = 2000 lbs. B = 8′0″ = 0.4L. L = 20′0″.
When D = 6′0″ = 0.3L, what is the bending moment and shear?
By the diagrams V_m = 0.15 and V_s = 0.5, then by formula, M = 2000 x 20 x 0.15 = 6000 ft. lbs. S = 2000 x 0.5 = 1000 lbs.

Contributed by John S. Myers.

IV.—SAFE STRESS FOR BEAMS UNSUPPORTED LATERALLY.

In order to provide the same security in both flanges of a beam the compression flange should either be supported against lateral flexure at distances not greater than 20 times the flange width, or a lower stress should be used for the compression flange than is permissible for the tension flange.

The formula given in the Cambria Steel Co's. hand-book corresponding to 16000 lbs. per sq inch safe tensile stress is:

$$S_c = \frac{18000}{1 + \frac{L^2}{3000 b^2}},$$

where the letters have the following values; S_c = safe compressive stress. L = length unsupported in inches. b = breadth of flange in inches.

The curve marked 16000 was plotted according to the above formula.

The curves for 14000, 12500 and 10000 corresponding tensile stresses were plotted from proportionally lower values.

Values of S_c read from the 10000 curve, if considered as a decimal, give the ratio of safe compressive to safe tensile stress.

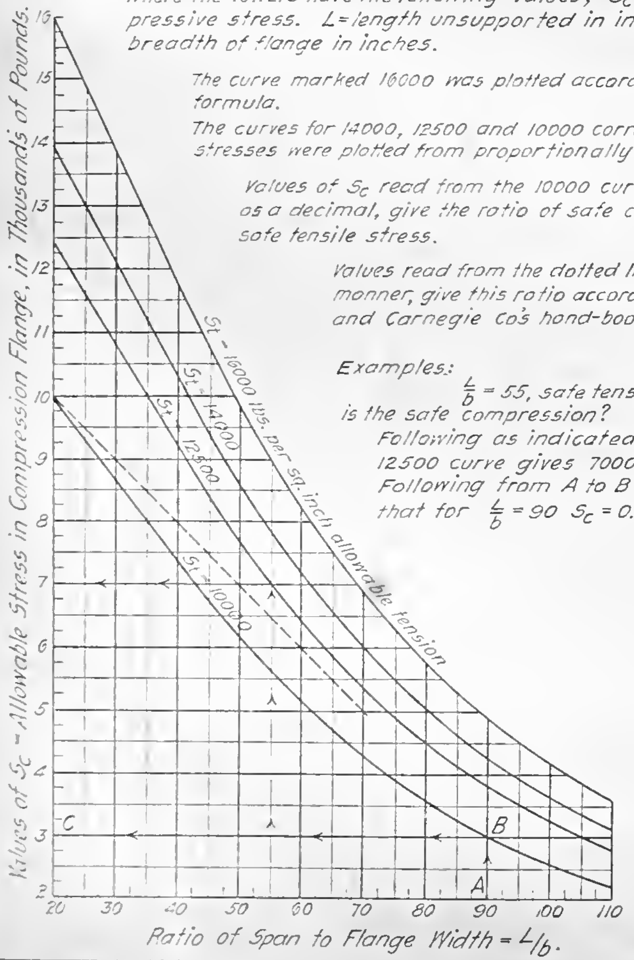
Values read from the dotted line in the same manner, give this ratio according to Pencoyd and Carnegie Co's hand-book.

Examples:

$\frac{L}{b}$ = 55, safe tension = 12500. What is the safe compression?

Following as indicated by arrows, the 12500 curve gives 7000; answer.

Following from A to B then to C indicates that for $\frac{L}{b}$ = 90 S_c = 0.3 S_t.



Contributed by John S. Myers.

MACHINERY.

March, 1908.

MAXIMUM STRESSES.—1.*

JOHN S. MYERS.†

THE problem of obtaining the maximum stress for which a part must be designed is sometimes a rather difficult matter. Often the designer arbitrarily assumes certain conditions to produce the maximum stress, which may be closely in accordance with the facts or may be far from them, depending entirely upon the judgment exercised.

Because of the time required to investigate, the extended operations necessary, men fully capable of performing the calculations, and often having a good understanding of the principles involved, sometimes make rash assumptions. In fact, there are many temptations to use a sort of combination of rough figures, judgment, and guess; satisfying the conscience by a wonderful faith in the factor of safety to cover a multitude of sins. It is often really necessary to pursue such a course in order to turn out the work with the expediency required by present-day employers. In some cases it is cheaper to be liberal with material than to virtually waste good time and brain fat on refinement of design. This is especially the case with the less important elements entering into a design. Too often, however, designs made with the foregoing ideas in mind are used over and over again, thus

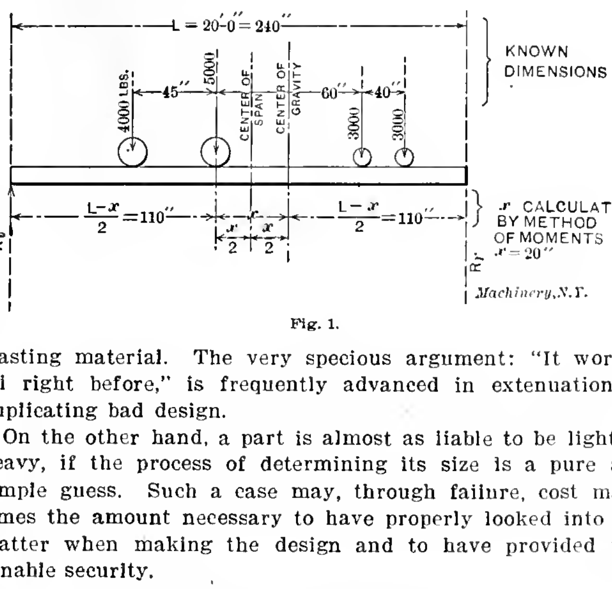


Fig. 1.

wasting material. The very specious argument: "It worked all right before," is frequently advanced in extenuation of duplicating bad design.

On the other hand, a part is almost as liable to be light as heavy, if the process of determining its size is a pure and simple guess. Such a case may, through failure, cost many times the amount necessary to have properly looked into the matter when making the design and to have provided reasonable security.

Purpose of Present Article.

It is the object of this article to present a few common cases of variable and of combined stresses, showing the manner of obtaining the maximum stress for which the part should be designed, these various cases leading up to the presentation of tables and diagrams, in data sheet form, whereby the labor of computing the stresses may be very much shortened.

Moving Loads.

The most common case of moving loads is that of two wheels equally loaded, such as a crane trolley on the crane bridge or the bridge upon the runway. There is nothing difficult about finding the maximum moment, provided the location of the load upon the span which produces the moment a maximum be known. This is also very simple, once the general rule covering the case is known. It is a fact, however, that many draftsmen, especially those engaged in mechanical work, do not know from positive knowledge what this location is. In many cases, they simply place the load in the center of the span or place one wheel in the center, and take it for granted that this location produces the maximum moment. If both locations be tried, the same moment will be found for each, which apparently confirms the supposition, and a man prone to jump at conclusions might readily draw the inference that the moment remains constant for any point intermediate between these two locations. Such is not the case.

General Rule.

For moving loads, when all the loads are upon the span at once, the maximum moment under any particular load will occur when the center of the span is midway between this load and the center of gravity of all the loads.

The load which produces the maximum moment will in nearly all cases be the heaviest one of the two loads adjoining the center of gravity, hence the rule may be stated:

Place the center of gravity of all the loads and the heaviest load adjacent to the center of gravity equidistant from the supports, and find the moment under the heaviest load.

Example.—What is the maximum moment produced by the system of wheel loading shown in Fig. 1?

Solution.—First find the center of gravity of all the loads by taking moments about some point of reference. Dividing the algebraic sum of the moments by the sum of the loads gives the distance from the point of reference to the center of gravity, thus:

Taking the 5,000-pound load as the point of reference,

Loads.	Distances.		Moments.
5,000 ×	0	=	000
3,000 ×	(+60)	=	+180,000
3,000 ×	(+100)	=	+300,000
4,000 ×	(—45)	=	—180,000

15,000 lbs. = total load. $\dfrac{300{,}000 = \text{moment}}{15{,}000} = 20$ inches,

distance of center of gravity to the right of the line of reference $= x$ in Fig. 1.

Placing the load such that the center of the span is midway between the center of gravity and the heaviest wheel load, or what is the same thing, placing the load such that the center of gravity of all the loads and the heaviest load are equidistant from the supports, gives the locations as indicated at the bottom of Fig. 1. To find R_l and R_r take moments as follows: Since the center of gravity of all loads is now known, consider them concentrated at this point; then $R_l = \dfrac{15{,}000 \times 110}{240} = 6{,}875$ pounds and $R_r = \dfrac{15{,}000 \times 130}{240} =$ 8,125 pounds. Adding the two reactions as a check, 6,875 + 8,125 = 15,000 pounds = total load. Taking moments under the 5,000-pound load,

$$6{,}875 \times 110 = +756{,}250$$
$$4{,}000 \times (-45) = -180{,}000$$

Maximum moment = 576,250 inch-pounds, the required answer.

Sections suitable for such purposes will be given in a later data sheet.

Two Wheels Equally Loaded.

The general rule previously stated, when applied to two wheels equally loaded, may be given as follows:

When the wheel base is less than $(2 - \sqrt{2})$ times the span $(= 0.5858 \times \text{span})$ the maximum moment occurs with both wheels on the span and when the distance from one support to the wheel nearest to it is equal to one-half the span minus one-fourth the wheel-base.

When the wheel-base exceeds 0.5858 times the span, the maximum moment occurs when one wheel is in the center of the span.

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: Notes on Design, March and April, 1904; Charts in Designing, September, 1904; Flexure Simplified, December, 1903.

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The equations expressing the various relations between the quantities involved and the method of deducing formulas equivalent to the foregoing rules are given below:

Referring to Figs. 2a, 2b, and 2c,

Let W = total weight carried by the two wheels,

$W/2$ = weight on one wheel,

L = length of span,

B = wheel-base.

Consider the load to be moving from left to right; and

Let D_f = distance to front wheel from left support.

D_r = distance to rear wheel from left support,

M_{f1} = moment under front wheel with but one wheel on the span.

M_{f2} = moment under front wheel with both wheels on the span.

M_{r1} = moment under rear wheel with but one wheel on the span.

M_{r2} = moment under rear wheel with both wheels on the span.

Then,

$$M_{f1} = \frac{W D_f}{2L}(L - D_f) \qquad (1)$$

$$M_{r1} = \frac{W D_r}{2L}(L - D_r) \qquad (2)$$

$$M_{f2} = \frac{W}{L}\left(D_f - \frac{B}{2}\right)(L - D_f) \qquad (3)$$

$$M_{r2} = \frac{W D_r}{L}\left(L - D_r - \frac{B}{2}\right) \qquad (4)$$

To find what location of the load upon the span produces the maximum moment when both wheels are on, differentiate* equation 4, whence we get

$$D_r = \frac{L}{2} - \frac{B}{4} \qquad (5)$$

which is the value of D_r which produces the maximum moment and agrees with the general principle previously stated.

To find the maximum moment, insert this value of D_r in equation 4 when it becomes, maximum

$$M_{r2} = \frac{WL}{4}\left(1 - \frac{B}{2L}\right)^2 \qquad (6)$$

For B = or exceeds $\frac{1}{2}L$ and one wheel in the center of the span, the load on this wheel being $\frac{W}{2}$, the moment is $\frac{WL}{8}$.

Substituting this moment for M_{r2} in equation (6) thus:

$$\frac{WL}{8} = \frac{WL}{4}\left(1 - \frac{B}{2L}\right)^2 \text{ and solving for } B,$$

$$B = (2 - \sqrt{2})\,L = 0.5858\,L \qquad (7)$$

Equation (7) shows that when $B = 0.5858L$ the moment with one wheel in the center of the span is just equal to the maximum moment with both wheels on the span, consequently equation (6) does not apply for values of B greater than this.

Let M = the maximum bending moment,

Z = section modulus,

S_b = stress due to bending.

Then,

$$S_b = \frac{M}{Z}; \text{ or } Z = \frac{M}{S_b} \qquad (8)$$

From this the maximum stress can be calculated when the section modulus is known, or the section modulus required to withstand a given moment and not exceed a specified stress may be determined.

It is interesting to note that for two wheels equally loaded, when the wheel-base equals or exceeds the span, the moment at any point of the beam is the same as for a uniformly distributed load, and that for wheel-bases equal to 0.5858 of the span or greater the maximum moment is the same as the maximum moment for a uniformly distributed load. For such cases, the beam required may be taken from the tables given in the various steel companies' hand-books by adding to the actual load a percentage to allow for impact, or by making the proper reduction in fiber stress. It follows from the above that, when the load is all carried on a single wheel, the moment at any point is double that for a uniformly distributed load. Hence, a beam may be picked out from the tables listed for double the load.

The Data Sheets.

Data Sheet No. 1.—The first part of data sheet No. 1 gives in condensed form the location for maximum moment, with formulas for same.

The second part gives a summary of the formulas for two wheels equally loaded, together with diagrams showing how

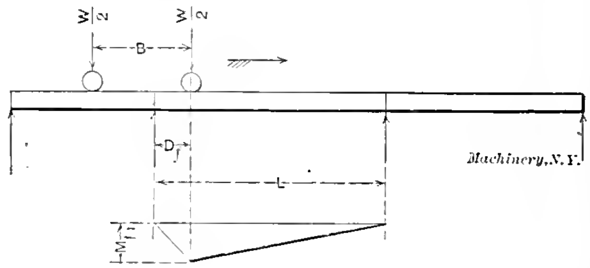


Fig. 2a.

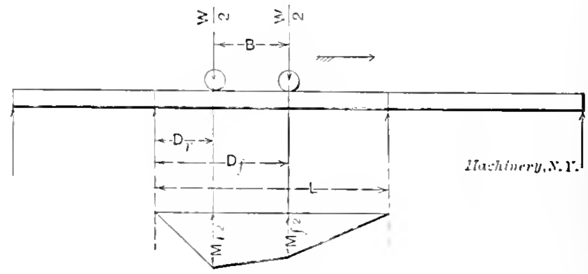


Fig. 2b.

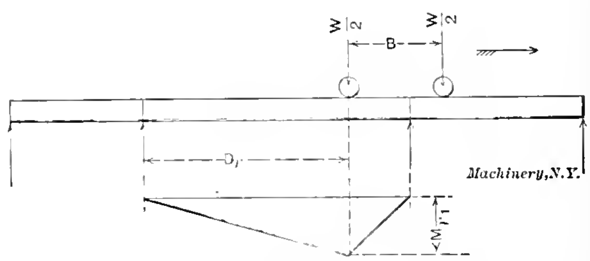


Fig. 2c.

the moment and shear varies for a specific location of the load or for any point of the beam.

The third part of sheet No. 1 will be discussed under its proper heading.

Data Sheet No. 2.—This sheet gives values of the variable Y_m in the formula $M = WLY_m$, where M = the moment occurring at any point throughout the length of the beam, L = length of span, and W = the load. The lower table on this sheet gives values of the variable Y_s in the formula $S = WY_s$ where S = the shear at any point of the beam and W = the load.

Data Sheet No. 3.—This sheet gives the same data as sheet No. 2, but in diagram form, which is easier to interpolate for intermediate values and will, therefore, recommend itself to those not prejudiced against diagrams. By the aid of these tables, or diagrams, the moment or shear at any point on the beam or girder can be quickly determined. This being known, it is easy to find the section modulus required, how close to the supports it may be necessary to bring the cover plates if a built-up section be used, and at what point the shear decreases sufficiently so that the web stiffeners may be omitted when such is permissible.

Example.—A girder of 20 feet span supports a load of 30,000 pounds carried on two wheels equally loaded, the wheel-base being 10 feet. (*a*) What is the maximum moment, and (*b*) what section modulus is required, assuming 12,000 pounds per square inch fiber stress?

$$* \; d\,M_{r2} = W\,d\,D_r - \frac{W}{L}\,2\,D_r\,d\,D_r - \frac{W\,B}{2\,L}\,d\,D_r. \quad \text{Placing}$$

$$\frac{d\,M_{r2}}{d\,D_r} = 0, \text{ and solving for } D_r \text{ gives,}$$

$$D_r = \frac{L}{2} - \frac{B}{4} \qquad (5)$$

Solution.—$L = 12 \times 20 = 240$ inches; $W = 30,000$ pounds; $B = 10$ feet $= 0.5L$. From the table (data sheet No. 2) or the diagram (data sheet No. 3) the maximum value of V_m is found to be 0.1406, say 0.14, then $M = WLV_m = 30,000 \times 240 \times 0.14 = 1,008,000$ inch-pounds. Ans. (*a*).

By formula 8, $Z = \dfrac{M}{S_b} = \dfrac{1,008,000}{12,000} = 84$. Ans. (*b*).

Example.—A girder carries a moving load on two wheels equally loaded, the wheel-base being 0.2 of the span. At what point could the outside cover plate be stopped off if it constitutes one-third of the flange area?

Solution.—It could be stopped off at a point where the moment is two-thirds the value of the maximum moment. Referring to the diagram on sheet No. 3 the curve for $B = 0.2L$ shows the maximum value of V_m to be 0.2025. Two-thirds of $0.2025 = 0.135$. The same curve shows for $V_m = 0.135$ that $D =$ about $0.158L$, which is the required answer. If the girder were 40 feet long, the outside cover-plate could be stopped off at $0.158 \times 40 = 6.32$ feet from each end. The plate should be carried beyond the theoretic point for a distance sufficient to insert two or three rivets.

Example.—The wheel-base being 0.4 the span, what is the maximum shear?

Solution.—By referring to either the table or diagram, the maximum shear is found to be 0.8 of the load.

Example.—If, in the last example, the web of the girder will carry 0.6 of the load without stiffeners, how far from each end must stiffeners be provided?

Solution.—Referring to the shear diagram, it is found that for $B = 0.4L$ and $V_s = 0.6$; $D = 0.2L$, or stiffeners must be provided at each end for a distance equal to 0.2 of the span.

Moving Load and Oblique Reaction.

Often a beam carrying a moving load is supported at one end by a tie-rod or a strut making an acute angle with the beam. In the case of a strut, this produces a direct tensile stress in the beam in addition to the bending stress, and in the case of a tie-rod a direct compressive stress is induced. A familiar example of this latter is found in a jib crane as illustrated by Fig. 3.

Let the notation be the same as in the case of simple beams with moving loads, making the addition of dimension H and angle α as indicated in Fig. 3; then let T = thrust on beam caused by the angle of the reaction. (If a strut be used, this angle is measured from the bottom of the beam, and a pull instead of a thrust is the result.)

$L =$ length of beam which is to be measured to the intersection of the center line of the rod with the center line of the beam.

α = angle of oblique reaction with beam,

A = cross-sectional area of beam,

S = direct stress,

S_b = stress due to bending.

Since the section modulus is based upon square inches, and stresses are expressed in pounds per square inch, all values should be expressed in inches and pounds.

The following formulas may then be developed:

$$T = \frac{W}{H}\left(D_r + \frac{B}{2}\right) \qquad (9)$$

or,

$$T = \frac{W}{L}\left(D_r + \frac{B}{2}\right)\cot\alpha. \qquad (9a)$$

$$S = \frac{T}{A} = \frac{W}{HA}\left(D_r + \frac{B}{2}\right) \qquad (10)$$

or

$$S = \frac{T}{A} = \frac{W}{LA}\left(D_r + \frac{B}{2}\right)\cot\alpha \qquad (10a)$$

$$M_{r2} = \frac{W D_r}{L}\left(L - D_r - \frac{B}{2}\right) \qquad (11)$$

$$S_b = \frac{M_{r2}}{Z} = \frac{W D_r}{LZ}\left(L - D_r - \frac{B}{2}\right) \qquad (12)$$

$$S + S_b = W\left(\frac{D_r + \frac{1}{2}B}{HA} + \frac{D_r(L - D_r - \frac{1}{2}B)}{LZ}\right) \qquad (13)$$

or

$$S + S_b = \frac{W}{L}\left(\frac{(D_r + \frac{1}{2}B)\cot\alpha}{A} + \frac{D_r(L - D_r - \frac{1}{2}B)}{Z}\right) \qquad (13a)$$

To find the value of D_r such that $S + S_b$ becomes a maximum, let $S + S_b = y$, substituting this in equation 13 and differentiating* gives

$$D_r = \frac{LZ}{2HA} + \frac{L}{2} - \frac{B}{4} \qquad (14)$$

which is the value of D_r which gives the combined stress $S + S_b$ a maximum.

The first term of equation (14) may be considered to be made up of two factors, namely, $\dfrac{L}{2H}$ and $\dfrac{Z}{A}$. The first, $\dfrac{L}{2H}$, will, in practice, generally be approximately equal to unity; the second, $\dfrac{Z}{A}$, will be quite approximately equal to one-third the depth of beam when the section used is a single, light weight I-beam, which is the section most commonly used in constructions of this kind. Formula (14) may then, with sufficient accuracy for all practical purposes, be expressed thus:

$$D_r = \frac{L}{2} - \frac{B}{4} + \frac{1}{3}\text{ the depth of beam.} \qquad (15)$$

Equation (13a), treated in a similar manner to that pursued in deriving formula (14), results in the expression

$$D_r = \frac{Z}{2A}\cot\alpha + \frac{L}{2} - \frac{B}{4} \qquad (14a)$$

which is the value of D_r giving the maximum combined stress $S + S_b$ expressed in relation to the angle α.

If the direct compressive stress S is greater than the tensile stress due to bending, S_b, the entire cross sectional area of the beam is subjected to compression. In this case the member must be treated as a strut or column, the maximum stress being determined by formula (13) or (13a) by inserting the value of D_r as given by formula (14), (14a), or (15), whichever best suits the case in hand. The allowable stress may then be determined by any approved column formula. Gordon's formula seems to be the most popular, tables based upon it being given in all the large steel companies' handbooks.

It will be found, however, in practice, that the direct compressive stress is nearly always much less than the tensile stress produced by bending, hence the compression flange only is liable to buckle, and it would give too heavy a member to treat the entire section as a column. This leads to the consideration of

Beams Unsupported Laterally.

Let P = ultimate strength in pounds per square inch.

L = length unsupported laterally in inches,

r = radius of gyration in inches.

b = breadth of compression flange in inches.

Considering the compression flange of a beam as a rectangle,

$$r = \frac{b}{\sqrt{12}} \text{ and } r^2 = \frac{b^2}{12}.$$

Gordon's formula for columns is,

$$P = \frac{50,000}{1 + \dfrac{L^2}{36,000\, r^2}} \qquad (16)$$

Inserting the value of r as given above in (16) gives,

$$* \; dy = \frac{W}{HA}dD_r + \frac{W}{Z}dD_r - \frac{W}{LZ}2D_r\,dD_r - \frac{WB}{2LZ}dD_r.$$

Placing $\dfrac{dy}{dD_r} = 0$ and solving for D_r gives

$$D_r = \frac{LZ}{2HA} + \frac{L}{2} - \frac{B}{4} \qquad (14)$$

$$P = \frac{50{,}000}{1 + \dfrac{L^2}{3{,}000\,b^2}} \qquad (16a)$$

This is the ultimate unit stress provided the compression flange received no support from the parts in tension. The 1900 hand-book of the Pencoyd Iron Works (now American Bridge Co.) states: "Experiments have shown a reduction of about one-third of the normal modulus of rupture when the unsupported length becomes 80 times its flange width." But as the long beam may suffer if exposed to accidental cross strains, they recommend the greatest safe load to be reduced in such a ratio for long beams that when the length is 70 times the flange width, the greatest safe loads will be reduced one-half. This gives safe loads, corresponding to given lengths, as follows:

Length of Beam.	Proportion of Tabular Load forming Safe Load, or Ratio of Safe Compressive Stress to Safe Tensile Stress.
20 times the flange width	1 whole load
30 times the flange width	9/10 of load, or of tensile stress
40 times the flange width	8/10 of load, or of tensile stress
50 times the flange width	7/10 of load, or of tensile stress
60 times the flange width	6/10 of load, or of tensile stress
70 times the flange width	5/10 of load, or of tensile stress

The same table is given in the Carnegie Steel Co.'s hand-book.

The Cambria Steel Co. gives the following formula,

$$S_c = \frac{18{,}000}{1 + \dfrac{L^2}{3{,}000\,b^2}} \qquad (17)$$

in which S_c = safe compressive stress when the safe tensile stress is 16,000 pounds per square inch. This formula is derived from Gordon's by making an allowance for a factor of safety and taking into account the fact that the compression flange receives some support from the parts in tension. The diagram on data sheet No. 4 is based upon this formula,

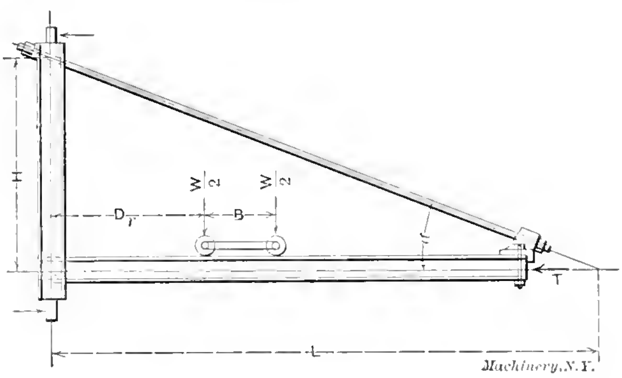


Fig. 3.

which seems more logical than the preceding table, and gives values on the side of safety. The curve giving safe compressive stresses for various ratios of $\frac{L}{b}$ corresponding to 16,000 pounds per square inch tensile stress was laid out from values calculated by the above formula. The curve for the lower allowable tensile stresses were reduced proportionally; thus, for 14,000 pounds tensile stress any value of $S_c = \frac{14{,}000}{16{,}000} = \frac{7}{8}$ of the value for 16,000 tensile stress.

From the foregoing it is seen that when applying formula (13) or (13a) the value of $S + S_c$ should not exceed the safe value of S_c as given by formula (17) and shown by the diagram on data sheet No. 4.

Example.—In a jib crane similar to Fig. 3, $W = 3{,}000$ pounds, $L = 10$ feet 0 inches, = 120 inches, $B = 24$ inches, $H = 60$ inches, the beam being a 6-inch, 12.25-pound I-beam, $Z = 7.3$ and $A = 3.61$ square inches. What is the maximum stress?

Solution.—By formula (14) the value of D_T for maximum stress is

$$D_T = \frac{LZ}{2HA} + \frac{L}{2} - \frac{B}{4} = \frac{120 \times 7.3}{2 \times 60 \times 3.61} + \frac{120}{2} - \frac{24}{4} = 56.023 \text{ ins.}$$

Inserting this value in equation (13),

$$S + S_c = 3000 \times \left(\frac{56\ 023 + \frac{1}{2} \times 24}{60 \times 3.61} + \frac{56.023 \times (120 - 56.023 - \frac{1}{2} \times 24)}{120 \times 7.3} \right)$$

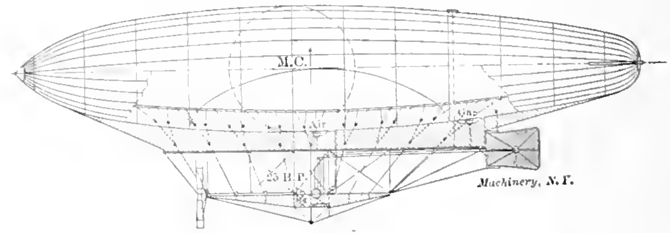
= 10,900 pounds per square inch approximately. This shows ample security until the fact that the compression flange is unsupported is taken into account. This flange is 3.33 inches wide, then $\frac{L}{b} = \frac{120}{3.33} = 36$, and referring to data sheet No. 4 it is seen that for this value of $\frac{L}{b}$ and $S_c = 10{,}900$, the corresponding tensile stress is about 14,000, which shows that there is not the security which at first seemed apparent.

* * *

THE ARRIVAL OF THE FLYING MACHINE AS A COMMERCIAL PRODUCT.

We received the other day what is, so far as we know, the first catalogue of a flying machine manufacturer, building a line of standard machines. We are not quite sure from the information given that the maker carries his product in stock, but the designs are evidently standardized and are adapted to building in large quantities.

The circular referred to is that of Louis Godard, of Saint-Ouen, France. Two examples of flying machines are shown.



"Yacht Aerien de Plaisance et de Tourisme."

One of them is the "1907 Model, Destroyer Type." It is stated that this can attain a speed of from 31 to 34 miles per hour. It has a gas bag 215 feet long and 38 feet maximum diameter, approximating a symmetrical cucumber in shape, though somewhat pointed at the leading end. Two motors of 70 horse-power each drive the two screws, one at the front and the other at the rear of the operator's platform. These motors are said to weigh about 6½ pounds per horse-power. The entire apparatus weighs about 6,150 pounds. With passengers and supplies on board, including fuel for ten hours ("essence for ten hours' march," literally), cooling water, seven passengers in all (a pilot, his assistant, two "mecaniciens" and three "invites") and a supply of food, the total weight is 9,200 pounds.

The other standard machine, of which we show a cut, is called a "Yacht Aerien de Plaisance et de Tourisme,"—which the reader can translate to suit himself. This is considerably smaller, being only about 130 feet long, and with a 30 horse-power motor which is capable of giving the machine a speed of 20 miles per hour, or thereabouts. It is hoped that this will suit the needs of sportsmen and aerostatic amateurs. It is also suited for military use in the instruction of "sky pilots," and in scouting work in colonies and other rough countries.

It begins to look as if the flying machine had arrived.

* * *

According to *Page's Weekly*, some experiments have recently been made on the Egyptian State railways, with regard to the heating of locomotive feed water. It is stated that the use of a heating apparatus for this purpose has effected a saving of 21.4 per cent in the coal consumption. The water is heated by the exhaust steam. It is claimed that the feed water heating apparatus saves its own cost in a year, allowance being made for depreciation.

* * *

A new recently completed mountain railway, built up the Wetterhorn in Switzerland, has a rise of about 1,500 feet in a distance of 2,000 feet, which is a "grade" of 75 per cent. On account of being so steep, the railroad is commonly referred to as the "elevator."

GEAR-CUTTING MACHINERY.—3.

RALPH E. FLANDERS.*

This installment of the series of articles on gear-cutting machinery describes the application of the molding-generating principle to the cutting of spur gears.

In the molding-generating method the processes which have been found most practical are planing or shaping, milling, and to a very limited extent, grinding or abrasion. For spur gears, so far as the writer knows, no use has been made of the impression process; it would be as practicable as in the case of bevel gears, of which an example will be shown in a succeeding issue, but there is no need for trying it. In the shaping process the commercial use of the molding-generating idea is confined largely to one machine, which has found a very extended application. In the milling process, there has been a wonderful development in the past few years, which

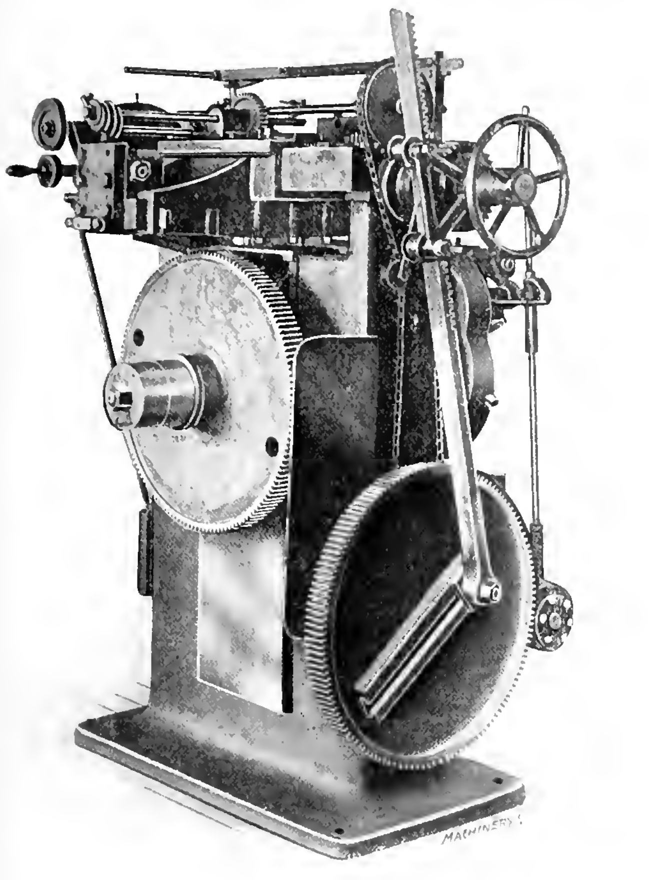


Fig. 48. The Bilgram Automatic Spur Gear Machine, using a Shaper Tool shaped like a Rack Tooth.

is witnessed to by the large number of machines we are able to show involving this operation. But one example can be given of the use of grinding.

Molding-Generating Machines Working by Shaper Action.

In Fig. 48 is shown an automatic spur gear cutting machine made by Hugo Bilgram, Philadelphia, Pa., and in use in his plant. The tool acts as a rack tooth, and generates the gear teeth in accordance with the principle of Fig. 8. Instead, however, of finishing one tooth space complete and then indexing to the next one, the operation is continuous. As has been explained, in the molding process the blank and tool must be rolled on each other as if the former were a gear meshing with a rack, of which the latter represents a tooth. In the Bilgram machine, instead of having this rolling action take place for each tooth, it takes place but once in the completion of the gear. The tool starts in at one side of the blank, being given a motion similar to that given by a shaper. It cuts its first stroke in the work, which is thereupon indexed for the tool to take a second cut in the next tooth. This indexing proceeds with every stroke of the shaper ram so that the teeth are all formed together. Besides the rotation of the blank due to the indexing, there is imposed on this that which we have described as being necessary for the rolling motion. For this, the blank is uniformly rotated, and the ram carrying the tool is fed along sideways to agree with the motion of the imaginary rack. These various movements are all attended to by change gearing. It will be seen that with this machine, as with others of the molding-generating type, but a single tool is needed for a given pitch. This may be used to cut any gear, from the smallest to the largest. This machine

Fig. 49. Detailed View of the Action of the Fellows Gear Shaper; see also Fig. 63.

is unusually interesting in its mechanical movements, and it is unfortunate that we have not the space here to go into its details more thoroughly.

The other machine we show of the molding-generating type involving the shaping process is one widely used, built by the Fellows Gear Shaper Co., of Springfield, Vt.* One of these machines is shown later in Fig. 63, engaged in cutting an internal gear, while in Fig. 49 is a nearer view which shows the action of the cutter in forming the teeth of a long spur pinion. The principle by which it operates is exactly that shown in Fig. 6. The cutter is a gear having the outline of a member of the interchangeable series to which the gear to be cut belongs. It and the blank are rotated together in the proper ratio. The cutter is first fed in to full depth and

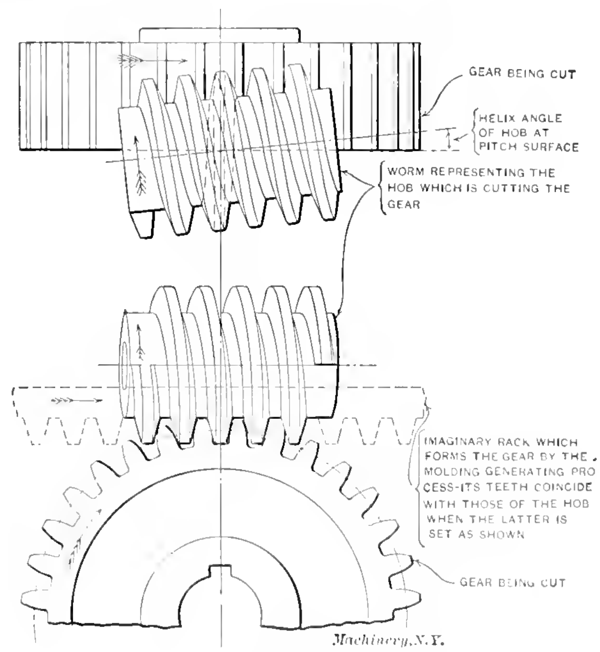


Fig. 50. Diagram illustrating the Principle of the Hobbing Process of Forming Spur Gears.

then the rotation is started and continued until the full periphery of the work has been formed. It is understood, of course, that the cutter is given a vertical shaping movement by the ram to which it is attached. The proper ratio between the cutter and the blank is obtained by change gears set for the number of teeth it is desired to have in the gear. The

* Associate Editor of MACHINERY.

* Previously described in MACHINERY in articles entitled "A Gear Shaper," January, 1898, and "Gear Shaper Improvements," February, 1900.

movements of the machine are automatic, in that when it has been set for the pitch of cutter and number of teeth, the machine will automatically feed itself to depth, stop this feeding and commence the slow rotary movement, continuing this until the work is completed, when the machine will stop. In the case of gears which have to be very accurately cut in refractory materials, provision is made for automatically taking a second cut around at a slightly increased depth, so as to give assurance that the form of the tooth is as true as can be obtained. There are many interesting phenomena connected with this method of gear cutting which cannot be entered into here. A study of it will serve as well as anything we know to introduce a student to the principles underlying the science of providing gears with suitable tooth outlines.

The Molding-Generating Milling or Hobbing Machine.

The most widely used process involving the milling operation of molding-generating is the hobbing process. The principle of this method is shown diagrammatically in Fig. 50. Here we have an imaginary rack meshing with a gear, and molding its teeth in the same way as in Figs. 7 to 10. The teeth of this rack, shown in dotted outline, coincide with the outlines of a hob, shown in full lines, which has been set at such an angle as to make the teeth on its front side parallel with the axis of the gear. In other words, it has been set at the angle of its helix, measured at the pitch line. It will be seen that the teeth of the hob, when set in this position, correspond with the teeth of the rack. If, now, the hob and blank be rotated at the ratio required by the number of threads in the hob and the number of teeth in the gear, this movement will cause the teeth of the hob to travel lengthwise in exactly the same way as the teeth of the imaginary rack would travel, if in mesh with the gear whose teeth are to be cut. It will thus be seen that the hob fulfills the requirements necessary for molding the teeth of the gear to the proper form. In practice the hob is rotated in the required ratio with the work, and fed gradually through it from one side of the face to the other. When it has passed through once, the work is completed.

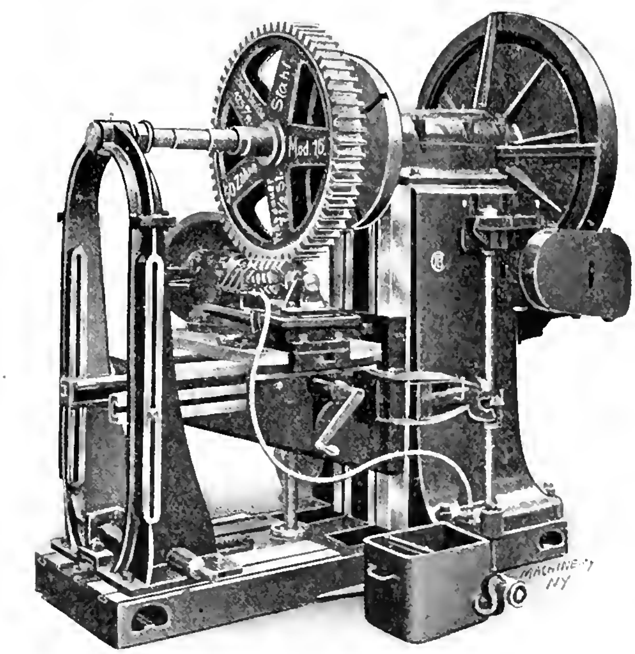


Fig. 51. The Reinecker Spur Gear Hobbing Machine.

Of the great number of machines built during the past few years involving this principle, many are arranged for cutting spiral gears as well as spur gears. In describing these tools part of them have been classed as spur gear cutting machines, while the remainder will be found under machinery for cutting spiral gears. Of course, all of the machines in the latter division are capable of cutting spur gears also, and in referring to machines for cutting spur gears they should be classed with those described in the following paragraphs. Some of the machines illustrated in Figs. 51 to 57 can be used for cutting spiral gears as well, but have been described in this section because the engravings we have at our disposal show them arranged for cutting spur gears.

The spiral gear-hobbing machine bears about the same relation to the plain spur gear hobbing machine that the universal does to the plain milling machine. The added adjustments and mechanism required in each case tend to somewhat limit the capacity of the machine in taking heavy cuts,

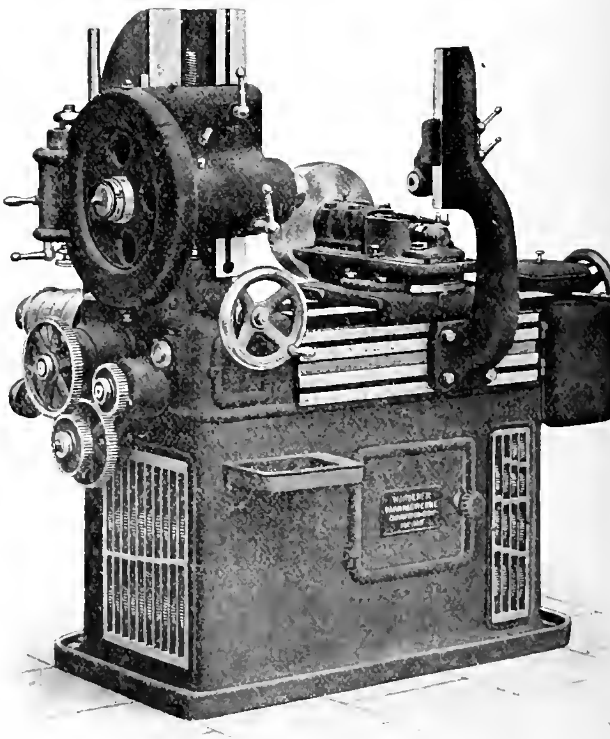


Fig. 52. The Wanderer Spur Gear Hobbing Machine.

though they add to its usefulness by extending the range of work it is capable of performing. The requirements of the successful gear hobbing machine are:

First. A frame and mechanism of great rigidity.

Second. Durable and powerful driving mechanism.

Third. Accurate indexing mechanism.

The first requirement is one of great importance, not only in its influence on the heaviness of the cut to be taken and the consequent output of work, but on the matter of accuracy as well. The connection between the hob and the work, through the shafts and gearing, is liable to be so complicated that the irregular cutting action of the hob produces torsional deflections in the connecting parts, leading to serious displacement from the desired relation between the hob and the teeth being cut. This displacement from the desired position results in teeth of inaccurate shape, weak and noisy at high speeds.

In its effect on the output, rigidity is even more important in the hobbing machine than in the orthodox automatic gear cutter. A heavier cut is taken, since a greater number of teeth are cutting on the work at once. The number of joints between the cutter and the work-supporting table and spindle, must therefore be reduced to a minimum, and the matter of overhang both for the work and the cutter must be carefully looked out for. The reduction of overhang is hampered at the cutter head by the necessity for a strong drive and an angular adjustment. In the case of the work-supporting parts, it is difficult to bring the cutting point close to the bearing on account of the necessity for plenty of clearance below the work for the hob and its driving gear to run out into.

The matter of design of the driving mechanism for the hob and the work is a difficult one. Not only must it be rigid for the sake of accuracy, as previously explained, but careful attention must be given to durability as well. It requires great skill to design a durable mechanism for the purpose within the limitations imposed—in the cutter head by the

necessity for reducing the overhang, and in the work table by the high speed required for cutting small gears.

Since the indexing wheel works constantly and under considerable load, it and the worm must be built of such materials as will preserve their accuracy after long continued use. Particular attention should be given to the homogeneity of the material of the index worm-wheel, to make sure that it does not wear faster on one side than on the other.

The field of the hobbing process for cutting spur gears has not yet been definitely determined. In some work it appears to have certain advantages over the usual type of automatic gear-cutting machine, while in other cases it falls behind. It will doubtless require continued use, with a variety of work, and for a considerable length of time, to determine just what cases are best suited for the hobbing machine, and what for the machine with the rotating disk cutter. It is not probable that in the future either of them will occupy the field to the exclusion of the other.

Examples of Spur Gear Hobbing Machines.

The first gear hobbing machine we show (see Fig. 51), is built by J. E. Reinecker of Chemnitz-Gablenz, Germany. This builder was one of the first to make a commercial success of the hobbing process, having applied it several years ago in his "Universal" gear-cutting machine. The tool we show is a specialized form of that universal machine, adapted particularly to the hobbing of spur gears. As may be seen, in form the machine is derived from the standard milling machine, bearing about the same relation to it that the Becker-Brainard gear-cutter in Fig. 20 does. The spindle is mounted on what corresponds to the carriage of the milling machine, which may be swiveled so as to bring the teeth of the hob on the upper surface parallel to the work spindle. The spindle is driven by an internal gear of large diameter. The work spindle is driven from the rear of the column by the index worm-wheel, which is connected with the cutter spindle through change gears (shown at the left of the picture) and the splined shafts and bevel gear connections. The knee of the machine having been raised so that the cutter is set at the proper height to cut teeth of the desired depth, and

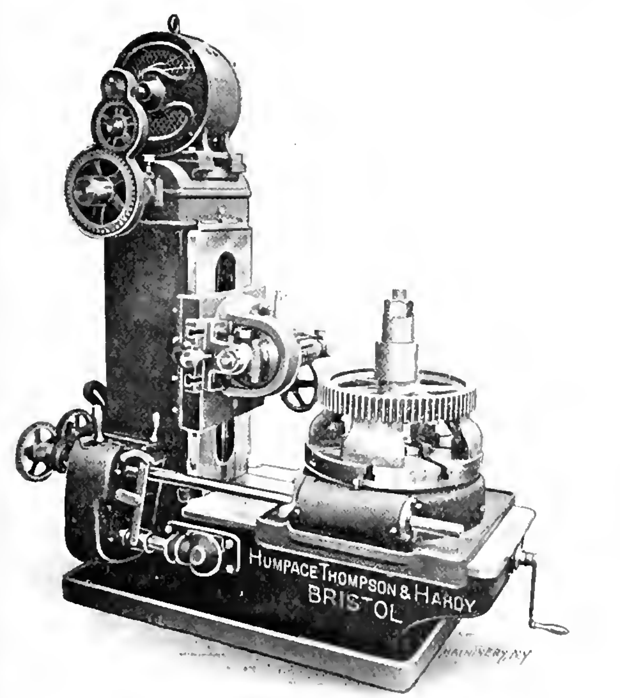


Fig. 53. An Electrically-driven Gear Hobbing Machine built by Humpage, Thompson & Hardy.

the machine being started, with hob and gear blank rotating in the proper ratio, the table with the hob is fed in along the knee toward the column of the machine, cutting the teeth in the wheel as it does so, the operation being completed when the hob has made one pass through the work. It will be noted that the work arbor, the knee and the base of the machine are all very firmly tied together by a rigid brace, which may be adjusted to suit different conditions of diameter and length of work.

Another machine, built by the Wanderer Works, formerly Winklhofer & Jaenicke, Ltd., Schoenau, near Chemnitz, Germany, is shown in Fig. 52. It is of the same type, so far as the frame work is concerned, as a regular automatic machine, it being almost identical in its lines with those shown in Figs. 21 to 28, inclusive. The differences in mechanism, of course, are those due to the necessity for connecting the work spindle and the cutter by change gearing to give the proper ratio, and for setting the spindle, as well, at the proper angle to agree

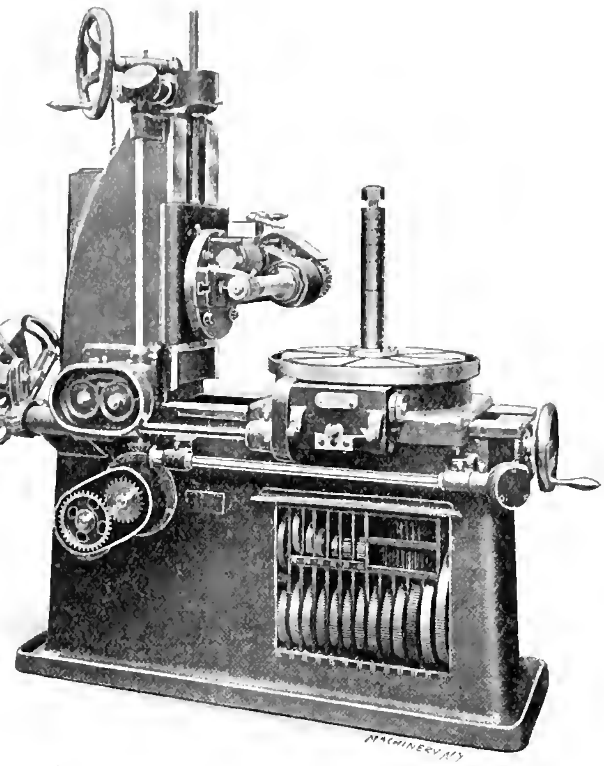


Fig. 54. The "Rhenania" or "Burton" Spur Gear Hobbing Machine.

with the helix angle of the hob. The feed, also, is continuously forward until the work is completed, instead of having a quick return for each tooth cut. It is readily seen that this rearrangement means, on the whole, a somewhat simpler machine in the case of the hobbing machine than for the automatic gear-cutter, particularly since intermittent indexing is avoided. The cutter spindle is driven by an internal gear of large diameter.

The orthodox type of spur gear hobbing machine differs from the examples we have just described in the position of the spindles. In this case the cutter spindle is mounted in a slide on the column, while the work is carried on the bed, being adjusted in or out on it according to its diameter. In its general arrangement it bears a strong resemblance to the standard type of formed cutter machine for heavy work as illustrated in Figs. 30 to 36.

In Fig. 53 is the first example we show of this type, a machine built by Humpage, Thompson & Hardy, of Bristol, England. It appears to be of unusually heavy construction. The machine as shown is entirely self-contained, a motor being mounted on top of the column. It can be made either motor or belt driven without other alteration than the removal of the motor and gears and the substitution of a pulley, or *vice versa*. The drive is of the constant speed type, the speed changes being obtained through gearing, running constantly in a bath of oil. The machine is provided with an unusually ingenious feed mechanism. A pair of taper pulleys, carrying a light belt, is used as a primary means of changing the feed. This operates, however, through the medium of an epicyclic gear arrangement through which most of the strain of transmission is taken. The cutter slide is over-balanced, so that it has to be fed against the pull of the counterweight, thus taking up all back lash.

The manufacturers call attention to the results of tests made on their machines; $2\frac{1}{2}$-pitch gears in cast iron have been cut at the rate of 4 inches of tooth length per minute; 3-pitch gears of the same material at 5.9 inches per minute,

while the same style teeth in mild steel have been cut at 4 inches per minute. The size shown will cut work 23 inches in diameter by 13½ inches face.

The machine shown in Fig. 54 is sold on the continent by Alfred Schütte, and there known as the "Rhenania." In England it is sold by Burton Griffiths & Co. and called the "Burton." This is one of the machines which can be furnished for cutting spiral gears if desired, though in the form

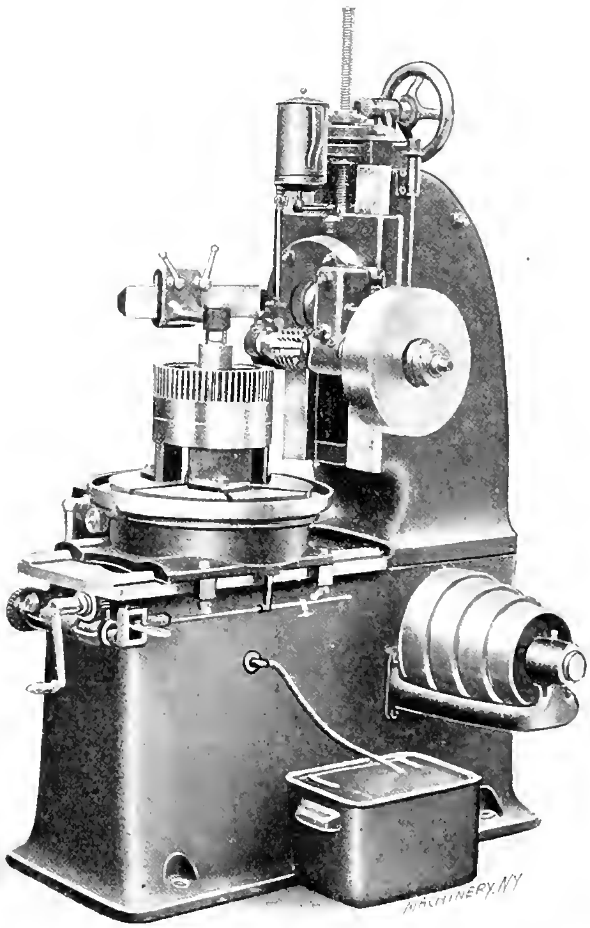


Fig 55. A Continental Gear Hobbing Machine, sold by Selig, Sonnenthal & Co.

shown it is adapted for spur gears only. The spindle of this machine is driven somewhat differently from the previous ones shown. A worm connected at its inner end by bevel gears to the vertical power transmission shaft, and located on the axis of the angular adjustment, drives a worm-wheel on the short shaft mounted above and to the rear of the cutter. Spur gears connect this short shaft with the spindle. This arrangement reduces the overhang of the cutter slide. The work table may be revolved freely in setting the work by withdrawing the index worm, this being mounted on a dove-tail slide, which is withdrawn or inserted again by operating the square head collar screw shown. Adjustable stops limiting this motion determine its adjustment, which may be altered to compensate for wear. The worm is of hardened steel, ground all over after hardening. The work spindle may be supported, when necessary, by a stiff outboard bearing on an arm which is fastened to the back of the table and the back of the bed, tying the work, work table and bed rigidly together.

Another machine of German origin, made by the Schubert & Salzer Maschinenfabrik, of Chemnitz, and sold by Selig, Sonnenthal & Co., of London, England, is shown in Fig. 55. This machine, like the one shown in Fig. 52, has the spindle driven by an internal gear. To allow this to be made of unusually large diameter and still bring the hob as close to the face of the column as possible, so as to give a rigid construction, the hob is carried below the axis around which the swiveled head is adjusted, instead of centrally with it, as is usually the case. This limits the adjustment to the comparatively slight angle required for spur gears, but it would seem to greatly increase the stiffness of the construction and the power of the drive. As may be seen, the outboard support for the work arbor is of unusual design, consisting of an arm bolted to the side of the column, carrying a slide which may be adjusted in or out to suit the position of the work table.

The machine shown in Fig. 56 is built by Henry Wallwork & Co., Ltd., Manchester, England, and sold by Alfred Herbert, Ltd., Coventry, England. A number of interesting features will be noted in this machine. The spindle drive, for instance, is unusual. A train of spur gears connects the shaft on the axis of the swiveling adjustment with a short vertical shaft which drives the cutter arbor by worm or spiral gearing. The work support consists of a triangular arm supported by two vertical posts, the outer end of the arm having a bushing for the work arbor. One of the vertical posts is longer than the other, and the arm may be raised from the shorter one and swiveled about the longer one when removing or replacing the work. Since this support always travels with the table it does not have to be adjusted when adjustments are made in the position of the latter. The table has a large annular bearing, with an extended shank having a tail bearing fitted with lock nuts to prevent lifting. The chip pan is solid with the slide and does not rotate with the table as in some of the other machines.

The machine shown in Fig. 57 (Sir W. G. Armstrong, Whitworth & Co., Ltd., Manchester, England,) belongs with the machines just described, but is differentiated from them by the fact that the column carrying the spindle is adjusted on the bed for the diameter of the work, instead of having the work table adjustable. In this respect it resembles the gear cutter shown in Figs. 37, 38 and 39. Since the work spindle is stationary, the index wheel is placed below the bed. The spindle drive is through spur and bevel gears from the vertical shaft alongside the column. This machine is so large that special provision is made for handling most of the movements, there being a power elevating device for the spindle head, and a power traverse of the head on the bed. As shown, also, the spindle head is swiveled by a worm meshing with worm-wheel teeth cut on a portion of the periphery of the sector.

An ingenious hobbing machine built a number of years ago by Warner & Swasey Co., Cleveland, Ohio, has been illustrated in our columns.* Instead of using a worm-shaped hob, the hob was formed with parallel circular teeth, but made in two halves which were shifted endwise with relation to each other by a cam mechanism. This split hob and the blank were geared together in the proper ratio and rotated together

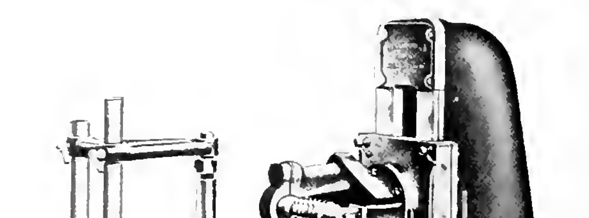


Fig. 56. The Wallwork Gear Hobbing Machine.

the same as in other hobbing machines. The half of the hob which was cutting was fed forward axially to correspond with the rack movement required by the rotation of this blank. When that half had left the cut, it was brought back by a cam movement, ready to start in again on its forward

* See article entitled "American Gear Cutting Machinery" in the June, 1898, issue of MACHINERY.

axial movement as soon as it again reached the cutting position. The other half of the hob was similarly controlled, the parts thus sliding in and out with each other alternately.

As previously explained, this list does not include all the machines of the hobbing type adapted to cutting spur gears. Those described under the heading of spiral gear cutting machines, found in a succeeding installment of this article, include examples by the following makers: Biernatzki & Co., Chemnitz, Germany; Gould & Eberhardt, Newark, N. J.; Grant Lees Machine Co., Cleveland, Ohio; John Holroyd & Co., Milnrow, England; Maschinenfabrik Lorenz, Ettlingen, Germany; Newton Machine Tool Works, Philadelphia, Pa., and Schuchardt & Schutte, Cologne, Germany. It will be seen that this list is quite an imposing one, including fourteen manufacturers of machines of this type. With the exception of the Reinecker machine, which dates from an earlier time, all of these were designed within the past few years, most of them to meet the demand for gear-cutting machinery created by the automobile trade.

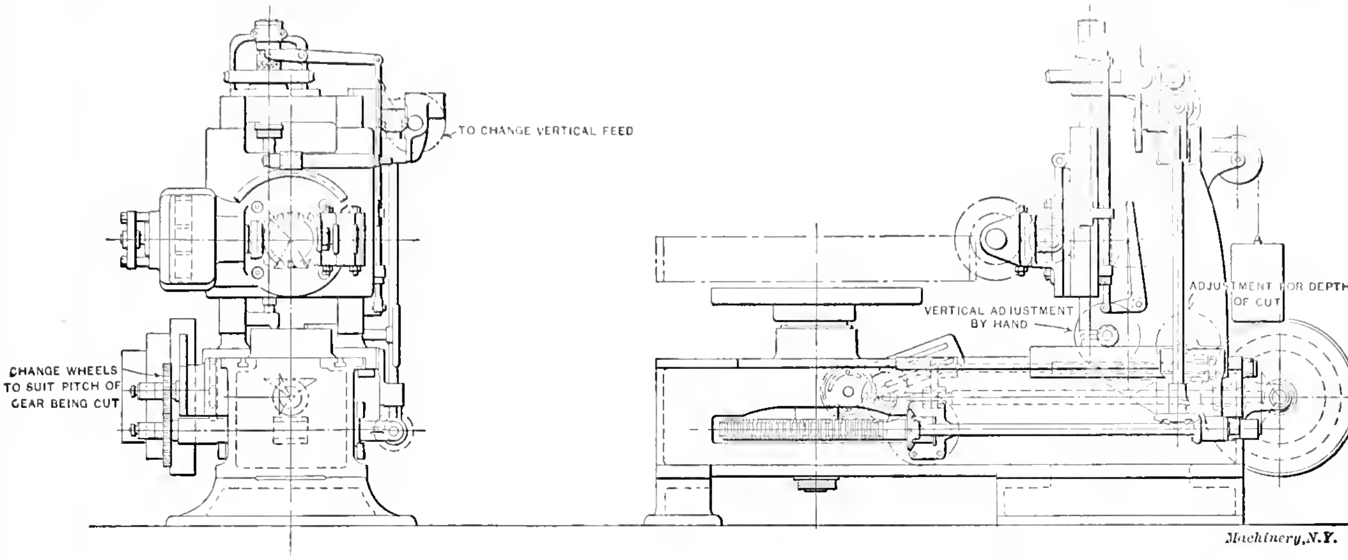


Fig. 57. Armstrong Whitworth & Co.'s 6-foot Hobbing Machine, with Column adjustable for Diameter.

The Grinding or Abrasion Operation, applied to the Molding-Generating Process.

One application of the molding-generating process involving the grinding operation, uses the rack tooth principle in a manner exactly identical with that shown in Fig. 10, in forming the cutters used with the Fellows system of gear tooth shaping. A special machine is provided, carrying an emery wheel with a plane face which can be constantly kept straight by means of a diamond truing device incorporated in the machine itself. The hardened gear-cutter, which has been cut to leave but a few thousandths of metal to finish on the sides of the teeth, is placed in the machine and rolled past the face of the emery wheel under the restraint of metallic tapes in a way that is identical with that shown in Fig. 10.

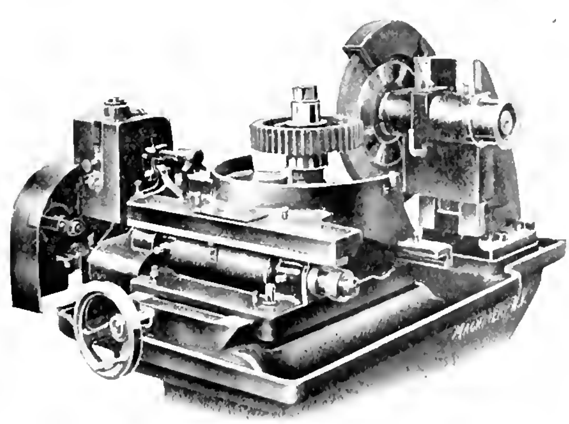


Fig. 58. Another View of the Machine shown in Fig. 59.

An application of this principle to the finishing of the teeth of hardened gears is shown in Figs. 58 and 59. This machine trues the teeth of hardened gears used in automobile construction. The principle of its action is also the same as in Fig. 10, though carried out in a somewhat different way than in the case of the Fellows cutter grinding machine just mentioned. In this case, the emery wheel has its outline beveled to the shape of the rack tooth, using for this purpose both sides of the wheel, which has an outline more nearly resembling the shaper tool T_1 in Fig. 8, than the grinding wheel of Fig. 10. Attachments permanently set to the proper angle (14½, 15 degrees or any other angle desired) are provided, by means of which the operator can almost instantly bring the wheel to the proper shape whenever it shows signs of losing it. The emery wheel has a continuous vertical reciprocating movement, great enough to cover the whole face of the wheel. It will be seen that it is thus made to cover the whole surface of the rack tooth which it represents in the molding-generating process.

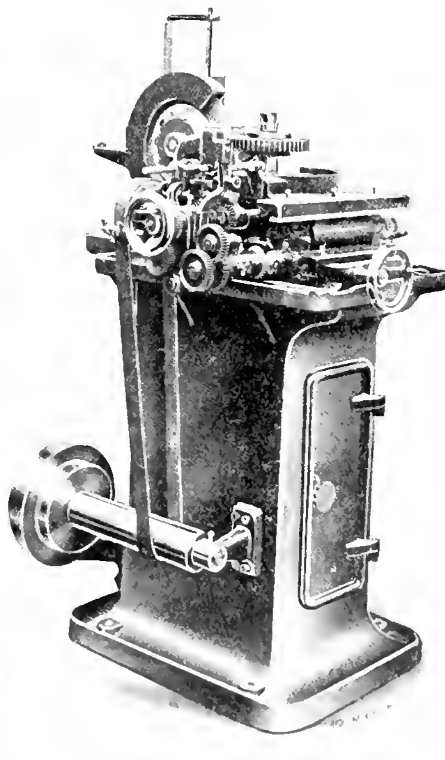


Fig. 59. A Machine for Grinding the Teeth of Gears to Accurate Shape after Hardening.

The hardened gear to be operated on, previously cut to leave a few thousandths for finishing, is mounted on the vertical work arbor on the table as shown. By suitable change gears and controlling mechanism, this slide is made to travel across the face of the wheel while the work is rotated at the same time, in such a ratio as to give the identical movement that would result from rolling the wheel on the imaginary rack, a tooth of which is represented by the outline of the emery wheel. The work starts in at one side of the wheel, out of contact with it, rolls into it until the grinding wheel is in action, passes by to the further side, and returns to its first position, thus finishing one tooth space to proper form. An automatic indexing mechanism (adjustable for any number of teeth within 12 and 60 inclusive) then indexes the wheel one space, and it again rolls along the front of the emery wheel and returns, thus finishing another tooth space.

This operation is repeated automatically until the whole gear has been ground to perfect form. The diameter of the wheel used is 12 inches. The maximum diameter of gear which can be finished is $11\frac{3}{4}$ inches with a 2-inch face.

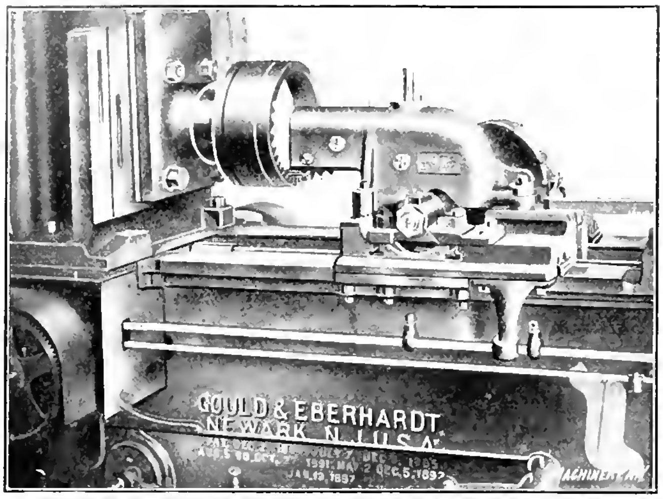


Fig. 60. Attachment to the Gould & Eberhardt Gear-cutter for Cutting Internal Gears.

This machine, which is built by J. E. Reinecker of Chemnitz-Gablenz, Germany, is sold by E. Chouanard, 3 Rue Saint-Denis, Paris, and by C. W. Burton, Griffiths & Co., Ludgate Square, London.

Machines and Attachments for Cutting Internal Gears.

As has been stated, the internal gear is akin to the spur gear, and the machinery for cutting it acts on practically the same principles, except as limitations are imposed by the concavity of the surface in which the teeth are cut, as compared with the convex shape of external gearing. As before, the formed tool method is the most obvious and the most commonly used. The teeth may be cut by a shaper tool with a projecting head, formed somewhat after the fashion of the tools used for cutting keyways in the hubs of pulleys, etc., the work being mounted on the face-plate of an indexing fixture on the table of the shaper, slotter or planer. We have * described a further development of this idea, in which the work was fastened on a face-plate on the spindle of an ordinary automatic gear-cutting machine while the shaping tool was operated by a shaper bodily lifted to a position on the bed of the gear-cutter, and clamped in place there. In such cases the movements are, of course, largely controlled by hand, the tool-holder being fed down into the work.

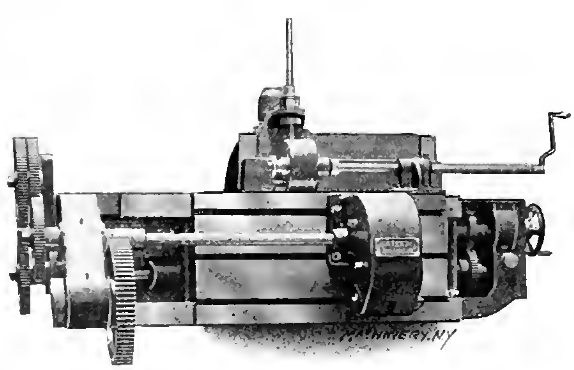


Fig. 61. The Atlas Machine as arranged for Cutting Internal Gears; compare with Fig. 34.

Most machines for internal gears use the formed milling cutter to shape the teeth. A common method of using this process employs an attachment to the regular automatic spur gear cutting machine, carrying the cutter on a projecting arm, adapted to enter the internal gear and work on its inner periphery. An example of this is seen in Fig. 60, which shows the attachment provided by Gould & Eberhardt, of Newark, N. J., for cutting internal gears on their regular spur gear cutting machine. The cutter is driven by a train of spur gears from a driving gear on the regular cutter arbor. The pivots of these gears are shown by the projecting ends of the studs on which they run. While this arrangement furnishes a practical and much-used means for cutting internal gears, it is evident, of course, that it is not possible to take quite so heavy cuts as when cutting spur gears, on account of the indirectness of the means by which the cutter is driven, and the necessarily small diameter of the gear from which it receives its motion.

An attachment of a very similar kind, modified to suit the changed design of the machine, is shown in Fig. 61. This is the Atlas gear-cutter shown in Fig. 34. As may be seen, the attachment is bolted to the face of the cross rail, and is fed down into the work in the same way that the attachment in Fig. 60 is fed forward into it. Other manufacturers make similar devices for use with their machinery.

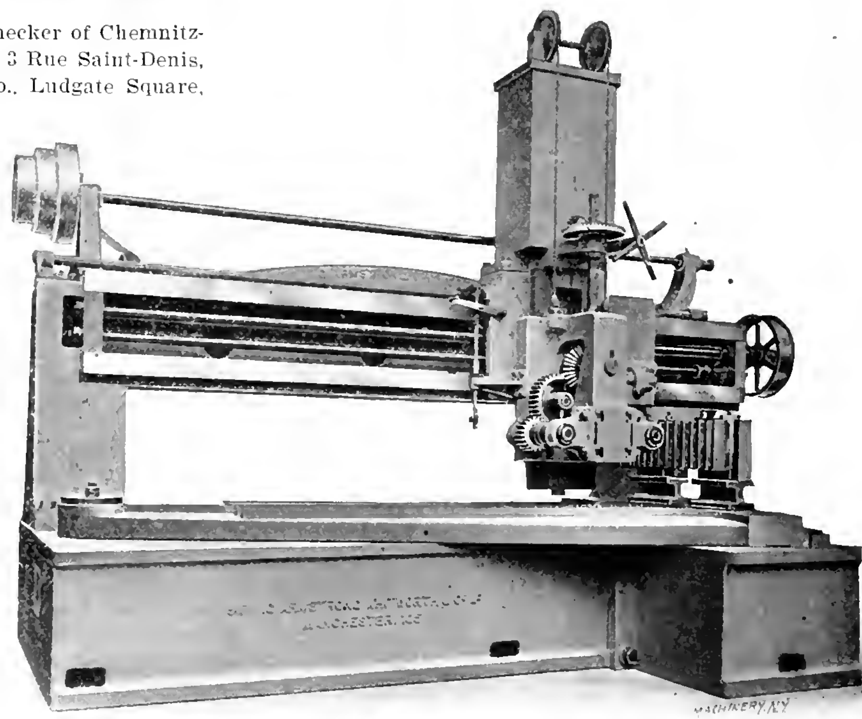


Fig. 62. Armstrong Whitworth Machine for Cutting Internal or External Teeth in Segments of Large Diameter.

In Fig. 62 is shown a machine of great capacity, arranged for the cutting of both internal and external spur gear segments. As posed, it is cutting internal teeth. The work is mounted on a sector pivoted at the left hand end of the bed, and having gear teeth cut in its periphery, by which it is indexed. The work is clamped to this sector at the proper distance from the pivot to give the radius desired. The cutter slide operates on vertical ways on a carriage carried by the cross rail. Two cutter spindles are provided, one on the right and the other on the left hand side of the cutter head, one being used for internal and the other for external gears. The movement is brought to the spindles through a train of spur and bevel gears as shown. This machine, which was designed primarily for dealing with gear segments for gun mountings, will cut teeth in segments having an extreme radius of 13 feet, and a face of 12 inches. It is automatic in all its movements, including the dividing mechanism. Sir W. G. Armstrong, Whitworth & Co., of Manchester, England, are the builders.

The Fellows system of gear cutting, previously described on page 429, is perhaps the most striking method of cutting internal gear teeth. The machine shown in Fig. 63 is forming the teeth in an internal gear. The process, which belongs

* See article entitled "Emergency Methods in Gear Cutting" in the November, 1907, issue of MACHINERY.

to the molding-generating order, is exactly identical to that employed for external spur gears, the cutter and work being geared to rotate together in the proper ratio. It has a number of advantages over the formed cutter method. It does not require the exaggerated clearance at the bottom which the rotary cutter needs for running out into. The cutting tool

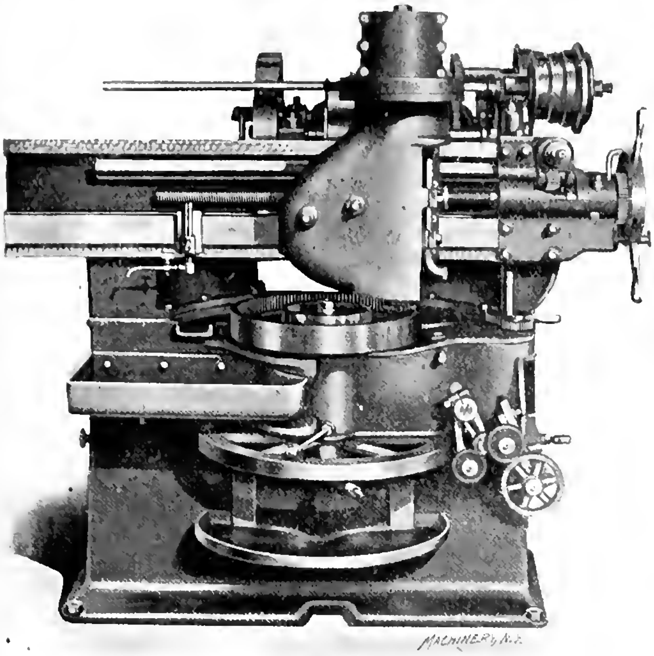


Fig. 63. The Fellows 36-inch Gear Shaper at Work on an Internal Gear.

works to as good advantage as when cutting external gears. No change in the machine is necessary, and special cutters are not required, the same tool being used as in cutting an internal gear of the same pitch. The ease with which internal gears may be cut with this machine, and the fact that it is quite generally used for this work, have encouraged the use of internal gearing in the past few years for cases in which it is better fitted than external spur gearing, but where the difficulty of making it would formerly have barred its use.

The odontographic and describing-generating methods are as limited in their application to internal gearing as to ex-

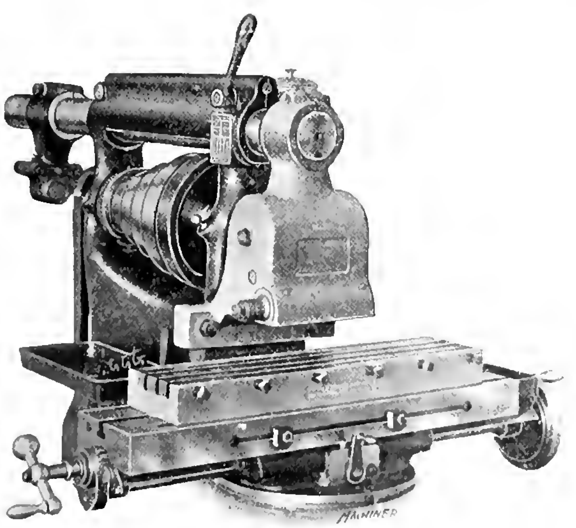


Fig. 64. The Rack-cutting Attachment used with the Brown & Sharpe Milling Machine.

ternal gearing. The grinding or abrasion, and impression operations, also, are seldom, if ever, applied to the cutting of internal gears.

Rack-cutting Attachments to Standard Machines.

As was the case with internal gearing, the formed tool method is that most largely used for cutting racks. The primitive means consists in clamping the work on the table of the planer or shaper, and cutting the tooth spaces with a properly shaped tool in the regular tool-post of the machine. After each space has been cut, the tool-post is moved along the proper distance to bring it in position for a new space—or, in the case of the shaper, the work table is shifted the same amount for the same purpose. A new tooth space is then formed as before, and the operation is repeated until the work is done. In making the measurements for the amount by which to shift the relative position of the work and the tool for each cut, various means may be used. A stop may be provided, set ahead of the previous position by an amount determined by a gage of a thickness equal to the circular pitch of the tooth being cut. After the adjustment has been made for a new tooth, it may again be located in position for the next cut by setting to the proper distance away, as determined by the thickness of the gage. If the screw by which this adjustment is made is provided with a dial reading to thousandths, this may be used. One way is to set the dial carefully to zero before making each setting; then operate the screw to move the slide the proper amount in thousandths of an inch as determined by the circular pitch of the tooth being cut. The dial may then be brought back to zero, repeating the operation when the next adjustment is to be made.

More elaborate means of indexing are provided for special rack-cutting machines. The arrangement generally used is identical with that shown in Fig. 16 as applied to the spur gear cutting machine, excepting that the index worm and

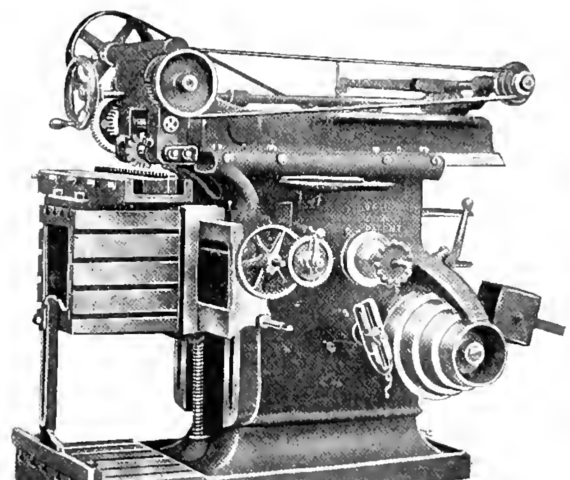


Fig. 65. The Gould & Eberhardt Shaper with Attachment for Cutting Racks.

index wheel are replaced by a lead-screw and nut, which serve to give a longitudinal movement to the work table in the same way that the rotary movement is given to the work spindle of the gear-cutting machine. This longitudinal movement equals the circular pitch, of course, and is obtained by using appropriate change gears between the one-revolution shaft and the lead-screw.

In Fig. 64 is shown an attachment for the milling machine used for cutting racks. This device, which is applied to the Brown & Sharpe milling machines, consists simply of a holder clamped to the front of the column and the overhanging arm, and carrying a short cutter spindle at right angles and below the main spindle of the machine. This is connected to the main spindle by suitable gearing. On the projecting end of it a formed cutter of ordinary construction is fastened. The vise shown in the cut is provided for holding the work. The work may be indexed by using the graduated dial as explained, or by making use of a change gear attachment furnished by the makers, operating on the principle described in the preceding paragraph.

Rack-cutting attachments are also made to apply to the shaper as well as to the milling machine. An example of one made by Gould & Eberhardt, Newark, N. J., is shown in Fig. 65. The regular swiveling tool head has been removed from the ram, and its place is taken by a casting carrying a cutter

arbor, and the necessary gearing and other mechanism for driving it. In addition to this, the ram is provided with attachments for giving a gradual forward screw feed for advancing the cutter through the work, in place of the usual reciprocating movement, which is disconnected when the machine is used in this way. A suitable vise for the work is clamped on the work table, and an indexing arrangement involving the use of change gears is provided for shifting the table from one cut to another.

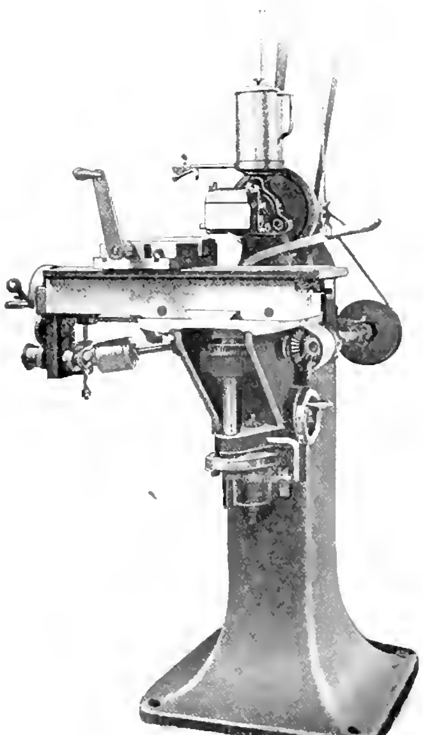


Fig. 66. The Sloan & Chace Rack-cutter for Small Work.

Rack-cutting Machines.

Most commercial rack-cutting machines in their structural design are developments of the milling machine idea. The automatic rack-cutter for small size and accurate work, shown in Fig. 66, is an example of this type. This tool is built by Sloan & Chace Mfg. Co., of Newark, N. J.* Its resemblance to the milling machine and attachment shown in Fig. 64 is obvious. It is automatic in all its movements, which are mostly cam-operated, as is usual in gear-cutting machinery of the precision type built by manufacturers of watch and clock-making machinery.

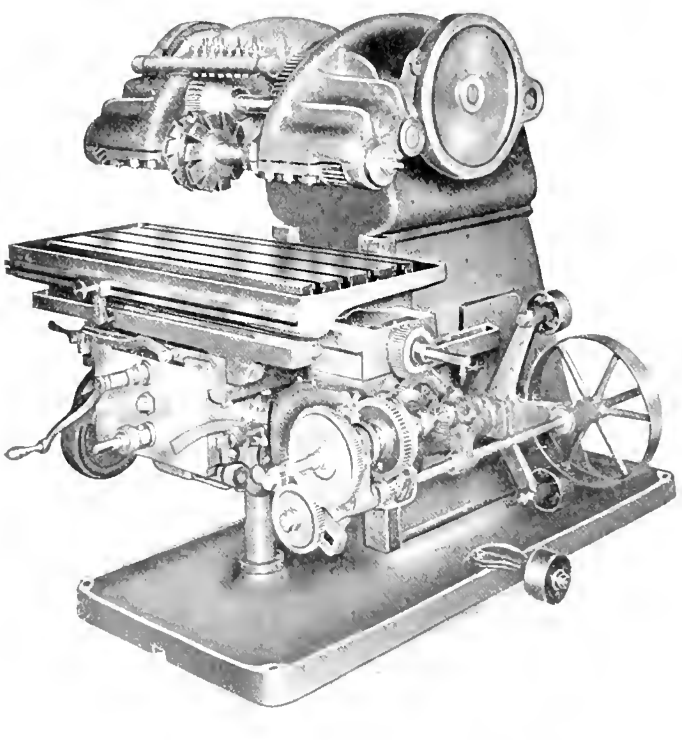


Fig. 67. The Walcott & Wood Automatic Rack-cutter.

Another machine of this kind is built by Walcott & Wood Machine Tool Co., Jackson, Mich.,† (Fig. 67). This machine, as may be seen, involves the same structural features as the preceding one, but is built for much larger and heavier work. Its movements are obtained by screws and gear-driven mechanisms, instead of by cam movements. As shown, the cutter spindle is driven by gearing on each side, the main drive on the left being by herring-bone gears. This tends to give a smoothness of action which the necessarily small diameter of the driving pinion would otherwise make impossible. The cutter arbor is driven by a tongued connection from each end. It is held in position by two bolts passing through the driving spindles at each side, which, when tightened together, make driving spindles and cutter arbor practically a solid piece, giving a very powerful support. There being 10 inches of cutter space on the arbor, it is well adapted to the use of gang or multiple cutters. Provision is made for this in the gearing, there being two sets of change gears, one of them set for the pitch in the ordinary way, while the other is set for the number of teeth it is desired to index at once. All of the gears shown are provided with guards, which have been removed in taking the photograph so that the drive may be more easily understood. A feature of this machine and the previous one is the automatic mechanism provided for throwing off the counter-shaft belt shifter when the required number of teeth has been cut.

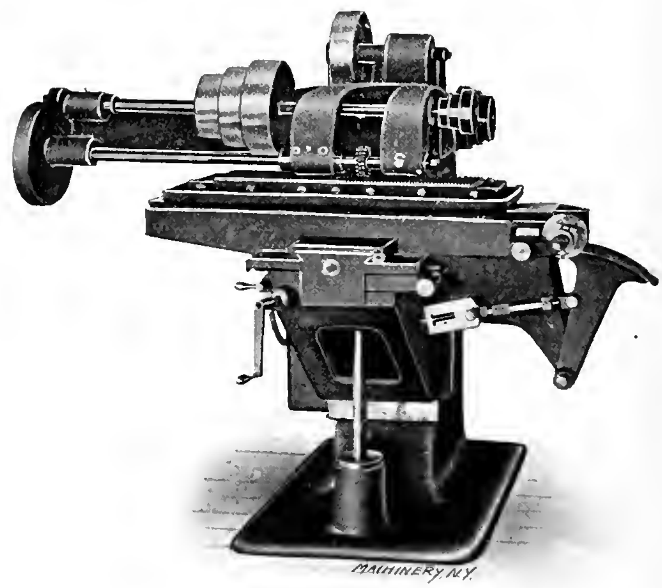


Fig. 68. The Machine built by Warner & Swasey Co., to overcome the Driving Difficulty.

In the machine shown in Fig. 68, formerly built by Warner & Swasey Co., of Cleveland, Ohio, the difficulty in the driving of the cutter spindle has been ingeniously overcome. The cutter spindle has been extended to great length at the left side of the machine, where it is driven by a gear of as large diameter as is necessary to give it a powerful, yet smooth and even movement. Of course the capacity of the machine for cutting racks is limited to the length from the cutter to the face of the driving gear. This is beyond the extreme indexing range of the table any way, but the possible range may be doubled by cutting half the rack, and then reversing it so that the overhang of the work is at the right end of the table. The efficacy of this method of driving the spindle in avoiding some of the difficulties inherent in the rack-cutter, may be vouched for from the fact that the idea in a modified form has been applied to all the rack-cutters of various types in the plant of one of the largest firms making a special business of cutting gear teeth.

Another point of interest is the indexing movement, which differs somewhat from that previously described. A slotted crank on the front of the bed is given one complete revolution for indexing. This crank operates the sector shown at the left of the table. This sector has teeth on its periphery, meshing with a ratchet gear by which the indexing lead-screw is driven. The setting of the crank-pin in the slotted crank at various positions determines the arc through which the toothed sector swings, and determines, in consequence, the amount of movement given by the ratchet to the lead-screw, thus determining the circular pitch of the rack.

* See "Machinery and Tools" in the January, 1907, issue of MACHINERY.
† See "Machinery and Tools" in the September, 1906, issue of MACHINERY.

JIGS AND FIXTURES IN THE PRATT & WHITNEY CO.'S SHOPS.

There are three distinct reasons for the use of jigs and fixtures in the manufacture of machinery. In the first place, jigs and fixtures are employed for reducing the cost of the article manufactured; in the second place, a higher degree of accuracy is attained; and in the third, the interchangeability of the parts manufactured is effected. One of the first firms in this country to realize the importance of these points and to use tools for interchangeable manufacture on a large scale was the Pratt & Whitney Co., which, in the late seventies and early eighties, was one of the pioneers of modern machine tool construction in this country, and which then commenced to introduce the application of jigs and fixtures in a degree previously unheard of. Since these early days of machine tool construction, the company has adhered to its policy of using special tools in the greatest possible degree, and many of the appliances designed and used are both elaborate and costly, but, as they serve the three objects mentioned above, the tendency is constantly toward more tools and more efficient devices.

Hardly any operation of consequence in the shops of this company is performed without the use of some special tool or fixture, whenever time or accuracy can be gained by the use of such appliances, and many of the tools used are so ingenious and complete in their design as to classify them rather as special machines than as jigs or fixtures. In the following, a few of the tools used in the Pratt & Whitney Co.'s shops, are described and shown. Some of the tools will be found to have a direct bearing on nearly any kind of machine construction, while others will have at least a great deal of suggestive value, and indicate the lines along which similar tools for kindred operations may be designed.

As is well known to almost every mechanic, one of the standard products of the Pratt & Whitney Co. is turret lathes, of which several sizes are built. In the half-tone, Fig. 1, the bed of one of these turret lathes is shown in position on a horizontal boring machine, to bore the spindle bearings. As will be noticed, the head and bed are cast integral. The fixture, which is shown clamped to the table of the boring machine and which holds the bed while the bearings are being bored, clamps the work by means of pneumatic pressure. The general design of this fixture is shown in the line illustration, Fig. 2, the only difference between the fixtures in Figs. 1 and 2 being that in Fig. 2 a fixture is shown which is used for turret lathes having back gearing, while the fixture shown in Fig. 1 is for one of the smaller sizes, not provided with back-gears. Referring to Fig. 2, the work is held down by four clamps A continuing down through the body of the fixture to an equalizing lever B, which is connected to a piston C actuated by air pressure. The required movement of this piston and of the clamps A is very small, because the ways of the bed are finished before being placed on this fixture, and consequently there is no need of allowance for variation. The air for the cylinder in which piston C moves is supplied through the pipe D. There are two sets of clamps, one at the front and one at the back end of the bed, both being supplied from the same main pipe as is plainly shown in the half-tone, Fig. 1, the clamping being effected by simply turning the handle on the air valve P.

In order to place the bed casting in position before clamping, the beveled surface E, Fig. 2, on the fixture, is planed to the same angle as the ways of the bed, and the bed is forced up against this bearing surface by means of two clamps F, previous to applying the air pressure. Springs G, of which one is shown in the end view of Fig. 2, serve the purpose of lifting the clamps from the work, as soon as the

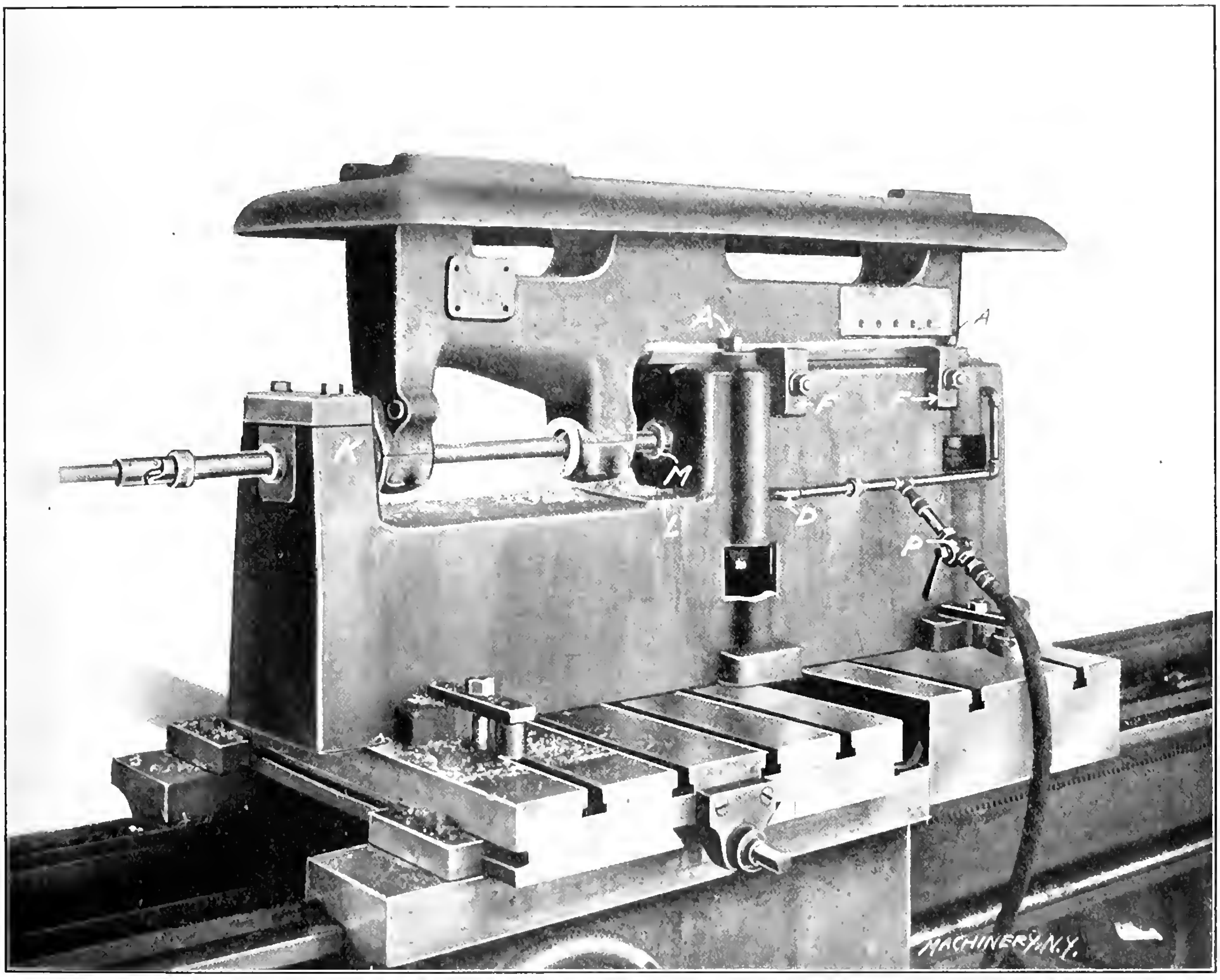


Fig. 1. Boring Fixture for Turret Lathes, with Pneumatic Clamping Arrangement.

air pressure on the piston is relieved, and the clamps can then be swung aside so as not to interfere with lifting the casting out of place, or the placing of a new casting in position.

The general construction of this fixture is also rather interesting. At *H* is shown a supplementary projection or lug, which is removed as soon as the holes in the back end *M* of the fixture have been bored to receive their bushings. This lug, containing bushings the same as these in the front projection *K*, serves simply the purpose of giving support to the boring bars, while boring the fixture, so that the holes in the fixture itself may be placed exactly in line. In Fig. 1 the pad *L* shows where this auxiliary lug has been removed.

One difficulty has been experienced with this clamping device. When a head was half bored at the time when the power was shut down at night, it was found that the clamps, on which, of course, the air pressure was relieved during the night, would not hold the bed in exactly the same position when the air pressure would be again applied, but that some slight variations were noticeable, and it became necessary to start the boring of the holes anew, in order to get them to line up exactly. For this reason, some of the fixtures of this design have been provided with small auxiliary clamps, which can be applied before the air pressure is relieved, whenever it is desired to hold the bed over night in exactly the same position as before. These clamps, being applied, will then prevent any motion of the casting, when the clamps *A* release their grip. The auxiliary clamps, of course, need not be applied excepting in such cases when the air pressure is to be shut off. In order to insure that the bed bears properly against the locating surface *E*, and also on the top portion of the fixture, feelers of tissue paper are put in between the bed and the fixture at six places—two on each side and two at the back end—and by means of these the proper location is ascertained.

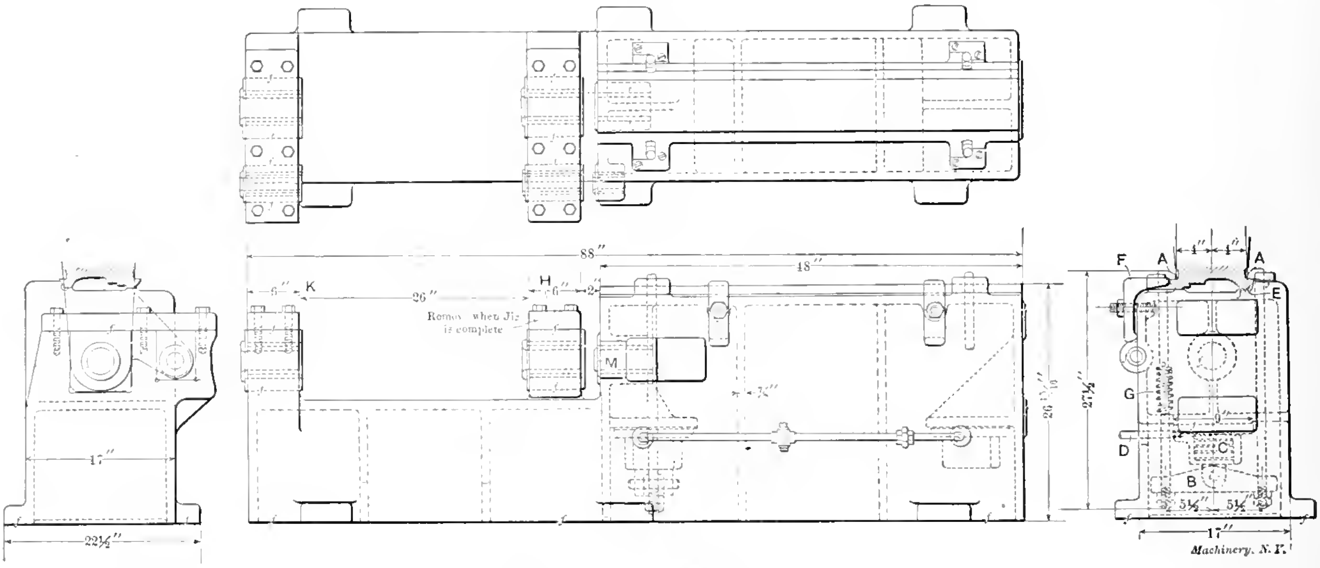


Fig. 2. Plan and Elevation of Fixture shown in Fig. 1.

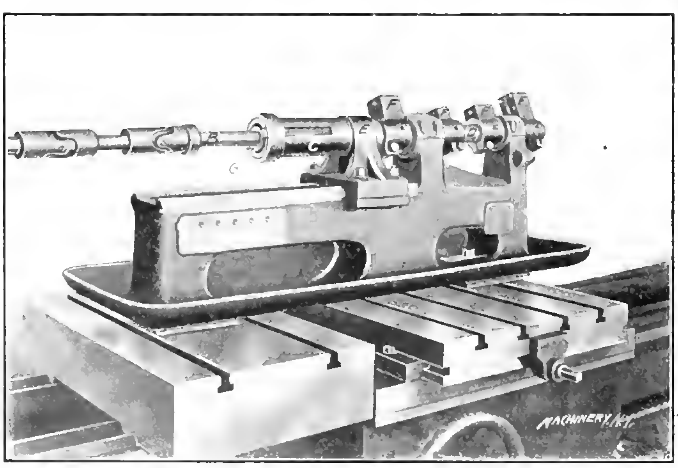


Fig. 3. Device for Facing the Head of Turret Lathes.

It will be noticed that there are a number of circular grooves cut on the surface of the plunger *C*, Fig. 2. It has been found advantageous to have these grooves on the plungers, and to fill them with vaseline, as this will act as a lubricant and permit the plunger to move freely, and at the same time act as a packing, preventing the escape of air.

Another tool of great interest and ingenuity of design is used for facing the ends of the bearings in the head of the turret lathes. This tool is shown in operation in Fig. 3, and details showing some of the component parts are shown in Figs. 5, 6, 7, and 8. The principle of this fixture is that the facing tool, inserted at *A* in the tool-holder shown in Fig. 6, moves automatically from the outside of the boss to be faced toward the center, the four faces of the head being faced off simultaneously. The fixture consists, in general, of a feed bar *B*; a feed bar sleeve *D*; a driver *C*; a driving clutch *G*; a supporting thrust bracket *E*; and four tool-carrying heads *F*, with tool-holders and tools. The bracket *E* is first clamped to the bed of the machine, the bearings of which are to be faced, the machine itself being placed on the table of the boring machine. This bracket *E* acts as a support and guide for the boring-bar sleeve *D*, on which the heads *F* are mounted, and which is keyed to driver *C*, thereby giving the rotary motion to the heads. Sleeve *D*, however, is held stationary endwise. There is little or no actual end thrust, as far as the cutting operation is concerned, inasmuch as all the four faces are finished at once, and the two opposing ones actually equalize one another in regard to end thrust. What end thrust there is, is caused by the feeding in of the tools toward the center, as explained in the following.

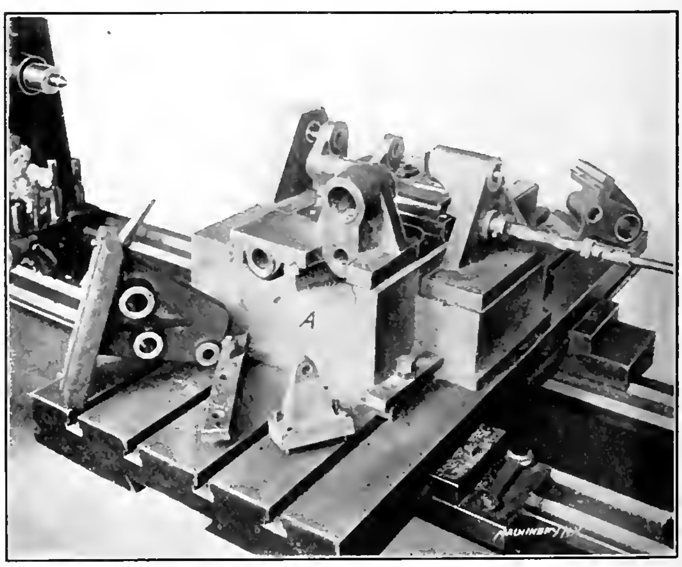


Fig. 4. Fixture for Boring Head-stock, Foot-stock, and Carriage for Thread Milling Machines.

The feed-bar B is designed in a manner as shown in Fig. 5. On the end, connecting with the ball joint, it is circular, but the portion of the bar which enters in the sleeve D is milled down, as indicated, and at the places where the four heads F are located, it is provided with ridges and grooves, as shown at H, Fig. 5. These ridges and grooves engage with similar ridges and grooves in the tool-holder, Fig. 6, and it is evident that when the table of the boring machine, to which the bed of the machine being faced is clamped, moves toward the head of the boring machine, so that the boring bar B is pushed forward, the engagement of the grooves in this bar, with the ridges in the tool-holder, forces the tool-holder to move in a direction at right angles to the axial direction of the boring-bar, so that the tool inserted at A in the tool-holder is fed from the outside periphery toward the center of the bosses on the head. The heads F, as mentioned before, are mounted on the sleeve D and are held stationary in relation to the bed through bracket E, so that there is no endwise motion of the tools in relation to the bed of the machine.

In Fig. 7 is shown a detailed drawing of one of the tool-carrying heads F, which acts as a guide and holder for the tool-holder in Fig. 6, and in Fig. 8 is shown a section through the head, when the tool-holder and feed bar are inserted. In this section, B represents the feed bar; D, the sleeve; F, the head itself; K, the tool-holder; and L, the facing tool. At M is shown a pin having a knurled head. This pin presses against the side of the tool-holder, and is actuated by the spring N. As soon as the tool-holder has been fed inward by the forward motion of the feed bar, so that the ridges and grooves of the feed bar have passed entirely through the corresponding grooves in the tool-holder, and the bar has disengaged the holder, the end of this pin enters into the corresponding hole P in the tool-holder. This prevents the tool-holder, which still has a rotating motion imparted by the head, from being entirely loose in the head, and from falling to and fro, according to which side of the head is turned upward.

The half-tone, Fig. 4, shows a fixture which is used for boring the head-stock, foot-stock, and the carriage which holds the cutter head for the thread milling machines, built by the Pratt & Whitney Co. Originally, special fixtures were made for boring each one of these three parts of the machine, but it was found that it was difficult to get all the holes to line up exactly when the different parts were placed on the bed of the machine. It is evident that it is necessary that the center of the holes, in which the cutter head swivels when it is set for milling, should be exactly at the same height as the center of the spindle of the machine, in order that the cutters may cut the exact shape of the thread desired, in the same way as it is necessary to have the thread tool set exactly at the height of the centers of the lathe, in order to obtain a perfectly shaped thread. In order to overcome the difficulty referred to, the fixture shown was designed. This fixture, in fact, consists of a short portion A of the bed of the machine itself, and the various parts are placed directly on this bed when being bored. The brackets shown lying on the table of the boring machine are used for the different parts of the machine, and are put in place as required. They are being located by dowel pins, so as to insure that they will always come in the same exact relation to the main bed A. It is evident that this provision permits all the parts that go on the bed of the thread milling machines to be bored so as to be perfectly interchangeable with one another, and at the same time that all the holes required to line up in the assembled machine will have a correct location.

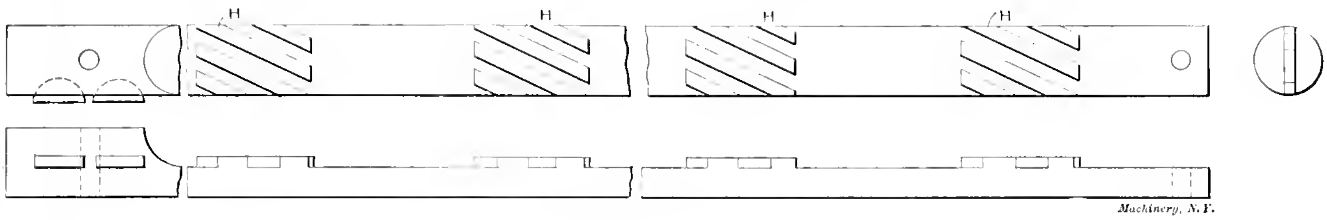
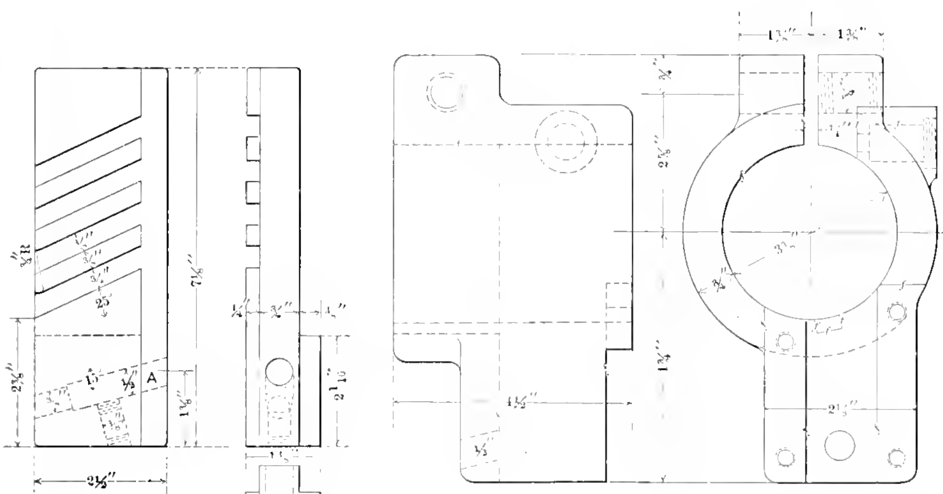
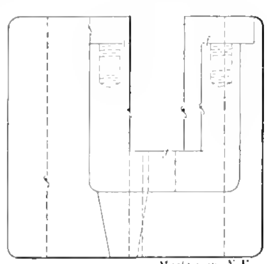


Fig 5. Feed Bar used in Device shown in Fig. 3.





Figs. 6 and 7. Tool-holder for Facing Device, and Tool-carrying Head.

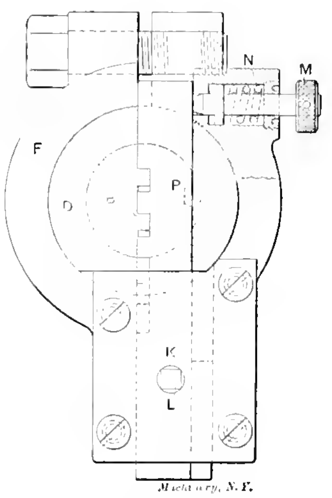


Fig 8. Section through Tool-carrying Head, with Feed Bar and Sleeve in Position.

The fixture shown in the half-tone, Fig. 9, is used for drilling the holes K and L in the casting in the line cut, Fig. 10, and also for drilling the corresponding holes in the bed of the machine onto which the casting is attached. This casting is what is known as the motion bracket on an automatic screw machine, built by the company, a worm being placed between the faces A A, working with a worm-wheel located on a stud in the frame of the machine. The fixture is also used as a gage for testing the worm-wheel after hobbing. As will be seen from the line cut, the casting is of a rather complicated design, and it would be rather difficult to drill holes in this casting, and then drill the corresponding holes in the bed of the machine, so that they would line up perfectly, unless as here, the same jig were used for both operations. When the piece in Fig. 10 is placed in the jig, shown in Fig. 9, the bottom face B is already planed, and it is clamped with its face against the finished pad on the jig, the holes then being drilled in the bracket. For sideways location, the

bracket is located by a movable stop, shown at M, so located that the center between faces A comes exactly in line with the center of the worm-wheel, which, when this fixture is used for a gage, is held on a stud entering the hole, shown at C in Fig. 9. The side of stop M locates the work by pushing face A of the casting up against it. When the bed is

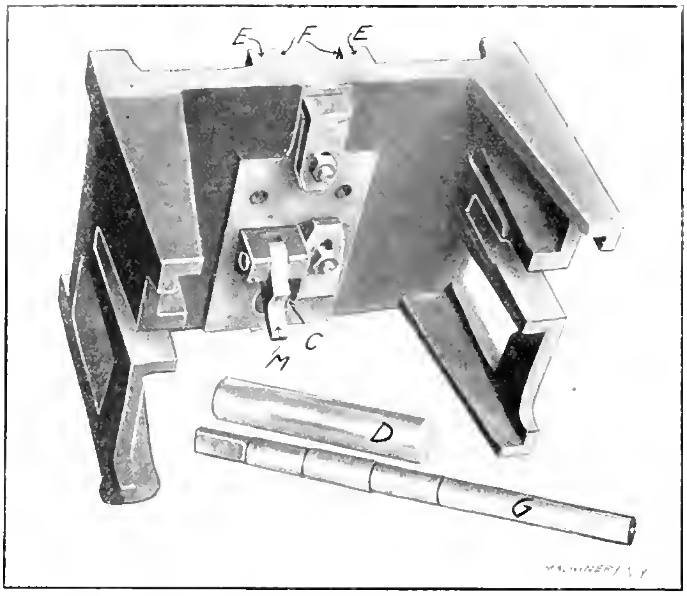


Fig 9. Jig for Drilling Screw-holes in Casting shown in Fig. 10, and for Drilling Corresponding Holes in Frame; also employed as a Worm-wheel Gage.

drilled, the jig is located through the stud D, Fig. 9, entering through the hole C in the drill jig, and at the same time through the hole already bored for the shaft of the worm-wheel in the bed. This locates the jig in relation to the height. To locate it sideways, the two lugs E, shown on the back of the fixture, are employed, the faces F fitting a finished projection on the machine. In order to permit the holes K to be tapped while in the jig, the bushings are removable. When the fixture is used as a gage for the hobbed worm-wheel, the bracket is clamped to the fixture in the same manner as when it is being drilled. The shaft G is

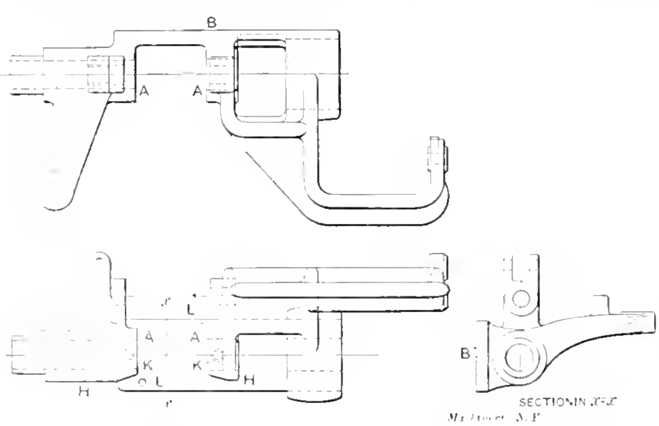


Fig. 10. Motion Bracket for Automatic Screw Machines—drilled in Jig Fig. 9.

placed in the bracket through the hole H, and a master worm is placed on this shaft. The stud D is then placed in the hole C, and the worm-wheel is placed on this stud. It is evident that, if the master worm fits the worm-wheel exactly when tested under these conditions, both the bed and the bracket having been drilled in this jig, it must necessarily follow that the worm and the worm-wheel will fit each other, when placed in position in the machine.

A most interesting device is shown in the half-tone, Fig. 11, and the line cut, Fig. 12. This device is intended for milling dove-tail slides in a vertical milling machine. As will be seen from the half-tone, Fig. 11, the device consists of a bottom plate A, in the center of which is pivoted a table B, provided with three T-slots. On this table is mounted the work holder plate C, provided with screws and studs for holding the work. At D is shown a dove-tail slide, placed on the device and milled to the desired dimensions. At the corners of the base plate A are shown disks E and H. These disks serve as gages when the device is used. The operation is as follows: When the work has been placed in position on the work holder, the table is fed forward, and one side of the slide is milled, the cutters used for milling being of the form shown in Fig. 14. As soon as one side is completed, the operator releases the handle F, which is attached to a stud, which binds the table B to the bottom plate A, and, with the other hand on the handle G, he swings the table around until it rests up against the side of the disk H at the other end of the base plate. In this position it is located to mill the other side of the dove-tail slide without changing the setting of the machine. When the disks E and H are of equal size a straight dove-tail slide will result, but if it is required to have the slides so milled that a tapered gib may be used, then one of the disks may be made larger than the other, the dimensions, of course, being determined by the taper required. One side of the dove-tail slide will then be milled straight, while the other will be made on the required taper. A tool steel piece K is inserted in the table B, where it strikes up against the hardened disks E and H, so that the device will stand without perceptible wear the constant impact that results from being pressed up against the disks.

In order that the disks may be figured and made once for all, and standard gages used for setting the cutters, it is necessary that one end of the slide to be milled be always

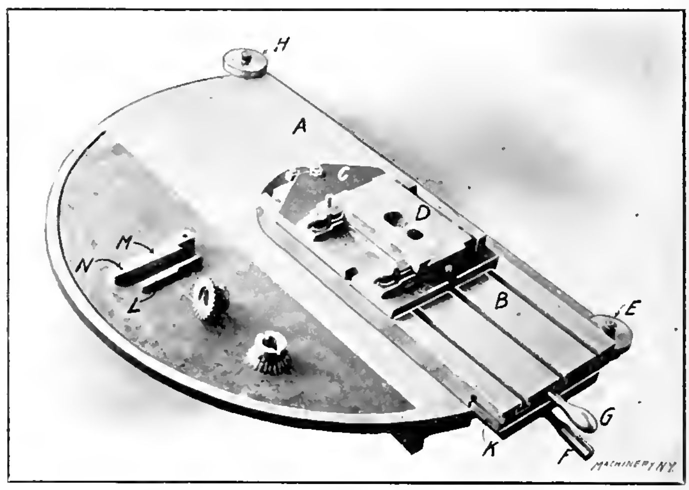


Fig. 11. Dove-tail Slide Milling Device.

a certain distance from the center of rotation. To ascertain this, a hole is drilled in the work holder C, and the work is located so that the center of this hole is exactly in line with the end of the work being milled. This hole is not shown in the cut, but the work is always so set that the end of the slide to be milled comes exactly at the center of this hole. The work-holding slide must, of course, itself be so clamped

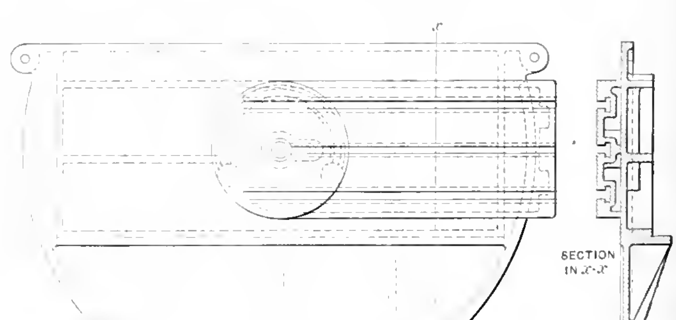


Fig. 12. General Construction of Dove tail Slide Milling Device.

in relation to the table B that the distance between the center of the hole referred to and the center of rotation is constant. The gage pin L is used for this purpose. A hole is drilled in table B, exactly three inches from the center of rotation, and the gage L is put through the holes in the work holder C and the table B, so that the exact relation is obtained. At M is shown one of the gages used for setting milling cutters to obtain exact sizes of the dove-tails. The hole at N is also

intended for the gage L which enters into this hole and into the hole in C, before mentioned, and thus locates the gage exactly in relation to the device.

The line cut, Fig. 12, simply shows the general details of the construction of the device. The cutters used, shown in Fig. 14, have one interesting feature. The cutter is first turned up to the shape shown at O, and then every alternating tooth is made as shown by the full line at P, and every remaining tooth as shown by the dotted line. This construction is used in order to get a sharp corner at R, it being desired to mill, at the same time that the dove-tail is milled, the small flat, which terminates the dove-tail, and prevents a sharp corner at the upper edge between the top and the beveled surface. Of course, in order to make a cutter this way, each tooth will have to be operated upon separately and given the desired shape. It is evident that this is rather a costly operation, but it insures efficient results.

In Fig. 13 is shown a universal fixture used for the boring of the largest size of turret lathes (3 x 36 inches), and also for the die-sinking machines made by the company. This

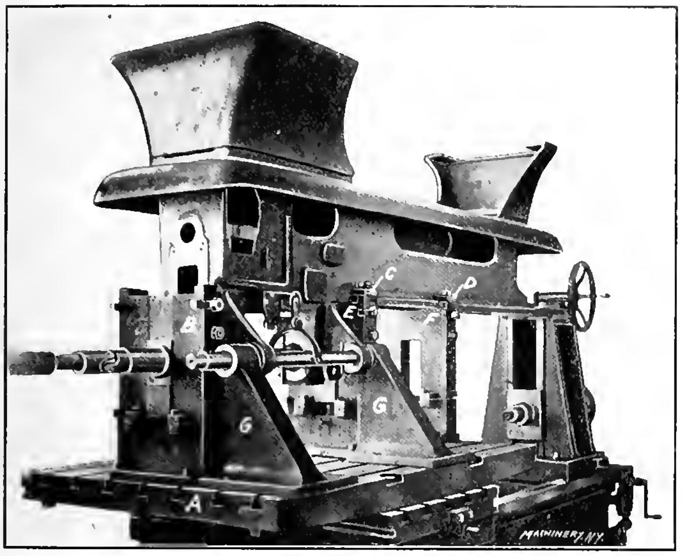


Fig. 13. Fixture for Boring Large Size Turret Lathes.

fixture consists of an auxiliary table A which is placed on the regular table of the boring machine. On this table are placed the brackets and uprights which guide the boring bars. The uprights B, E and F are provided with slots for a certain distance down, and in these slots are placed square guide blocks which hold the bushings for the boring bars. The construction permits of adjusting the bushings to different positions for different machines, and the arrangement makes a very useful and universal tool for interchangeable work. The

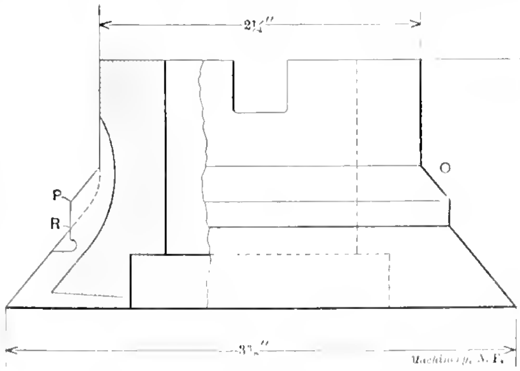


Fig. 14. Cutters used for Milling Dove-tail Slides.

machine is clamped to the fixture by clamps at C and D, and rests entirely on the uprights E and F. The bed and the pedestals complete, arranged on the table of the boring machine, as shown, weigh approximately 2,800 pounds.

It will be noticed that, for boring the holes for the backgear shaft, two separate brackets G are used, shown at the front of the table A. For some work, which is not made in sufficient quantities to warrant the expense of making separate brackets, two heavy knees, with adjustable arms, as indicated in the perspective drawing in Fig. 15, are used. As will be seen, there are vertical slots in the knee, and slots at right angles to these in the arm clamped to the knee, so that the guide bushing for the boring bar can be placed at any position required. These arms are provided with removable bushings, so as to accommodate the different sizes of boring bars and fill the requirements fully as well as the removable brackets, excepting, of course, that they have to be set to the correct position every time they are changed from one job to another. The arrangement shown in Fig. 13

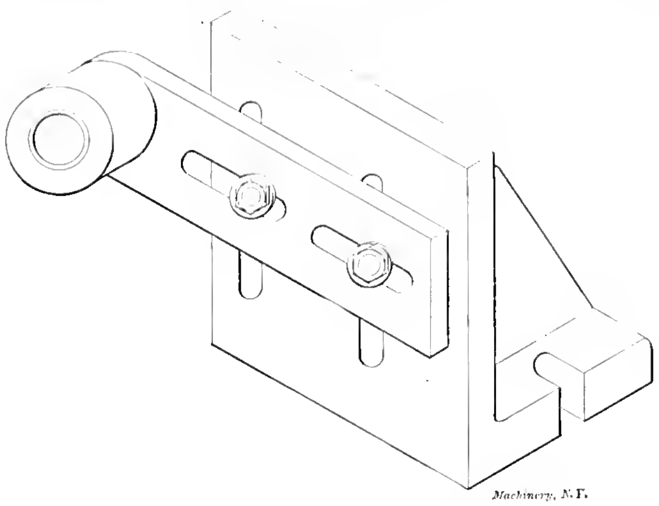


Fig. 15. Bracket with Adjustable Arm for holding Boring Bar Bushings used with Fixture shown in Fig. 13.

illustrates also how in the modern machine shops the size or the weight of the machines being operated upon does not interfere in any way with their being placed in the most convenient way for the operation of the tools, and that comparatively simple devices, if provided with adjustable features, may be used for operations requiring great accuracy.

The illustrations of the tools shown above (the devices having been reproduced directly as used in the shops) may suggest a great deal more than has been conveyed by the description itself. Photographs are one of the best means of conveying ideas in mechanical work, as they often show to each individual exactly the things that he may be most interested in, whereas a description may often ignore certain points, seemingly of more trivial interest, which to some may be considered as the most interesting points. The half-tones shown also illustrate plainly that in our most modern machine tool shops there is no limit to the application of special tools to the operations performed in building machinery, and that by the use of such devices work can be carried out in a fraction of the time that was formerly required to carry out the same operations.

E. O.

* * *

Some years ago (October, 1899) an article was published in MACHINERY on the manufacture of hydraulic jacks as carried on by a well-known concern, and in it the importance of the unit system was pointed out as applied to this business. The number of devices and designs of hydraulic apparatus is very large, there being literally hundreds of jacks, presses, etc., listed which the concern is prepared to supply on short notice, but this does not mean that there are as many designs of the pumping mechanisms as there are designs of jacks listed. On the contrary, these costly parts are standardized and are manufactured entirely apart from the general construction of the apparatus in which they may be used. The general line of apparatus is designed to use these standard parts, and they are assembled in exactly the same essential form as they appear, for example, in the ordinary hydraulic jack.

* * *

The common process of protecting metals by plating them with copper or other metals by electrolysis is often inconvenient because of the large size of vat necessary. It has been found possible to apply the electrolyte with a paint-brush attached to one pole of the source of current. By this means a smooth, strong coating of metal may be built up to any reasonable thickness. This process, it is said, has been successful in plating with silver, gold, copper and nickel.

TAPER TAPS.—1.

ERIK OBERG *

Taper taps, if the expression be properly understood, are taps which have the diameter of the thread nearest the shank larger than the diameter of the full thread at the point, the intermediate portion being formed by the gradual taper from one end of the thread to the other. It is necessary to call attention to this proper meaning of the expression taper tap, because of the fact that the first tap in a set of hand taps is commonly, but not properly, referred to as a taper tap. As this expression is used to designate two widely different things, and as its common usage in connection with the first tap in a set of hand taps prevents any possible change, it is always well, when speaking of taper taps, to state which of the two meanings is referred to in any particular case. In the present discussion, we are referring to the taps properly termed taper taps; that is those with the diameter of the full thread at the point smaller than the diameter of the thread at the end nearest the shank.

There are three particular points to take into consideration when making taper taps. In the first place, the threading tool must be presented to the tap at right angles to the axis

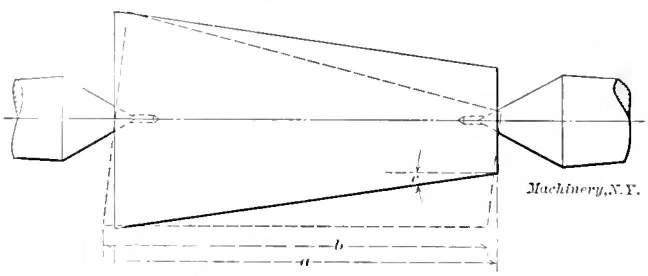


Fig. 1. Showing Effect of setting over Tail-stock when threading Taper Taps.

of the tap, and not at right angles to its tapered surface, unless the tool is specially made for taper threading of taps with a definite taper. In the second place, taper taps should, if possible, be turned on lathes being provided with taper attachments, and not by setting over the tail-stock of the lathe, and, finally, proper relief should in all cases be given a taper tap. The first of these questions was treated at length in the article entitled "Cutting Taper Threaded Taps with Chasers," which appeared in the May, 1907, issue of MACHINERY. The second and third questions will be dealt with in the following.

Effect of Setting Over Tail-stock when Threading Taper Taps.

If the old method of setting over the tail-stock is used when cutting taper threads, two errors will be introduced, and these errors will increase as the taper of the taps increases. The first error consists in the pitch of the thread becoming finer than the standard, which is readily seen by referring to Fig. 1. The length of the work shown between the centers of the lathe is a, if measured along the axis of the work. If measured along the tapered surface the length is b; but $b = \dfrac{a}{\cos v}$, if v be the angle which the side of the tapered piece makes with the center line. If the piece is threaded with a certain number of threads per inch c, the number of threads when threading by means of a taper attachment would be $a \times c$, but if the threading is done with the tail-stock set over, as shown by the dotted lines, the number of threads would be $\dfrac{a}{\cos v} \times c$, or a greater number of threads, and consequently a finer pitch, than in the first case.

An example will plainly demonstrate the case. Let the length a, measured parallel to the axis, be 12 inches. Assume that we wish to cut 10 threads per inch and that the angle v is 8 degrees. The number of threads on the whole length of the piece, when cut in a correct way by means of a taper attachment will be 120 threads. Now, the length b, or the length of the piece measured parallel to the outside, equals $\dfrac{12}{\cos 8 \text{ deg.}} = 12.121$, or $12\frac{1}{8}$ inches approximately. In this length we would get $121\frac{1}{4}$ threads instead of 120. It is thus evident that for steep tapers the difference is quite considerable, and cannot be overlooked.

"Drunken" Thread.

The second error, due to setting over the tail-stock when cutting a taper thread, consists in that the thread, instead of becoming a true, continuous helix, becomes "drunken." An exaggerated drunken thread is shown in Fig. 2. The drunken thread is due to the fact that in taper turning with the tail-stock set over, the work does not turn with a uniform angular velocity, while the cutting tool is advancing along the work longitudinally with a uniform linear velocity. The change in the pitch and the irregularity of the thread is so small as to be imperceptible to the eye if the taper is slight, but as the tapers increase to say ¾ inch per foot or more, the errors become more pronounced. While the setting over of the tail-stock for cutting taper threads should be as much as possible discouraged, in such cases where it is necessary, however, the detrimental effects of the method may be partly overcome, at least in as far as the cutting qualities of the taps are concerned, by relieving the threads liberally. This will, obviously, not correct the errors in regard to incorrect pitch or imperfect helix of the thread, but it will cause the tap to cut freely, even if it does not produce a theoretically perfect thread of the desired pitch and form.

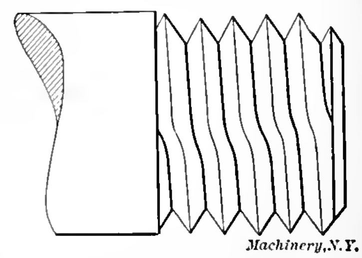


Fig. 2. "Drunken" Thread, Exaggerated.

Amount of Error due to Setting Over the Tail-stock.

In Table I, figures are given stating the amount a tap will be *short in the lead per foot* for various tapers, if threaded with the tail-stock set over. The amount of taper is always, in regard to taps and reamers, intended to mean the *difference in diameters per foot of length* measured along the center line or axis of the tool. By means of the table given, it is easily seen whether the inaccuracy produced will be of consequence

TABLE I. AMOUNT OF SHORTAGE IN LEAD IN ONE FOOT OF SCREWS THREADED BY SETTING OVER THE TAIL-STOCK.

Taper per foot.	Error in Lead per foot.	Taper per foot.	Error in Lead per foot.
⅛	0.0001	1½	0.023
¼	0.0006	1¾	0.031
⅜	0.0014	2	0.042
½	0.0026	2½	0.065
⅝	0.0041	3	0.094
¾	0.0058	3½	0.126
1	0.0108	4	0.164
1¼	0.0168	..	.....

in a particular case or not. It is also seen that the error for reasonable tapers is very small indeed, so small, in fact, as to have no commercial importance whatever.

The amount of the error in one inch is figured from the formula

$$\text{Shortage in lead in one inch} = 1 - \cos v,$$

if v is figured from the formula

$$\tan v = \frac{t}{2 \times 12},$$

in which latter formula t is the taper per foot of the piece to be threaded.

An example will tend to make the formula more easily understood. Suppose the taper per foot of a particular piece of work is ⅝ inch. The angle v is then first determined:

$$\tan v = \frac{0.625}{2 \times 12} = 0.026$$

$$v = 1 \text{ degree } 30 \text{ min.}$$

The amount the lead of the thread will be short is one inch, if threaded with the tail-stock set over, equals

$$1 - \cos 1 \text{ deg. } 30 \text{ min.} = 0.00034,$$

or about 0.004 inch per foot. Being a fairly small taper we see that the amount of the error is comparatively slight. If

* Associate Editor of MACHINERY.

the taper is increased, however, the error will soon assume such proportions as to be negligible only in very rough work.

Relief of Taper Taps.

The third, and perhaps the main, consideration in regard to making taper taps is the question of a proper relief. This question has been a greatly perplexing one in machine shop practice, particularly in the case of taps with steep tapers. It is evident that a taper tap, not relieved either on the top or in the angle of the thread, will refuse to cut altogether, or, if forced through a hole, will either leave a very rough and irregular thread, or break off its own teeth. This depends upon that, as the tap is continuously tapering upward, the heels of the teeth are always located in a circular section of a larger diameter than the cutting edge of the corresponding tooth. Consequently, if forced to cut a thread, the tap, if not relieved, will squeeze the metal back of the cutting edge in order to find room for the increasing diameter. While the edge cuts, the space produced by the cutting point of the thread is not large enough for the increasing diameter of the part of the thread immediately following. On account of this, it is imperative that taper taps be relieved the full length of the thread, on the top as well as in the angle of the thread, for the full width of the land. Referring to Fig. 3, the relief should also be greater on the side D than on the side E of the thread. This will lessen the friction and the resistance while cutting a thread, inasmuch as it is obvious that the greater pressure on the thread of the tap created by the cutting process comes on the side D. Thus, if this side is properly relieved so as to permit only the cutting edge to come in contact with the material to be cut, the friction is reduced to the smallest possible amount, and at the same time the keenness of the cutting edge is increased.

Fig. 3. Section of Threads of Taper Tap.

With the exception of the previous remarks, there is nothing to be said in regard to taper taps which has not already been discussed in these columns in relation to straight taps. (See MACHINERY, June and July, 1907.) As a rule there is not the necessity of the extreme accuracy in taper taps as is sometimes expected from hand taps, because, with incidental exceptions, of course, taper taps are usually employed on work of a rougher character. Besides, being tapered, there is never any requirements for a working fit between the stud and the nut, as the taper taps are used mainly for tapping holes where a water, steam or air-tight fit is required.

TABLE II. NUMBER OF FLUTES OF PIPE TAPS.

Nominal Size of Tap.	Number of Flutes.	Nominal Size of Tap.	Number of Flutes.
1/8	4	1 1/2	6
1/4	4	2	7
3/8	4	2 1/2	8
1/2	4	3	9
3/4	5	3 1/2	10
1	5	4	11
1 1/4	6	..	..

Pipe Taps.

The most common of all taper taps is the pipe tap. The shape of the thread for this tap was referred to in the February, 1907, issue of MACHINERY in the article entitled "Screw Thread Systems" under the sub-head "Briggs Standard Pipe Thread." The pipe tap tapers 3/4 inch per foot, or 1/16 inch per inch, measured along its axis. The taps are known by the nominal size of the pipe for which they are intended; consequently a pipe tap is a great deal larger, measured in inches, than the size by which it is designated. The largest diameter of a half-inch pipe tap, for instance, as seen from Table IV, is 0.887 inch.

Fluting.

Pipe taps are fluted with the same kind of cutters as are used for hand taps. (See June, 1907, issue of MACHINERY.) As there is a considerable difference in the manner in which a hand tap and a pipe tap cut, there is some difference in regard to the required chip room. In the case of a hand tap, as soon as the thread has been cut by the chamfered portion, the straight part of the thread does not cut or produce any chips. The pipe tap, again, being tapered, is constantly cutting, no matter which part of the tap is in contact with the work, and therefore there is a necessity for large chip room, and the flutes should be made as deep as possible without impairing the strength of the tap.

TABLE III. AMOUNT MEASURED ALONG THE TAPERED SURFACE, CORRESPONDING TO ONE INCH ALONG THE AXIS.

Taper per foot.	Amount Measured along the Tapered Surface corresponding to one inch along the Axis.	Taper per foot.	Amount Measured along the Tapered Surface, corresponding to one inch along the Axis.
1/8	1.0000	1 1/2	1.002
1/4	1.0001	1 3/4	1.0025
3/8	1.0001	2	1.0035
1/2	1.0002	2 1/2	1.0055
5/8	1.0003	3	1.008
3/4	1.0005	3 1/2	1.011
1	1.0009	4	1.014
1 1/4	1.0015	..	......

The number of flutes for pipe taps may be approximately determined by the formula:

$$N = 1.75\,A + 3,$$

in which N is the number of the flutes, and A, the diameter at the size line of the tap. This formula gives the number of flutes given in Table II for sizes up to 4-inch pipe tap.

The formula given for the number of flutes makes the distance from cutting edge to cutting edge at the size line larger as the sizes grow larger, thereby making possible deeper flutes in the larger sizes.

Testing Lead of Taper Taps.

In testing or inspecting the lead of taper taps, it must be remembered that the correct lead should be measured on a line parallel to the axis of the tap, and the lead of the thread cannot be measured in the same manner as is done with straight taps, unless due allowance is made for the differences in length along the axis and the tapered surface. In Table III the values are given which should be measured along the tapered surface to correspond to one inch along the axis, for different tapers. In other words, if a tap is tapered 3/4 inch per foot, and is provided with eight threads per inch, the distance covering 8 threads on the surface of the tap is not one inch but 1.0005 inch, as seen from the table opposite 3/4 taper per foot. If the lead of the thread is tested by comparing it with a standard tapered thread plug, this need, of course, not be taken into consideration, as then any device for comparing the lead of straight taps is equally applicable to taper taps. The distance on the tapered surface corresponding to one inch along the axis is $\frac{1}{\cos v}$, if v, as before, is determined by the formula

$$\tan v = \frac{t}{2 \times 12},$$

where t is the taper per foot.

Thus, if a tap tapers 1¼ inch per foot, and has 8 threads to the inch, if 16 threads were measured at the surface of the taper, the length, if the lead be correct, should not be 2 inches, but 2.003 inch, which we find from

$$\tan v = \frac{1.25}{2 \times 12} = 0.0521,$$

$$v = 3 \text{ deg. (approximately), and } \frac{1}{\cos 3 \text{ deg.}} = 1.0014;$$

$$2 \times 1.0014 = 2.003 \text{ (approximately).}$$

In Tables I and III figures have been given for tapers as steep as 4 inches per foot. Of course, such steep tapers are very seldom encountered.

Dimensions of Pipe Taps.

The dimensions of pipe taps are given in Table IV. Referring to Fig. 4, a dimension A is given at the distance B from the point of the tap. This diameter is the essential diametral measure of a pipe tap, and the circular line which may be

TABLE IV. DIMENSIONS OF BRIGGS STANDARD PIPE TAPS.

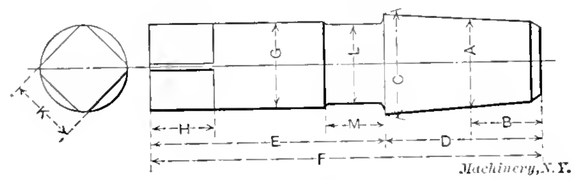


Fig. 4.

Nominal Pipe Size.	Diameter at Size Line.	Distance from End to Size Line.	Diameter at Large End.	Length of Thread.	Length of Shank.	Total Length.	Diameter of Shank.	Length of Square.	Size of Square.	Diameter of Neck.	Length of Neck.
	A	B	C	D	E	F	G	H	K	L	M
1/8	0.405	25/64	0.443	1	1 5/8	2 5/8	7/16	9/16	5/16	3/8	3/8
1/4	0.540	9/16	0.575	1 1/8	1 3/4	2 7/8	17/32	9/16	3/8	15/32	
3/8	0.675	9/16	0.718	1 1/4	1 7/8	3 1/8	9/16	5/8	7/16	These sizes have no neck.	These sizes have no neck.
1/2	0.840	3/4	0.887	1 1/2	2	3 1/2	3/4	11/16	9/16		
3/4	1.050	3/4	1.104	1 5/8	2 1/4	3 7/8	15/16	3/4	11/16		
1	1.315	15/16	1.366	1 3/4	2 1/2	4 1/4	1 1/8	13/16	13/16		
1 1/4	1.660	31/32	1.717	1 7/8	2 3/4	4 5/8	1 5/16	15/16	1		
1 1/2	1.900	1	1.963	2	3	5	1 1/2	1	1 1/8		
2	2.375	1	2.453	2 1/4	3 1/2	5 3/4	1 7/8	1 3/16	1 3/8		
2 1/2	2.875	1 1/2	2.961	2 7/8	4	6 7/8	2 1/4	1 3/8	1 11/16		
3	3.500	1 9/16	3.605	3 1/4	4 1/2	7 3/4	2 5/8	1 1/2	1 15/16		
3 1/2	4.000	1 5/8	4.125	3 5/8	4 9/16	8 3/16	2 13/16	1 9/16	2 1/8		
4	4.500	1 11/16	4.629	3 3/4	4 5/8	8 3/8	3	1 5/8	2 1/4		
4 1/2	5.000	1 7/8	5.125	3 7/8	4 11/16	8 9/16	3 3/16	1 11/16	2 3/8		
5	5.563	2	5.687	4	4 3/4	8 3/4	3 3/8	1 3/4	2 1/2		
6	6.625	2 1/4	6.766	4 1/2	4 7/8	9 3/8	3 3/4	1 7/8	2 13/16		
7	7.625	2 3/8	7.773	4 3/4	5	9 3/4	4 1/8	2	3 1/16		
8	8.625	2 3/8	8.773	4 3/4	5 1/4	9 7/8	4 1/2	2 1/8	3 3/8		
9	9.625	2 1/2	9.781	5	5 1/4	10 1/4	4 7/8	2 1/4	3 5/8		
10	10.750	2 1/2	10.906	5	5 3/8	10 3/8	5 1/4	2 3/8	3 15/16		

imagined to be drawn around the tap at this point is termed the size line. The two smallest sizes are provided with a neck between the threaded part and the shank. On the remaining sizes the shank is made small enough to come below the root diameter of the thread, and a neck is therefore unnecessary.

As pipe taps must be made according to the established manufacturing standard, formulas for the dimensions cannot be given, excepting for those measurements which are unessential, like the dimensions for the shank and square; but

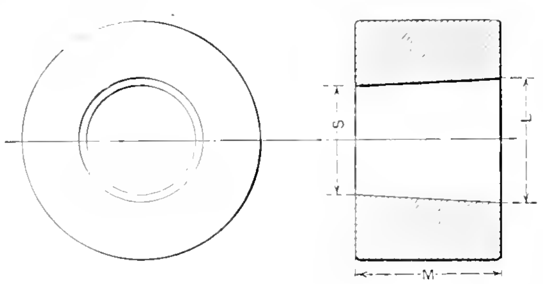


Fig. 5. Ring Gage for Testing Diameters of Taper Taps.

Table IV gives all necessary information in regard to all standard sizes, and formulas, even if they could be given, would consequently be superfluous.

Limits of Accuracy.

The accuracy usually demanded of taper pipe taps in regard to the exact location of the size line is given below. The method of testing or measuring taper taps in order to insure that they are within the permitted limits of variation in this respect is by means of a plain ring gage, as shown in Fig. 5, the diameter L at the large end of which is the dimension at the size line; the diameter S at the small end of the hole is the diameter at the point of the tap, and the length M of the ring gage equals the dimension B in Fig. 4, representing the distance from the size line to the point of the tap. Thus, when the tap is tested with this ring gage, if the end of the tap comes exactly flush with the end of the gage, the location of the size line is exactly correct. If the end of the tap projects through, or comes short of the face of the ring gage at the small end of the hole, such projection or shortage represents the error in the location of the size line. The permissible errors are as follows:

Pipe Sizes.	Error Permitted in the Location of the Size Line.
1/8 – 1	± 1/32
1 1/4 – 3	± 1/16
3 1/2 and up	± 1/8

Plus in the above table signifies a projection of the tap through the ring gage, and minus the amount by which the point of the tap fails to reach through the gage in order to come flush with the end of the gage.

* * *

DON'TS FOR MACHINISTS.

W. H. ADDIS.

Don't talk too much.

Don't attempt to bore a taper hole unless the cutting edge of the tool is in line with the centers.

Don't throw in the feed and lead at the same time.

Don't say, "I'll finish this up to-morrow;" earn your money to-day.

Don't believe that every micrometer dial is so graduated that every graduation measures 0.001 inch.

Don't forget to take up lost motion in the feed screws before starting an accurate job.

Don't forget that a little chalk will prevent your file from filling up.

Don't force or jam your turret tools into the work; it is better to sharpen them.

Don't say, "This is good enough"; do it right.

Don't leave oily waste as a collection in the corners. It may cost you your job, and your employer his shop building.

Don't file the cutting edge of a tool to see if it is hard; it may be.

Don't let the emery from the tool-post grinder fall on your lathe ways; newspapers are cheaper.

Don't allow steel chips or filings to become imbedded in your copper vise jaws.

Don't ream a center without using a little oil.

Don't wash a finished screw or bolt with gasoline, and then use it in assembling; gasoline is a poor lubricant.

Don't cut off a piece of work between centers.

Don't stand with your face in line with an emery wheel; the face might get spoiled.

Don't forget to oil the shanks of your turret tools.

Don't forget to measure the rough stock when you receive a job; the stock might be wrong.

Don't forget that a common bottle cork placed over the spout of your oil-can may save you an eye.

* * *

It has been stated over and over again, in the daily as well as in the mechanical press, that fast ocean liners are not directly paying propositions, excepting that, of course, they possess a great advertising value. German periodicals, in particular, have been eager to put forth this theory since the two new Cunarders have taken the blue ribbon of the ocean from the German liners. If a statement, which lately appeared in a Liverpool paper, regarding the expense of running the new Cunard liners is founded on good authority, as it appears to be, fast liners are, however, by no means failures, even from a commercial point of view. According to this statement, the passage money, with the passenger accommodations used to the fullest extent, for a single trip of the *Lusitania* or *Mauretania* amounts to about $140,000, while other incomes from carrying cargo, proportion of ship subsidy, etc., amount to about $16,000. All expenses, including coal, food supplies, harbor dues, insurance, interest, sinking fund, etc., amount to about $90,000. According to this, there should be a clear profit of something like $66,000 on each voyage.

PRACTICAL POINTS ON SURVEYING.*

CHARLES L. HUBBARD.†‡

It frequently happens around manufacturing plants that simple work along the line of surveying is required, such as locating new buildings or extensions, establishing property boundaries, determining grades for drains or steam and return mains, etc. The object of this article is to describe, briefly, the use of transit and level, methods of taking measurements, arrangement of notes, and the plotting of results. No attempt will be made to go into the accurate methods required in important engineering undertakings, as work of this kind is entirely beyond the scope of the present article.

Measurements.

Measurements were formerly made either with a Gunters' or an engineer's chain. The former has 100 links, each 7.92 inches long, making the total length 66 feet, or 4 rods. The handles and the center of the chain are fitted with swivels to

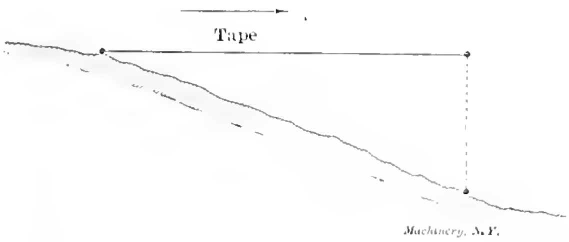


Fig. 1. Method of Holding Tape when measuring over Uneven Ground.

prevent kinking, and at every tenth link from either end is attached a brass tag with one, two, three, or four prongs to assist in measuring. The fifty-link mark is round in form, so it may be easily distinguished from the others. The engineer's chain is similar in construction to the one just described, except the links are one foot long, making the total length of the chain 100 feet. Measurements made with a chain are liable to be inaccurate unless great care is taken, owing to the sagging at the center due to its weight, and also to changes in length caused by wearing at the joints or by the links becoming bent. For the usual work around a manufacturing plant a steel tape of good quality, divided into feet and decimals of a foot, is much better than a chain. Tapes of this kind may be had either in 50- or 100-foot lengths. In addition to the tape, there should be provided eleven marking pins. These should be furnished with a strip of red flannel tied into the loop or handle to prevent their being overlooked in the grass.

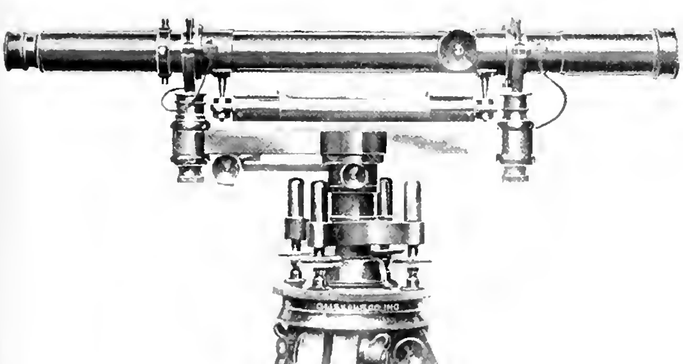


Fig. 2. A Wye Level.

For measuring a line with a tape, two men, one called the leader, and the other the follower, are required. A stake is driven at the starting point, and another provided with a flag, if the distance is considerable, is set to mark the farther end of the line. The tape is then unrolled in the direction of the line, the 100-foot mark going ahead. The leader takes the pins and the forward end of the tape and walks in the direction of the line, dragging the tape after him. When near the end of the tape, the follower ranges him exactly in line by word or gesture, the tape is drawn taut, the follower holding the end exactly over the starting point, while the leader puts down a pin at the 100-foot mark. This operation is repeated at each tape length, the follower taking up the pins as each measurement is completed. If the line is less than 1,000 feet in length, the distance is determined by counting the pins which the follower has taken up, multiplying the number by 100, and adding the last measurement taken. If a 50-foot chain is used, the number of pins should, of course, be multiplied by 50 instead of by 100. If the line is more than ten tapes in length, the follower should give the pins to the leader when he has collected ten, and a note made each time this exchange is made.

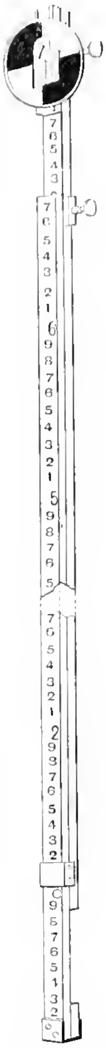


Fig. 3. Leveling-rod.

Since distances used in surveying are horizontal distances, it is necessary that the tape, in measuring over uneven ground, should always be held in a horizontal position. In going down hill, the leader must hold his end of the tape elevated, and in going up hill, the follower must elevate the tape to maintain a horizontal position, as shown in Fig. 1. For ordinary work, the tape is leveled by the eye. If the slope is too steep to permit of one end of a full tape being raised enough to bring it horizontal, the tape is broken, that is, only a part of it is used at each measurement. To do this, the tape should be stretched to its full length, the leader returning to such a point that the portion between himself and the follower may be properly leveled. A measurement is made with this portion of the tape, the operation being repeated with the next section, and so on until the entire tape has been used. The high end of the tape may be transferred to the ground by means of a plumb-bob if great accuracy is desired, but for ordinary work this may be accomplished by dropping a pebble, or a pin with its head down. In measuring up hill, the follower must hold the plumb-bob directly over the pin in the ground while he aligns the leader, and sees that he sticks the pin when the bob is directly over the proper point. It is much easier to measure down hill than up, so that when close measurements are required on slopes, the measurement should, if possible, be made down hill.

Leveling.

Leveling may consist in simply finding the difference in elevation between two points, or, the elevation of a series of points. The former would apply to finding the pressure or head to be obtained at a given point from a pond or reservoir at a higher elevation; or, it might be desired to know the elevation of a steam main above the water line in a boiler located in another building. Again, this applies to the laying out of buildings upon sloping or uneven ground where it is desired to maintain a certain relation between the floor elevations of the different buildings. A series of elevations is required in case of excavation or trenching, in order to determine the depth at different points and the quantity of earth to be removed.

Leveling-rod.

One of the instruments used in leveling is the leveling-rod, a common form of which is shown in Fig. 3. This consists of a wooden rod, usually 6½ feet high, graduated to hundredths of a foot, and provided with a sliding target. The rod is made in two parts, so arranged that its length can be extended to 12 feet. The target is provided with a vernier for accurate work, reading to thousandths of a foot, but the vernier is not often used in the class of work covered by this article. In using, the rod is held in a vertical position with its lower end resting upon the point, the elevation of which is desired, and the target moved up or down until its center coincides with the cross-wires of the telescope of the level.

* See "Surveying without Instruments," by A. L. De Leeuw, July, 1906.

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The reading of the elevation is made from the rod on a line corresponding with the center-line of the target. There are several forms of rods in common use, some of which are read by the rodman, while others are read through the telescope of the level.

The Level.

The instrument usually employed for determining the difference in elevation between points, is called a level. A common form known as the wye level is shown in Fig. 2. It consists of a telescope mounted upon two supports which from their shape are called wyes. The cross-bar supporting the telescope is attached to a vertical spindle which allows it to be turned in a horizontal plane. Directly beneath the telescope, and attached parallel to it, is a spirit level by means of which the line of collimation of the telescope may be rendered horizontal. The telescope is provided with a diaphragm at its focus, consisting of a vertical and horizontal thread or wire. Another instrument in common use is known as the Dumpy level. This is somewhat simpler and more compact than the one just described.

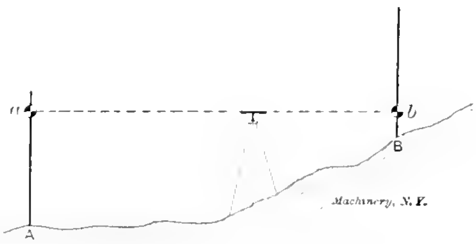

Fig. 4. Finding the Difference in Level between Two Points when the Difference is Less than the Height of the Leveling-rod.

As the various adjustments depend upon the type of level, and as suitable directions are furnished by the makers, only the use of the instrument after it is properly adjusted will be considered. Both types of levels are mounted upon a tripod head and supported upon a tripod. In using the instrument, it should be set up as nearly level as possible by adjusting the legs of the tripod, and then brought to a true level by means of the adjusting screws. To do this, turn the telescope upon its vertical spindle until it is in line with one pair of the leveling screws, then by the proper adjustment of these screws, bring the bubble of the spirit level to the center of the scale; then turn the telescope until it is in line with the other pair of screws, and bring the bubble to the center. Turn back to the first pair of screws, and so repeat the process until the bubble stands at the center of the scale for any position of the telescope in the horizontal plane. The instrument is now ready for sighting upon the leveling-rod.

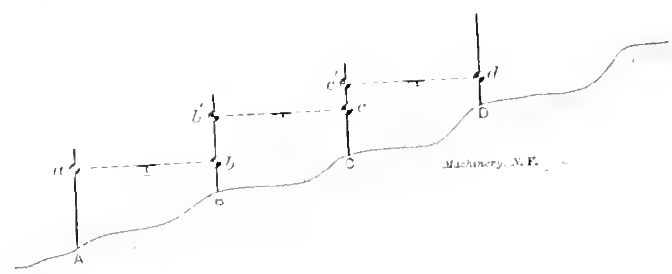

Fig. 5. Finding the Difference in Level when the Difference is Greater than the Height of the Rod.

To find the difference in level between two points which are visible from a third point, is a simple matter. First, set up and level the instrument, as described, at some point approximately midway between the two given points, but not necessarily in line with them. The leveling-rod should now be held vertically upon one of the points (see Fig. 4) and the target moved until its center coincides with the cross-wires of the level, and the reading on the rod taken. This gives the distance $A\,a$. The rod should now be held on the other point B, and the telescope turned upon its spindle and a reading taken with the rod in its new position. This gives the distance $B\,b$, and from the figure it is evident that the difference in level between A and B is equal to $A\,a - B\,b$.

The method just described applies only to cases where the difference in level is less than the height of the rod. Let Fig. 5 illustrate a case where the difference is greater than the height of the rod, as between A and D. First, divide the distance into sections of such length that the difference in level between the dividing points A, B, C, etc., called *stations*, shall be less than the height of the rod. Set up the level between A and B, and measure the distance $A\,a$, called the *backsight*; then reverse the telescope and measure distance $B\,b$, called the *foresight*. Next set up the level between B and C, and measure distances $B\,b'$ and $C\,c$. Repeat the operation with the instrument between C and D, measuring the distances $C\,c'$ and $D\,d$. Referring to Fig. 5, it is evident that the difference in level between stations A and D is equal to the sum of the differences between the intermediate stations, which is

$$(A\,a - B\,b) + (B\,b' - C\,c) + (C\,c' - D\,d),$$

or written in another form is

$$(A\,a + B\,b' + C\,c') - (B\,b + C\,c + D\,d).$$

This shows that the difference in level between two stations is equal to the difference between the sum of the backsights and the sum of the foresights. When the object is simply to determine the difference in level between two points, the above process is all that is necessary, and the only notes required are a record of the foresights and backsights.

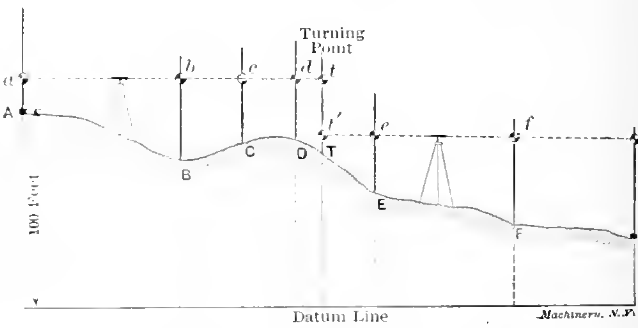

Fig. 6. Finding the Relative Elevations of Several Points.

When it is desired to find the relative elevations of several points, as in grading or trench work, it is necessary to keep more elaborate notes, and to measure the distances between the stations. The first step is to assume a datum line which shall be below the lowest point in the contour, and to refer all elevations to this line. It is also customary to start the line at some fixed mark which cannot be easily disturbed, such as the corner or top of a rock, the stump of a tree, a mark on a building wall, or the top of a hydrant, etc. This is called a bench-mark. In Fig. 6 let A be a bench-mark, and let us assume a datum line 100 feet below the level of the bench-mark A. The field notes corresponding to the operations shown in Fig. 6 are given in Fig. 7. Starting with the instrument between A and B, and taking a backsight on A, we find the distance $A\,a$ to be 4.2 feet, which added to 100 gives the height of the instrument. We next take foresights on B, C, and D, and record them in the proper column. It is evident from Fig. 6 that readings $B\,b$, $C\,c$, etc.,

Station.	Distance.	Backsight.	Height of Instrument.	Foresight.	Elevations.	Remarks.
A	0	4.2	104.2	......	100	Bench-mark, top of hydrant.
B	100	....	......	10 1	94.1	
C	60	......	......	7.3	96.9	
D	50	......	......	5.8	98.4	
T	......	4.1	99.1	9.2	95.1	Turning point.
E	70	6.8	.....	....	92.3	
F	110	......	......	9.5	89.6	
G	80	......	......	11.5	87.6	

Fig. 7. Field Notes corresponding to the Operations illustrated in Fig. 6.

subtracted from the height of the instrument will give the elevation at B, C, etc. This is done, and the results recorded in the proper column. The ground falls away so rapidly beyond D that it is necessary to set up the level further along and establish a new height of instrument. This is done by holding the rod at some convenient point as at T, called a *turning point*, and taking a foresight, which measures the

distance $T\,t$ (9.2). The level is then set up in its second position between E and F, and a backsight taken on the rod in the same position which gives the distance $T\,t'$ (4.1). Then the distance $t'\,t = 9.2 - 4.1 = 5.1$, and this subtracted from the previous height of instrument gives the new height which is $104.2 - 5.1 = 99.1$. A backsight is now taken on E, and foresights on F and G. These are recorded in the proper columns, and the elevations found by subtracting these distances from the new height of instrument.

The horizontal distances between the stations are measured with a tape as already described, and recorded in the second column. In plotting a cross-section from notes kept in this way, the datum line is first drawn, and perpendiculars erected at points corresponding to the different stations. The proper elevations are then indicated on these vertical lines, and a contour-line drawn through the points so marked.

The Transit.

The transit (see Fig. 8) is an instrument for measuring both horizontal and vertical angles, although for ordinary

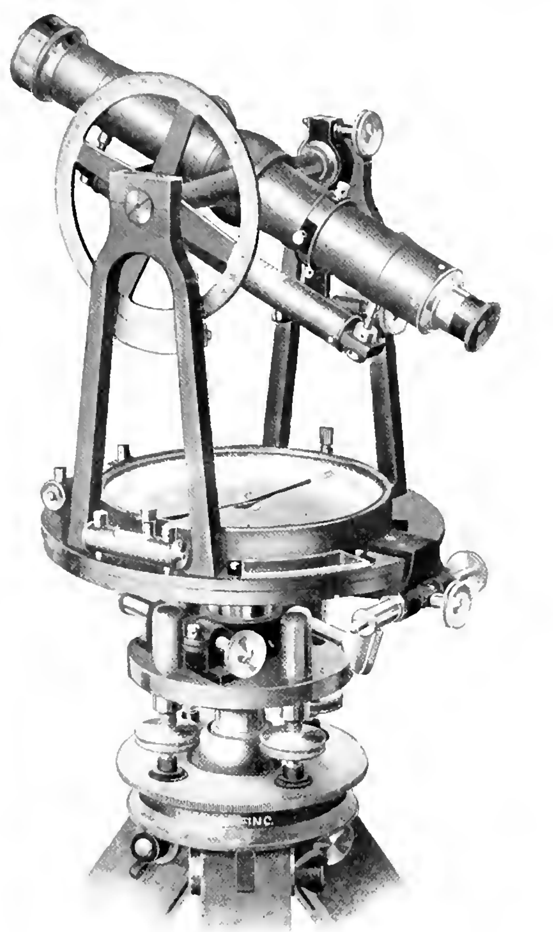

Fig. 8. Transit used for Measuring Horizontal and Vertical Angles.

work the vertical attachment is omitted. This instrument consists of a telescope mounted in standards which are attached to a horizontal plate called the *limb*. Inside of the limb, and concentric with it, is another plate called the *vernier-plate*. The lower plate or limb turns on a vertical spindle or axis which fits into a socket in the tripod head. By means of a clamp and tangent-screw, shown in the figure, it may be clamped fast in any position, and made to move slowly through a small arc. The circumference of this plate is usually graduated in divisions of either one-half or one-third of a degree, and in the common form of transit these divisions are numbered from some one point on the limb in both directions around to the opposite point which will be 180 degrees. The graduation is generally concealed beneath the plate above it except at the verniers. This upper plate is the vernier-plate, which turns on a spindle fitted into a socket in the lower plate. It is also provided with a clamp by means of which it can be held in any position, and with a tangent-screw by which it can be turned through a small arc.

A vernier is a device for reading smaller divisions on the scales than could otherwise be done. The method of reading a vernier is shown in Figs. 9 and 10. The lower scale represents a portion of the graduations upon the limb, and the upper scale, the graduations of the vernier. In Fig. 9 the vernier is set at zero, and in Fig. 10 the vernier-plate has been revolved through a certain angle which we wish to read. Looking at the pointer at the extreme right of the

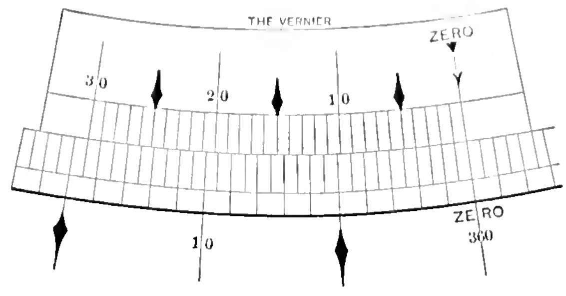

Fig. 9. The Vernier set at the Zero Mark.

vernier, we see that it stands between 20 and 20½ degrees on the lower scale. We next follow along the vernier until we find a division which is exactly in line with one on the lower scale; this we find to be 10 on the vernier, therefore, the reading is 20 degrees and 10 minutes. A vernier reading to minutes is sufficiently accurate for ordinary work.

The transit shown in Fig. 8 is provided with a compass so that the bearing of any given line with the magnetic meridian may be determined if desired. It also has a spirit level attached to the telescope so that it may be brought to a horizontal position and made to serve as a level. Fig. 11 shows an instrument known as the *architect's level*. This is a level with a short telescope, and is provided with a graduated circle and vernier for measuring horizontal angles. It is a very useful instrument for simple work, such as laying out buildings, etc., where great accuracy is not required. The transit requires various adjustments, a description of which may be had from the makers.

To center the transit over a stake, rest one leg of the tripod upon the ground, then grasp the other legs and place the instrument as nearly over the stake as possible. Then attach the plumb bob and center it accurately by means of the shifting head. Avoid having the plates too much out of level, as this will result in unnecessary straining of the leveling screws and plates. Having centered the instrument over the stake, level it up by the spirit levels upon the horizontal plate. To do this, turn the instrument upon its vertical axis until the bubble tubes are parallel to a pair of diagonally opposite plate-screws. Then, as you stand facing the instrument, grasp the screws between the thumb and forefinger, and turn the thumb of the left hand in the direction the

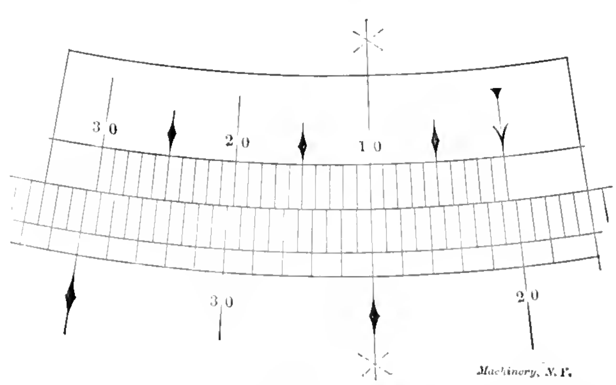

Fig. 10. The Vernier set 20 Degrees and 10 Minutes from the Zero Mark.

bubble must move. When adjusting the screws, turn both thumbs in or out, never in the same direction. Adjusting one level will disturb the other, but each must be adjusted alternately until both bubbles remain constant.

To measure an angle as between the lines $A\,B$ and $A\,C$ (Fig. 12), set up and level the instrument at A as already described, and clamp one of the verniers at the zero mark on the circle. Turn the telescope upon the target at B, and clamp the limb.

Unclamp the vernier-plate, and turn the telescope upon the other target at C. Read the vernier which had been set at zero, and the reading will be the horizontal angle through which the telescope turned from B to C. It is not necessary to set the vernier at zero before pointing at the first target The result will be the same if the vernier is read when pointed at the first target, and then again, when pointed at the second. The difference between the two readings will be the angle required. Care must be taken in this method to note if the vernier passes the 180 degree mark, and if so, to make the proper calculations. For simple work where there are but few angles to be measured, it is less confusing to set the vernier at zero each time, especially for those not experienced in the work.

The process of laying off a given angle is similar to that of measuring an angle. The transit is set up at the vertex

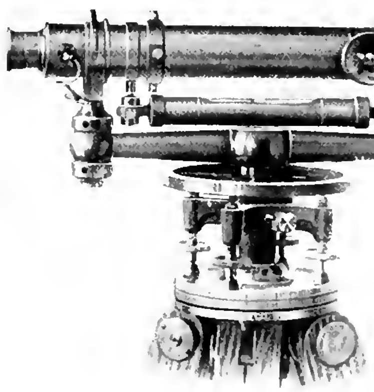

Fig. 11. Architects' Level.

of the angle, the vernier clamped at zero, and the telescope pointed at the target marking the direction of the fixed line. The limb is now clamped, the vernier unclamped, and the vernier-plate turned through the desired angle and clamped. A stake should now be driven in line with the vertical wire in the telescope, thus establishing the two sides of the angle.

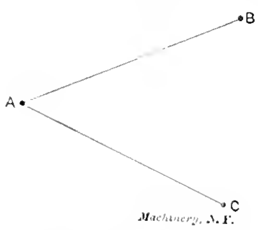

Fig. 12. Measuring a Horizontal Angle.

In laying out the foundations of buildings, a corner stake is first located by measurement, then the direction of one of the walls is laid out by driving a second stake. This direction may be determined by local conditions, such as the shape of the lot, or the relation to other buildings. If the building is to be an extension to, or in line with another building, the direction can be obtained by sighting along the building wall and driving two stakes in line with it. If it is to make a given angle with another building, this angle can be laid off as shown in Fig. 13. After the corner and the direction of one wall are determined, a right angle may be laid off (if the building is rectangular), thus locating two of the sides,

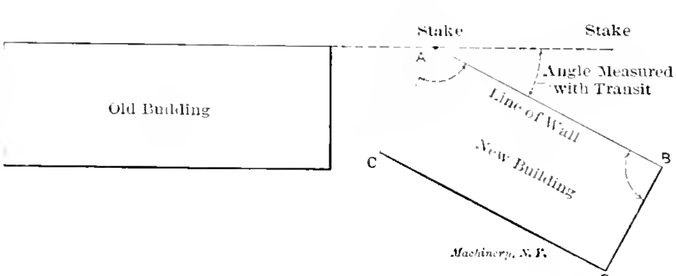

Fig. 13. Laying Out One Building at a Given Angle with Another.

as A B and A C. The length of the side A B is now measured, locating the corner B. The transit is now set up at B, and the line B D laid off at right angles to A B. A C and B D are then laid off the proper length, and thus the four corners of the building located. If the building had not been rectangular, the proper angles could have been laid off instead of right angles.

It is often desirable to make a block plan or map of the grounds and buildings of a plant. In Fig. 14 is shown the general method of plotting an irregular street or road, and of locating buildings with reference to it. First, locate a series of stations along the center of the street as A, B, C, etc. Then set the transit up at B and measure the angle A B C. Also measure the angle A B N by means of the compass which

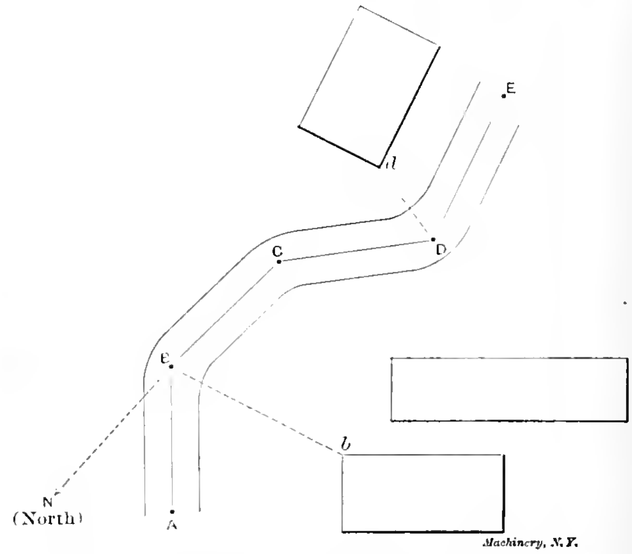

Fig. 14. Method of Plotting an Irregular Street or Road, and obtaining the Relative Positions of Adjacent Buildings.

is usually furnished with a transit, thus establishing the bearing of the line A B with the points of the compass. While the transit is at B the angle A B b should be measured, which, with the distance B b will locate the corner of the building. The direction of the building wall can be determined by continuing the direction of one of its sides, and measuring the angle between it and the magnetic needle of the compass. The instrument may now be set up at C and the angle B C D measured; also set up at D and the angle C D d measured, which locates the corner of the second building. Angle C D E is then measured in a like manner. All distances between stations should be measured by means of a tape.

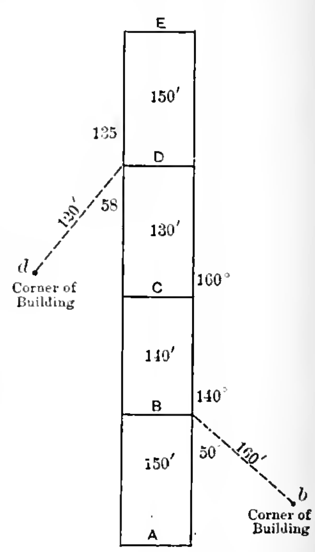

Fig. 15. Method of Keeping Notes for the Survey illustrated in Fig. 14.

The method of keeping the notes for the above survey may be as shown in Fig. 15. The different stations are represented by A, B, C, etc., and the distances between them are noted between the vertical lines, as 150′ 140′, etc. With each change in direction, the angle made by the preceding line is noted outside of the vertical column, and on the side which the line turns. For example, B C makes an angle of 140 degrees with A B, and turns toward the right; E D makes an angle of 135 degrees with C D, and turns toward the left. The line locating the corner of building at b, is measured from station B, and makes an angle of 50 degrees with A B. In plotting a map from the notes, the distances are measured off to a suitable scale, and the angles laid out by means of a protractor.

* * *

It is not too broad a statement to make, that it is of the utmost importance that every young engineer should from the start develop for his own use a system of record keeping of the information which he may use in his professional work and of the facts connected with the design, construction, maintenance, and operation of the plants, machinery, etc., with which he is connected.—*H. M. Brinckerhoff, in Stevens Institute Indicator.*

ON THE STATE OF THE PATENT OFFICE.

H. ADDISON JOHNSTON.*

If a prospector discovers gold-bearing rock on unclaimed land in the United States, he can, by doing certain things prescribed by law, secure to himself, his heirs and assigns, *forever*, the exclusive right to mine the gold that he has discovered. What he has discovered is *his* property.

If an inventor discovers (or invents) a new and useful combination of elements, in unclaimed ground in the United States, he can, by doing certain things prescribed by law, and *paying a considerable sum of money*, secure to himself, his heirs and assigns, *for seventeen years only*, the exclusive right to manufacture the invention that he has made. What he has discovered (or invented) is *his property*, but the government makes this bargain: "If the inventor will fully describe and make known his invention, and give it to the public after seventeen years, then the government will provide punishment for anyone who tries to steal the invention during the seventeen years, provided, however, that the inventor must himself catch the thief and prove his guilt.

What would be the result if the government passed a law that all the gold mines, the homesteads, and the coal fields were to be thrown open to the general public after seventeen years? Yet this is what happens to patented inventions.

Now, I do not wish to be understood as advocating an extension of the life of a patent; the point I wish to make is this: A man's invention is as truly his own property as is his house, or clothes, or farm; no one else has any right to it. Hence, in justice, there should be no attempt made to collect heavy fees from the inventor for the purpose of paying the expenses of the patent office. The country is benefited many times the cost of the patent by the mere fact of the invention being made and, in any case, if the government takes away his invention at the end of seventeen years, it has then much more than obtained value for any expense to which it may have been put in issuing the patent.

The present United States patent office stands in greater need of reorganization than any other institution with which I have had the misfortune to do business. It is safe to say that were any commercial firm to conduct its business with no greater regard for the satisfaction of its customers than the patent office shows in its treatment of applicants, it would close its doors in less than six months. A general criticism is productive of nothing but hard feelings, hence I proceed to details.

1. The whole story of the obtaining of a patent is delay, delay, delay. When an application is sent in it is delayed from a few weeks to several months before it is acted upon. When it is amended, another delay, and amendments and delays follow each other indefinitely. If the delays were eliminated many of the other sources of dissatisfaction could be borne with.

2. When an examiner makes citations against a case, instead of searching thoroughly and bringing out all the references to be had, either through lack of time, incompetence, or what not, he cites only two or three references. When the patent claims are amended so that the references are avoided, and the inventor expects the patent to be allowed on the next actions, instead, after a long delay, he gets two or three more references. This process may be repeated several times.

3. References are cited against applications which have no bearing on the case; when these references are shown to be irrelevant, they are dropped and new citations made which may have no more bearing on the case than the old ones. After each action there is a long delay. No other cause can be shown for this state of affairs than incompetence in the examiner. An examiner should be so familiar with the work of his class that it would be impossible for him to mistake the bearing of other inventions on the one in hand.

4. There is apparently no special examination made as to the ground covered by an application when it is first received. It is a most aggravating experience, after waiting several months for action on a case which has been amended several times to suit the office, and for which notice of allowance is expected, to receive an official communication asking for division of the application, and to find that nothing whatever has been done as to the merits of the case. This may cost the inventor six months of valuable time, and the worst feature of the case is that there is absolutely no reason for any lost time at all. Action as to the merits of the case need not be suspended just because division is required.

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5. Misleading information is published in the *Patent Office Gazette*. For instance, it may be stated in the *Gazette* that on February 1 in a certain class the oldest amended application awaiting action bears filing date of August 1 of the year previous. The applicant may have sent his amended application to the office many weeks before August 1 yet no action has been taken on his case. I have been unable to explain this discrepancy and it is exceedingly unfortunate that it should exist.

6. Copies of patents are allowed to run out. Surely it would be as easy to replenish the stock of copies just before the supply is exhausted as it is a month after.

It is not generally realized how much the present condition of the patent office operates to favor the large industrial corporations at the expense of independent inventors. A company that is already established and has its product on the market is continually taking out patents on improvements in its methods and manufactures. The longer such patents are delayed in issuing the better pleased is the company, for its mark "Pat. applied for," gives plenty of protection at first, and the effective life of the patent is lengthened by the time taken to have it issued. Patents have been purposely delayed in issuing for years for this very reason.

On the other hand the independent inventor needs his patent just as soon as he can get it. In 99 per cent of the cases he must obtain outside capital to develop his invention, and his only resource for so doing is his patent. When the patent is delayed, the inventor either has to stop work for lack of cash or is driven into hard bargains to obtain money to live.

Although justice demands that patents should be issued promptly, and to all alike, yet it has often seemed that a much more satisfactory method than the "general delay" practice now in use would be to give prompt action to those who requested prompt action, and delayed action to those who wanted delay or were indifferent. [We would emphatically object to delayed action in any case, because of the abuses fostered by delays.—EDITOR.]

After criticism of existing conditions, suggestions for betterment are in order, and I would suggest:

1. That the commissioner of patents be authorized to secure *sufficient* assistance in the patent office so that no application will be awaiting action more than ten days in any class.

2. That examiners be instructed to cite as nearly as possible all references upon the first action. The practice of continually bringing forward new references should be strongly condemned, and any examiner who constantly follows this practice should be deemed incompetent. In certain cases new references will naturally be found, but as a general principle the foregoing should apply.

3. That it should be deemed evidence of incompetence on the part of an examiner to cite references which have no bearing upon the case in point. The continual dropping of references upon explanation of the inventor and the citing of new ones is entirely unnecessary, and could be avoided by care on the part of the examiner.

4. That an examination as to correctness of form and ground covered by an application should be made immediately upon receipt of the application. If an examiner calls for the division of an application after one or two actions on the merits of the case, he should be made to pay the additional fees himself.

5. That the commissioner of patents be instructed to see that no further misleading information with regard to the amount of time the office is behind its work, is published in the *Gazette*. There is no reason why correct information cannot be given.

6. That a clerk be appointed to see that the stock of printed copies of patents is not allowed to run out. It is just as easy to start printing when there are 5 or 10 copies left, as to wait until some one has ordered a copy after the stock is exhausted.

7. That all the claims of a patent be printed in the *Gazette*. The recent decision to print only five claims of a patent in the *Gazette* seems to be extremely unwise. The value of the *Gazette* as a book of reference lies in its completeness. Printing the *Gazette* with claims missing all through it, would be on a par with publishing a novel with pages left out here and there. If it costs too much to sell it at its present price, raise the price, but publish all the claims.

8. That, if possible, a department of search be instituted at the patent office to make search of the records for intending patentees, at cost.

9. That the commissioner of patents be made a "general manager" with full authority to spend whatever money may

be necessary to get results, and that he be instructed to get results no matter at what cost. Would any man with common sense place an employe in charge of a business with these orders: "All business must be taken care of, no matter what the increase;" "The staff must not be increased nor any money spent except on postage, express and paper;" "Take in all the money offered; if the customers complain of delays, tell them it costs us nothing to wait"?

I have before me copies of Mr. Pratt's bills, H. R. 6173 and 6228 *re* patent office, one to increase the staff and salaries of examiners at the patent office, the other to increase the fees. I am certainly in favor of increasing the staff, and the efficiency of the staff, of the patent office, and, if it is necessary to increase the salaries to get competent men, by all means do so, but get them.

In regard to fees, as I look at the matter the fees should be kept at a merely nominal figure, say $25, or at just sufficient to keep down the number of applications for patents on inventions of little or no value. If the government absolutely refuses to consider the matter in this light and insists upon the office being self-supporting, then the funds should be obtained, not by raising the initial fee, but by requiring increasing license fees to be paid as the years pass. Let them be, say $25 for the third year, $50 for the fourth, $75 for the fifth, and $100 for the sixth, and succeeding years.

The independent inventor is an asset to the country and should be encouraged. Generally he finds money very hard to get at first. If his invention is worth anything by the time the third year is reached he will be able to pay the fees, if not, he can allow the patent to lapse without further loss to himself. The country does not lose anything in any case.

Since writing the above, the last report of the commissioner of patents has reached me, and in it some very interesting information may be found. I quote from it:

Over 56,000 patents applied for last year.

Total surplus to credit of patent office, January 1, 1908, $6,706,181.64.

Surplus last year, $275,000.

After stating that the force of examiners is not sufficient, and that more room is needed, and that part of the building now occupied is not suited for the work, he states:

"Examiners frequently work overtime to try to catch up with their work *in order that a good showing might be made before Congress met.* Their efforts under these conditions were at best spasmodic, and simply resulted in thousands of actions being made that were nothing more than frivolous. After one of these annual efforts it was necessary to do a greater portion of the work all over again, and it really had the effect of throwing the business of examination further back than ever. This resulted not only in vexatious delays to the inventors, but it caused hundreds of complaints to be filed, and what was still more embarrassing and serious, a great many applications were passed to issue that were not ready for patent, with the result that the inventors and owners of meritorious inventions forfeited valuable rights by these careless, ill-considered and hasty actions on the part of the office.

"The inventors are entitled to be protected as well as the public, and they should be helped by the office in all legitimate ways.

"The inventors pay the government for the work done in the examination and issue of their patents.

"Complaints against the conduct of affairs have been numerous and many have been based upon good and sufficient grounds. The affairs of the office should be so conducted that very few if any complaints could be lodged.

"I am most decidedly of the opinion that the present force cannot cope with it (the increased business of the patent office), and I have asked for a sufficient number of examiners and clerks to bring the arrearages up to date and to dispose of the great amount of increasing work material.

"If the force asked for is granted and made immediately available, I believe that the accumulated work can be disposed of, and that it will be possible in the future for the average inventor's application to be acted upon and either rejected or a patent allowed within thirty days of its receipt.

"The inventors are entitled to prompt action and they should be accorded it.

"The incompetency of a portion of the clerks in the examining and other divisions is in a measure responsible for the backward condition of the work."

The commissioner states that as soon as a man is well broken in to his work, he is offered more than the office is allowed to pay, to go to outside work. This is a fine (?) way to supply good patent attorneys for large corporations. The inventors pay for their education, and when they are worth something they move out. In the name of common sense, let the patent business be conducted in a businesslike way, which manifestly is not the present practice.

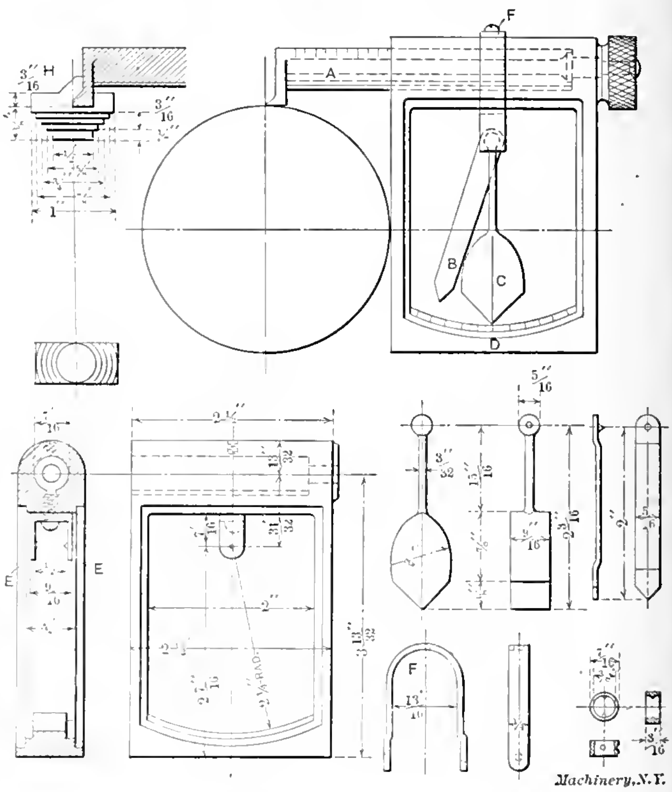
If proof is required as to the truth of my statements the report of the commissioner gives quite sufficient confirmation. The question is: "What are we going to do about it?"

* * *

DEVICE FOR LAYING OUT AND TESTING KEYWAYS.

W. O. RENKIN.

The accompanying cut shows a device which can be used either for checking the location of keyways already cut, or for locating the center line for keyways on shafts. Its particular usefulness comes into evidence when it is wanted to check the location of keyways at different parts of long shafts, the procedure of which is as follows: First, have the shaft lying free, but not necessarily level, and then place the side of the device against the shaft and the point of the bar *A* in the keyway, and set the indicator *B* directly over the center line of the plummet *C*. When the device then is moved to



Device for Laying Out and Testing Keyways.

different parts of the shaft, if the keyway is placed exactly in the center at each point, the plummet end and the indicator retain their relative positions. When it is wanted to locate the center line on shafts for cutting keyways, the bar *A* is screwed out until the point is located exactly one-half the diameter of the shaft from the side of the device, and then, with the shaft lying on a planer table or bed plate, adjust the device further until the plummet hangs directly over the center mark at *D*, after which the center of the shaft may be marked and the device moved to another point. As will be noticed from the detailed drawings shown, the body of the device has a recess on each side at *E*. This recess is intended for holding a thick piece of glass enclosing the plummet on the sides. The indicators are placed one on each side of the device, resting against the glass and held up to it by the saddle *F*. This permits the device to be used from either side. At *H* are shown different size "feet" for the center bar *A*. The writer believes that this is the only tool so far designed which can be readily used for this work without necessitating that the shaft be first levelled up.

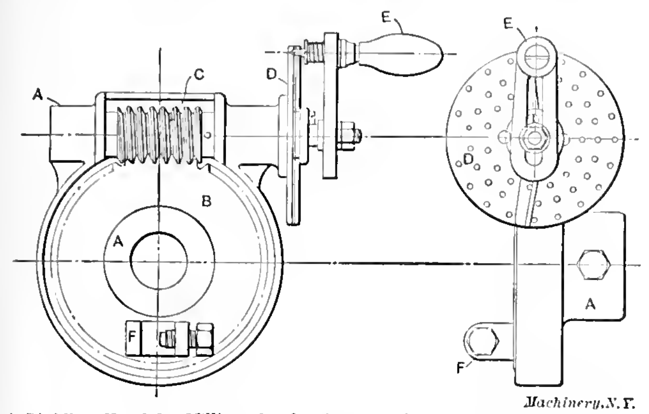
* * *

It is stated by the *Practical Engineer* that out of 824,000 tons of manganese used in this country, Great Britain, and Germany, during 1905, over 90 per cent was used for alloy steels.

ITEMS OF MECHANICAL INTEREST.

DIVIDING HEAD FOR USE WITH THE LATHE.

Occasionally it is necessary to do on the lathe a piece of work that requires dividing. If there is no milling machine in the shop, the lathe is sometimes rigged with a milling spindle on a knee attached to the carriage, for operating on work between centers. If a gear, for instance, is to be cut in this way, the question of indexing is often somewhat puzzling. If the number of teeth desired is a factor of the number of teeth in the main spindle driving gear, this may be used for indexing. If not, other more cumbersome methods have to be devised. The apparatus shown in the accompanying engraving is intended to give the lathe for such work, nearly as great facility as is offered by the milling machine



A Dividing Head for Milling, Graduating, etc., between the Lathe Centers; it is mounted on the Tail-stock Spindle.

with its dividing head. This device, which is patented, was illustrated in a recent issue of *Machines Outils et Outillage*, of Paris.

The main casting *A*, of the attachment is fastened, by the set-screw shown, to the tail-stock spindle. On the front side it is provided with a projecting hub which forms a journal for dividing worm-wheel *B*. The main casting encloses this wheel in a guard, and on its upper side is provided with bearings to support the shaft on which the worm *C* is mounted. The worm shaft is controlled by the adjustable crank *E*, having a pin entering holes in index plate *D*, substantially as arranged for the milling machine dividing head. The usual adjustable sectors are provided. The work, which is supposed to be mounted on centers, is driven by a dog whose tail is engaged in clamp *F*, bolted to the face of the index wheel *B*. It will readily be seen that any desired spacing can be given to the work thus mounted, by operating the index handle in the same way as in the milling machine.

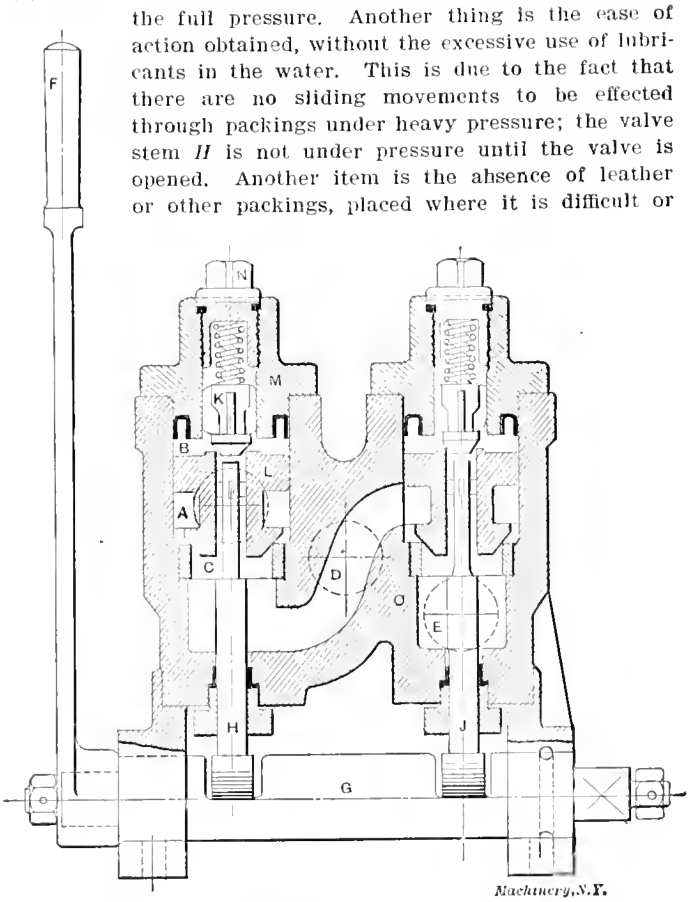
HYDRAULIC VALVE OF ENGLISH DESIGN.

A catalogue recently received from an English firm, Dewhurst's Engineering Co., Ltd., of Sheffield, describes a design of hydraulic valve for high pressures and large volumes that is ingenious enough to warrant some attention. A cross section of the valve is shown in the accompanying line engraving. In the case shown, there are two valves with an inlet at *A*, a connection at *D* for the hydraulic cylinder to be operated, and an outlet at *E*. These valves are operated by handle *F*, connected to rock-shaft *G*. Throwing *F* in one direction opens the inlet valve at *A*; throwing it in the other allows the water to escape from *D* through outlet at *E*.

The valve stems *H* are raised by cam surfaces cut in the upper side of rock-shaft *G*. The stems do not directly open the main valves; the upper end of a stem passes through main valve *L* in a hole large enough to allow it plenty of clearance, as shown, and when raised, it strikes against the bottom of pilot valve *K*, which it lifts against the pressure of the spring above it and against the pressure of the water in chamber *B*. Chamber *B* is filled with water leaking from inlet space *A*, past the easy fit of the piston portion of valve *L* between them. As soon as *K* is raised, the pressure in *B* rapidly drops to that in service connection *D*, since the outlet through the center of the main valve is much larger than the area through which the leakage escapes from *A*. Under these circumstances there is an unbalanced pressure on valve *L* from the water in *A*, which forces it from its seat on ring *C*. This unbalanced pressure is obviously due to the fact that the piston portion of main valve *L* is much larger in diameter than the seat on which it rests in ring *C*.

In closing, the reverse of this action takes place. Handle *F* being brought back to its central position, valve stem *H*, and with it pilot valve *K*, are lowered until the latter reaches its seat in valve *L*. Connection between *B* and *D* being thus closed, the leakage from *A* into *B* allows the pressure in the latter space to rise until it balances that in *A* when the coil spring has sufficient pressure to force valve *L* down against its seat. The two valves are identical in construction and operation.

This construction evidently has a number of advantages. The use of the small pilot valve, the only member which has to be lifted against the full pressure of the water, makes the apparatus more easy to handle than would be the case if the whole main valve *L* had to be raised from its seat against the full pressure. Another thing is the ease of action obtained, without the excessive use of lubricants in the water. This is due to the fact that there are no sliding movements to be effected through packings under heavy pressure; the valve stem *H* is not under pressure until the valve is opened. Another item is the absence of leather or other packings, placed where it is difficult or



A Hydraulic Valve which is controlled by the Operation of a Small Pilot Valve.

impossible to detect leakage past them. Packing is provided for plug *N*, cap *M* and valve rod *H*. All of these, it will be seen, pack against the atmosphere. It will also be noted that both the main and pilot valves can be easily reground without breaking any of the hydraulic joints. There would appear, also, to be little danger of shock from sudden closing of the valves, since the lowering of main valve *L* to its seat on *C* is effected by the leakage from *A* to *B*, which can be made as gradual as seems advisable, being regulated by the fit of *L* in its cylindrical chamber in main casting *O*.

* * *

Once in a while we find the idea cropping up of using an impeller instead of a propeller for driving a ship. In other words, the jet propulsion idea is one that inventors seem to still worry about. The jet or hydraulic propulsion has, however, been tried a great many times with very little success. The trouble seems to be the low efficiency of the pump or impeller, the combined propulsive efficiency of which is far below that of the screw propeller. The constant failures of many inventions seem to indicate that jet propulsion, like rotary steam engines, belongs to a class that are more interesting to the ingenious inventor than useful to the practical shipbuilding engineer.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE RECOGNITION OF ABILITY.

From an interview with President Nash of the Corn Exchange Bank of New York, published in a recent Sunday issue of the *New York Times*, we quote the following:

"Too many of our young men seem to lack distinction, originality of thought—I might say initiative. In a word, they do not think for themselves, and make suggestions. I know how it is here in the bank. We have a number of young men who are capable, intelligent fellows. They do their work in a satisfactory way. Yet they do not come forward with new ideas. That is the thing a modern business man is always seeking in an employe. I know we are always glad to get them. We may not follow the suggestions, still the ideas are welcome."

We do not wish to put ourselves in the position of criticising Mr. Nash, who is a man of great ability and strong character; but it is not going too far to say that the sentiments he expresses, though superficially true, are radically false, as thousands of men of suppressed ability can testify. One would think from the banker's language that men in authority are always eagerly sensitive to the slightest sign of originality in the ranks of their subordinates. In reality this is so only in exceptional cases. In the first place, the commanding officer is often temperamentally unfitted to recognize ability in a subordinate. It is one of the rarest qualities of genius to be able to do this, and instead of seeking new assistants, most captains of industry have to be content with using, to the limit of their capacity, the men whom chance and natural aptitude combined, have brought to responsible secondary positions. Besides this, even though the leader may have this power of recognizing genius, there must necessarily be so great a gulf fixed between him and the private that it is only by some stroke of good fortune that the latter ever comes in contact with his superior at all. Even though he may persistently seek that contact, he has still to pass the high and wide barrier of arrogance and petty jealousy erected by secondary officials.

There is most certainly a fortuitous element in success. There are many men of the class of our banker, but without his unusual ability and character, who have been carried into power and place by the swelling tide of our national development, nothing more having been required of them than the ordinary common sense and application daily exhibited by tens of thousands of their less fortunate brothers. Where, for instance, are the life insurance presidents of yesterday, whose great ability (we were told) was the cause and justification of the enormous salaries they received? After the storm which swept these men from their lofty positions, down to the level where men compete with one another on the hard, cold terms under which such competition rages in our times, these men were never heard of more. Their places are acceptably filled by other men with smaller salaries, and who doubts but that there are scores yet left who could replace the present incumbents if they should step from their positions?

This fortuitous element in success is one of the most discouraging things the young man has to face. In "Captain Stormfield's Visit to Heaven" Mark Twain causes the narrator to discover that the other world is a place where men are rewarded according to their real ability, and not according to their earthly reputations. He found, for instance, that the greatest general in Heaven, to whom Napoleon, Cæsar, and Alexander bow in humble reverence, was an East Boston cobbler who lived during the Revolutionary War. He had in him a military genius the like of which the world has never seen. He tried again and again to enlist as a private, but was refused each time, owing to the fact that he had lost his trigger finger. Most young men are not content to wait for Heaven to have their abilities recognized, and they would chant an earthly hymn of praise to the wise counselor who would give definite, positive, practical information on the question of the successful marketing of ability. Let us have something of this kind, in place of the conventional lament over the lack of originality and initiative in the decadent generation to which we belong.

* * *

THE WIVES OF OUR READERS.

It may seem a trifle inquisitive, but we must admit that we are vitally—because pecuniarily—interested in the wives of our subscribers. As nearly as we can figure it out, a large proportion of the readers of MACHINERY are young men. Along about twenty-two years of age or thereabouts the normal young man is beginning to think quite seriously of the possibility of supporting a wife in the style to which she has been accustomed. He has perhaps had difficulty supporting himself on the salary he has been receiving, and the prospect seems almost hopeless for two. A condition of this sort is a powerful spur to ambition, and MACHINERY and other technical papers, as well as scientific text-books and the correspondence courses, all play their part in assisting the desperate youth to a better livelihood.

In too many cases the effort is a spasmodic one, never repeated; and this is often the fault of the wife. There are exceptional men, of strong enough personality to sink or swim independent of the influence of the other half of the family; but made up as most of us are, the need for courage and ambition in the wife is a vital one. As the man gets along toward middle age and loses the exhilaration of high animal spirits, the possibility of progress seems to be dependent on efforts which become more and more difficult. Take the simple matter of subscribing to MACHINERY, for instance. With a house full of children to feed and clothe, there seems to be a need for every available dollar that can be brought into the family, and the few luxuries have to be carefully planned for. Under such circumstances we can imagine the wife saying "Why do you keep spending money for that old MACHINERY? Why don't you get something we can both enjoy?" And thus MACHINERY and the machinist alike are foully dealt with.

There is a moral to this, which we leave those of our readers who are contemplating matrimony to discover.

* * *

The man who is worthy of being a leader of men will never complain of the stupidity of his helpers, of the ingratitude of mankind nor of the inappreciation of the public. These things are all a part of the great game of life, and to meet them and not go down before them in discouragement and defeat is the final proof of power.—*Elbert Hubbard.*

HIGH-SPEED STEEL FOR MILLING CUTTERS.

A great many opinions have been expressed in the technical press regarding the value of high-speed steels for milling cutters. An article by Mr. Robert Grimshaw appeared in February, 1907, MACHINERY, in which were given the opinions of several German firms, all of whom pointed out that high-speed steel was not very efficient for milling cutters, because the cutting speed cannot be increased in the same proportion as on lathe tools. The difference in the results of milling and turning is accounted for by the fact that high-speed steel must be heated to a certain degree by the cutting operation in order to most effectively perform its work; and continuous heating of the milling cutter teeth is impossible, because they are in contact with the work for only a part of each revolution, and are cooled off in the air during the interval.

While this reasoning is undoubtedly correct, we understand that both here and in England a number of the leading manufacturers, who are users of milling cutters, find that although the cutting speed can be only slightly increased, so that the saving in time does not in itself outweigh the increased expense of material for cutters of high-speed steel, such cutters retain their cutting edges much longer than those made of ordinary tool steel; and this fact, when considering the question of economy, is nearly as important as that of high cutting speed.

In large shops, where several hundred milling cutters are in constant use, their grinding is a very important item in the expense account, and as high-speed steel cutters have to be ground less frequently, that is a distinct saving. The labor cost in the making of milling cutters is considerable, in many cases so great that the cost of material is small in comparison; and the greater the labor cost the more important it is to use material which adds to the cutter's life. The greater cost of high-speed steel becomes a heavy item in tools where the labor cost of making the tool is comparatively small; but in the case of a formed milling cutter, where the labor cost is large, the difference in the total cost between ordinary carbon steel and high-speed steel becomes insignificant.

* * *

THE GROWING RESPONSIBILITY OF WORKMEN.

Those who read the editorial on "The Growing Inefficiency of Workmen" in the December MACHINERY, will understand that we are not satisfied with the attitude of labor, particularly in the larger centers of population. We wish it were possible to find words to set forth the responsibilities and possibilities which are presented to the men in this country who make their living by the work of their hands. One often gets the impression, after listening to speeches in meetings of manufacturers' associations, industrial educational societies, etc., that it is the duty of the employer and educator to lead the American workman in the way he must go, if certain "national perils" are to be avoided.

Despite the folly often displayed by individual and organized labor, we believe that the paternal position thus taken by its "superiors" is fundamentally and absolutely false. We believe that from the workingman is coming in the present, and is to come in the future, the enthusiasm and intelligence which are to solve some of the difficulties which now seem so thickly to beset our path. He may listen to the employer and the educator, but he must think and decide for himself. Clear and honest thought devoted to the problems with which he has to deal, will convince the workman that the attitude taken by many of his fellows is wrong. As a beginning, how would it do to meditate on the matter of the truth or falsity of the following propositions:

Inefficiency and loafing—in other words, restriction of output—will not help the workman as an individual or as a class; the whole effect is injurious.

Improved machinery and processes work no harm to labor as a class, though they may temporarily injure individuals. Labor has profited from their producing power in the past, and should profit therefrom even more in the future.

These propositions touch but one side of the problem, and the employers' side at that—to judge from surface appearances. But they do not trespass on debatable ground, questionable as they may appear. A clear understanding of them is essential to an intelligent search for the still unknown, or at least unapplied, solution of the problem of the proper distribution of wealth.

* * *

FINE FINISH ON MACHINERY.

There is a growing tendency to leave off all ornamental finish on manufactured machinery. The reaction from the absurd practices of two generations ago seems to gain momentum, and perhaps it is time to call a halt before it goes too far. To illustrate, take past and present locomotive practice. In the '50's and '60's many passenger locomotives were marvels of polished brass, walnut cabinet work, bright paint and fancy striping. It gradually dawned upon railway men that though high finish meant no greater tractive power or higher speed, it did mean higher first cost and continued expense to keep it in good order, and then came the change to the other extreme. But, while the change to the present style of severely plain finish has the merit of lessened first cost and economy of up-keep, it is not without certain disadvantages. Human nature is unchanging in its love for the bright and shining; it is a trait common to all. We admire the beautiful, and the beautiful attracts and holds attention when the plain receives scant respect. The romance of the locomotive has largely departed with the coming of the severely plain styles, and with it has gone the love of the engineer for his engine. The practical is not everything, and it is quite possible that the large economy supposed to result from plain finish is more imaginary than real.

On machine tools considerable ornamental effect is possible in the finish of working surfaces. Most machine builders believe that all flat working surfaces, such as cross-rails, planer uprights, V-ways, etc., should be carefully planed, and afterwards scraped with hand tools, to surface-plates, leaving the surfaces ornamented in approved fancy designs. Now the iconoclasts argue that all this hand work is waste effort. They aver that hand scraping does not improve the accuracy of the flat surfaces but that it rather has the contrary effect, and they would have all flat working surfaces left in the condition produced by the planer. We are not prepared to accept the proposed reform yet, and there are many others of like mind.

In the first place, we believe that intelligent and careful scraping does improve the accuracy of most planed work. It doubtless is possible to produce planed surfaces that cannot be improved in accuracy by scraping, but that is not the general condition of planer work "by a long shot." In the second place, scraping changes the nature of the surface and materially improves its wearing quality. Scraping both smooths and condenses the surfaces, and a scraped surface is not so likely to scratch and cut as an unscraped surface. The unscraped surface has a "fur" of minute iron particles detached, but still clinging to the solid iron underneath. The scraper cleans this dust off, leaving a clean, hard surface ready for immediate use. In the third place, the effect of the beautiful finish on the buyer and user should be considered. We would not do away with all attractiveness, and a handsome machine tool is quite as desirable as a handsome suit of clothes. We all might wear burlap, but the resulting economy would be largely imaginary. The average man would lose more in efficiency and self-respect than he could gain by the saving in cost. In short, the utilitarian is not all of life. We must have ideals, and love for ideals is a sentiment of practical value in business as well as in art.

* * *

The value of a developed water-power is stated by Charles T. Main, mill engineer and architect, of Boston, to be as follows: "If the power can be run cheaper than steam, the value is that of the power, plus the cost of plant, less depreciation. If it cannot be run as cheaply as steam, considering its cost, etc., the value of the power itself is nothing, but the value of the plant is such a sum as could be paid for it new, which would bring the total cost of running down to the cost of steam power, less depreciation. That is, it is worth just what can be gotten out of the plant, and no more."

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

An unusual power contract has been made by the city of New York with the New York Edison Co., for supplying power for the operation of electric pumps for the new emergency high-pressure fire mains. A penalty of $500 per minute is imposed for the failure of the electric power supply within three minutes after a fire alarm.

In the December, 1907, issue of MACHINERY, we mentioned that the German Society of Engineers had discontinued the work on its *Technolexion*, on account of the high cost. It is stated in the *Times Engineering Supplement* that the society has appealed to the Prussian Government for assistance in finishing the work, and it will depend upon the decision of the Minister of Education whether the work will proceed or not.

At a meeting of the Institution of Mechanical Engineers, of Great Britain, one of the speakers mentioned that the manager of an automobile factory had stated to him that by using distilled water as a cooling medium and cutting lubricant, in place of ordinary water, he had been able to increase the life of the milling cutters, used in the factory, from five to ten times. Condensed steam from the steam engine would serve the same purpose as distilled water.

The production of denatured alcohol for the first six months of 1907, under the new law covering its manufacture, amounted to 1,774,272 gallons. The supplemental new alcohol law will, it is estimated, lead to a production of 4,000,000 gallons for the calendar year. The operation of the law has already reduced the cost of wood alcohol from prices varying between 60 and 75 cents to 30 cents a gallon, a fact which amply indicates that a fairly efficient monopoly has been established in the wood alcohol business.

Vice-Consul-General Paul H. Cram, of Marseilles, France, in a report to the Department of Commerce and Labor, calls the attention of American manufacturers to the fact that it is of very little use to distribute catalogues, printed in the English language, in France, and also to the fact that circular matter or letters should state dimensions and weights in the metric system, and prices of goods, delivered in France. Letters to France should also preferably be written in French.

New records in wireless telegraphy are constantly being established. A despatch from Berlin states that the Wireless Spark Telegraph Co. has transmitted a message between its station near Berlin and the Hamburg-American liner, *Cape Blanco*, off Teneriffe, a distance of 2,290 miles. Wireless communication has been established between the coast of Morocco and Paris, France, the Eiffel tower station communicating with war ships on the coast of Northern Africa, a distance of nearly 1,200 miles.

Experiments have been carried on for several years at the Oerlikon Machine Works, in Switzerland, with electrical trains for the purpose of ascertaining the best methods of electrically operating main line railroads with heavy traffic. The experiments are now closed, and, according to the *Railroad Gazette*, the system adopted is single-phase alternating current of 15,000 volts, with 15 periods per second, using overhead conductors. The experiments are said to have determined that there is no danger in employing high voltage, *provided proper precautions are taken*. The question is: "What are they?"

In the discussion of one of the papers presented before the December meeting of the American Society of Mechanical Engineers, it was stated that the limit of superheating desirable for Corliss engines is 500 degrees F. If the steam is used at a higher temperature, the valves warp and bind, due to their unsymmetrical form, and in some cases, cylinders have been known to change their shape sufficiently to cause difficulties. In engines fitted with ordinary slide valves, no difficulty is experienced, except with lubrication, but this has, in some cases, been overcome by direct oil connections to the valve seats.

It is stated that, at the present time, there is a large demand for machinery in China. The imports of machinery are constantly increasing, being, in 1906, nearly three times as high as the average for the previous five years. Great Britain supplies the greatest amount of the demand, Germany, the United States, and Belgium coming next, in order. Industrial undertakings are, at the present time, favored to a great extent by the Chinese, and there is undoubtedly an opportunity for firms who are able to supply considerable quantities of the machinery demanded.

A short description is given in the *Practical Engineer* of a number of "rail-less tramways" now in operation in different parts of Germany, for the conveyance of both passengers and goods. The cars consist of dirigible vehicles, propelled by electric motors, which receive their current from an overhead conductor, supported on trolley poles. The cars have sufficient freedom of movement to enable them to turn aside about 12 feet in either direction from their wires. When two cars, traveling in opposite directions, meet, the contact rods of one are removed from the wires, and replaced when the other car has passed by. The first tramway on this system was constructed in Saxony, in 1901.

It is stated in *The Times* (London) that the Danish Government is considering a project to construct a railway tunnel under the Great Belt. The total length of this tunnel would be about 17 miles, of which 12 miles would be under the sea. The estimate of the cost is put at slightly more than $7,000,000. At the present time, there is a train ferry service across the Belt, but it is often handicapped by bad weather, and it is calculated that the tunnel service would be profitable, even if the cost were considerably more than the estimate given. Test borings have shown that the condition of the materials in which the tunneling work would have to be carried out is favorable for the work.

It is mentioned in the *Mechanical World* that an English firm has lately been experimenting with the object of producing a file which will do more work and last longer than files made from ordinary tool steel. The outcome of these experiments is a new special chrome-steel file. These files have recently been tested at Sheffield, with excellent results. The total number of strokes made with the file tested was 270,000, the strokes per minute being 51, and the number of hours 88¼. The amount of filings removed during this time was 10½ pounds. The makers, W. Atkins & Co., Ltd., Sheffield, England, claim that this is far in excess of any result known at the present time, and that it represents a marked advance in the cutting power and ability of files.

The German navy has ordered one of its ships to be fitted with an electric propulsion system of the Siemens-Schuchardt type. According to this system, the power generated in the engines—in this case steam turbines—is converted into electric energy, and part of it is stored in accumulators and is utilized as occasion may require. It is not stated what advantages are expected to be derived by this system, excepting, possibly, greater flexibility of the power. The steam turbine alone, of course, drives the propellers at too high speed for economical working, whereas if the steam turbine is used at a high speed of revolution, and corresponding high efficiency, and electric power transmission, with low rotating speed of the propellers, is employed, greater economy is obtained. The propellers can be controlled directly from the bridge by this method, which, of course, would be a decided advantage.

As a result of a two years' trial of a four-cylinder, balanced, simple locomotive, on the London and South Western Railway of England, says the *Railway and Engineering Review*, a number of ten-wheel locomotives of this type have been designed and built by the railway, and put into service as a standard for heavy passenger service. The boilers of these locomotives have a tube heating surface of 2,210 square feet, a fire-box heating surface of 160 square feet, and 357 square feet of additional fire-box heating surface, secured from cross water-tubes. The grate area is 31.5 square feet. No injectors are used, these being replaced by two duplex feed-pumps, and the feed-water is heated by the exhaust steam from the pumps. All the cylinders are 16½ x 26 inches, the exterior being coupled to the middle drivers, and the interior to the forward drivers. The exterior valve motion is Walschaerts' and the interior, Stephenson's, both handled together by a steam-hydraulic device. All the cylinders exhaust through one pipe. The drivers are 72 inches in diameter, and the engines weigh 52 tons on the drivers, and 75 tons complete.

The passage of the free alcohol bill by Congress last year did not carry with it such enormous immediate changes in its use in the industries as was predicted, nor did the price of denatured alcohol fall to anything like the figures intimated. There are, however, strong indications that alcohol finally will become cheap enough to enter into active competition with gasoline and kerosene for a variety of power purposes. It has been shown by a congressional committee investigating the matter that the total cost of producing a gallon of 90 per cent alcohol at a large distillery in Peoria, Ill., is 18.4 cents. This, however, was when producing alcohol directly from corn. A far cheaper price may be reached by producing alcohol from potatoes, or even from the stalks of corn and corn cobs. In Cuba alcohol is now made from a cheap grade of molasses, which ordinarily is a waste product, at a cost of 10 cents a gallon, and there is no good reason why we may not ultimately expect the same low level of price to be reached in the United States. If the price were right, alcohol would, for many reasons, be far preferable to any of the common liquid fuels for power purposes.

In an article in the *L'Electricien*, a system of winding magnet coils, using bare wire, is described. The reason for the possibility of using bare wire in winding is that when two adjacent turns of the wire come in contact, they only make a line contact, and the resistance of this contact will be so great compared with the resistance of one turn of wire, that the current will flow through the wire rather than across the contact. If then the coil consists of but one single layer of wire, it is not necessary to insulate this wire, as the resistance of the contact will be sufficient to prevent short circuit. Of course, this does not apply to the second layer of wire, since the latter will come in contact with the layer below, and the resistance of the contact will be small compared with the total resistance of the intervening turns of wire. Consecutive layers, of course, have to be insulated from one another. The system is evidently limited by the diameter of the coil of the wire. If the diameter of the coil is large, and the wire is small, the current may pass across from turn to turn easier than by passing around the coil. Therefore the system is suitable for large coils only in cases when these are wound with fairly large wire. It is claimed that magnet coils wound in this way have proved satisfactory.

The automobile situation abroad seems, in some respects, not to be any more promising than that in the United States. The stocks of some of the French automobile companies have declined heavily, and although the year just closed has been one of greater sales and greater activity than in any of the previous years in the automobile industry, the future is not promising. One German automobile firm has issued a statement, in which it is claimed that a great deal too much has been spent by automobile manufacturers on exhibitions of all kinds, and that it would remove a great burden if the manufacturers would free themselves from excessive demands made upon them in this direction. The German automobile manufacturers at their annual meeting, voted not to take part in any German automobile show before September 1, 1909. This tendency undoubtedly is one which must be considered as indicating a new and healthy development of the automobile trade. The automobile shows have been largely devoted to exhibiting luxurious cars, for pleasure purposes, the commercial vehicles having been almost totally neglected. There are strong indications in Europe, as well as in the United States, that this condition will cease, and the tendency toward that firmer basis on which the industry will be placed when attention is given to vehicles that will be actually useful, is the most hopeful sign of the present time.

Should aerial flight ever become an accomplished fact so far as humanity in general is concerned, the exhibit of Mr. Henry Farman in Paris, January 13, will become of considerable historical interest. Mr. Farman sailed nearly one mile in a circle with an aeroplane flying machine heavier than air, and won the Deutsch-Archdeacon prize of $10,000. The flight was made at a height of 25 feet from the ground, and the speed averaged 34 miles per hour. The machine in plan is somewhat like that of a bird, the two wings being duplicated by two aeroplanes, one above the other on each side, with a third double aeroplane trailing behind to form the tail. The propulsion is effected by a propeller driven by a 50 H.P. gasoline engine of extraordinary power in proportion to its weight, which is approximately only 175 pounds. To enable the machine to rise from the ground, it is necessary that it be mounted on wheels so as to gain sufficient speed to balance its weight on the air before rising from the earth. These wheels are of very light construction, similar to those used on bicycles. The successful trial demonstrated that it is possible to build machines heavier than air which can raise themselves from the earth and sail in any direction, under favorable atmospheric conditions. For brief review of recent dirigible balloon exploits, see MACHINERY, January, 1908, page 281, Engineering edition.

The results obtained from some interesting experiments undertaken to ascertain the bursting strength of malleable iron pipe fittings, were published in *Power* some time ago. These experiments were undertaken by the Pittsburg Valve and Fittings Co., and the tests were made on 4-inch standard threaded malleable iron tees, both black and galvanized. The metal of all the fittings was ¼ inch thick on the body portion. It was found that the average bursting pressure for the black fittings was 2,900 pounds per square inch, and for the galvanized fitting, 2,833 pounds per square inch. The working pressure recommended by the manufacturers for these fittings is 150 pounds, giving thus a factor of safety of about 19. One of the interesting facts proved by these experiments is that the galvanized fittings can stand practically the same pressures as the black, which is contrary to the expressed belief of many users of malleable fittings, who have been very positive in their statements that galvanizing greatly weakened the strength of the pipe, because the dipping of the fitting in a bath of molten zinc, and then suddenly cooling it by immersing in cold water, would have a tendency to bring the castings back to the unannealed state, making them hard and brittle. That this theory is not correct is conclusively shown by these tests. As compared with experiments undertaken with cast iron tees, the strength of the malleable fittings is more than 50 per cent greater than that of cast iron fittings. In most cases the malleable fittings developed leakage through minute "pin holes" at pressures ranging from 1,000 to 2,500 pounds. In no instance were these pin holes visible below a pressure of 1,000 pounds with the black fittings, or below 2,000 pounds with the galvanized fittings, while two of the galvanized fittings sustained a pressure of 2,500 pounds before pin holes developed. It is therefore evident that galvanizing is very effective in closing small imperfections or pin holes in the malleable iron.

ELECTRIFICATION OF THE SWEDISH STATE RAILWAYS.

More detailed information regarding the electrification of the Swedish State Railways has now been published. As will be remembered, we have several times referred to the plans for the electrification of the Swedish State Railways, which

proposition has been given thorough consideration by the Swedish government, particularly because of the abundance of water power available in the country, and because of the fact that coal must be imported at high cost. For some time past the government railway administration has carried on various experiments with electric power on a part of the State Railways, outside of Stockholm, and the estimates for the cost of power of installations necessary have been founded on the results of these experiments. The length of the railways which would ultimately be electrified is about 1,300 miles, the total length of track, including double track and sidings, being somewhat more than 1,800 miles. Five water falls of great capacity, located at various parts of the country, will give the required power. Power transmissions will conduct electric current of 50,000 volts, which will be transformed to 15,000-volt current in the contact conductors. The transformers will be located about 30 miles apart. The total cost for conductors and transformers is estimated to be nearly $10,000,000, and for the power stations, about $6,500,000, to which would be added $400,000 for special buildings required. The estimates show that at the present time, the saving of electrification over steam traction would amount to $120,000 a year, but when the traffic increased about 60 per cent, as it is estimated that the traffic will by 1920, the saving would amount to about $400,000 a year. The estimates have been

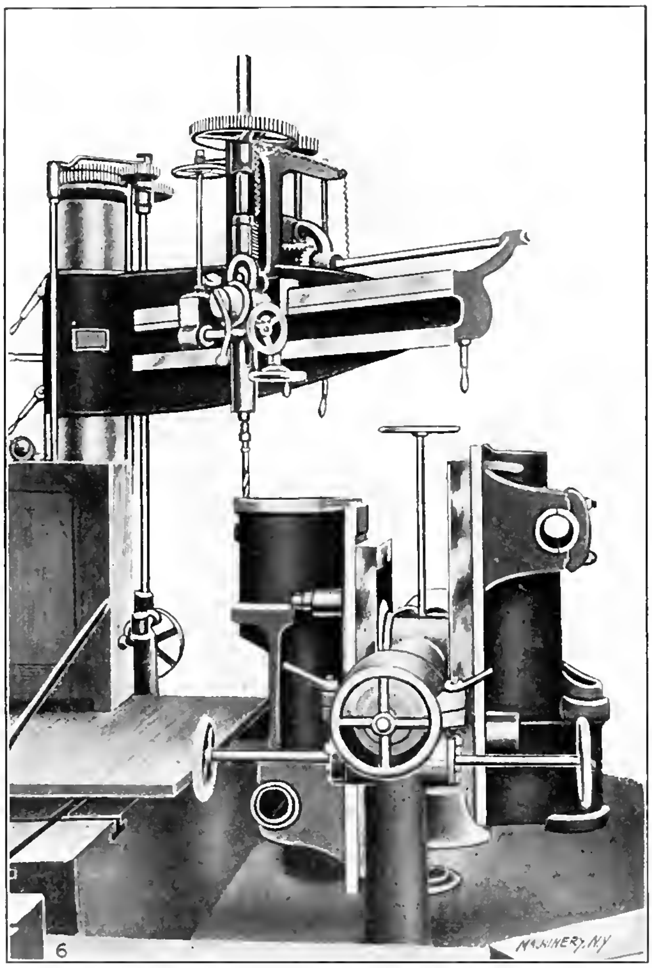


Fig. 1. Universal Table for Machine Tools.

carried out carefully into details, and it is believed that this is the most thorough scheme for the electrification of railways that has ever been worked out anywhere. A complete official report regarding all the experiments which have been carried out by the Swedish Government Railways, and the results obtained, is to be expected in the near future.

That these plans are not merely to be made on paper, but are intended to be actually carried out, is indicated by the fact that the Swedish Government, at the present time, is building its first large power station which ultimately will be capable of developing 100,000 horse-power, and has possibilities for being increased to 180,000 horse-power through the purchase of some additional water rights. This power station will not be completed to this enormous extent all at once, but, at the present time, four generators, to be driven by water turbines, have been ordered from the General Swedish Electric Co., in Västeras, Sweden. These generators will be the largest that have so far been made in Europe. They will be made of the horizontal type, and will have an outside diameter of 27 feet. Each will generate 10,000 horse-power, normally, the maximum load being 12,500 horse-power.

UNIVERSAL TABLE FOR MACHINE TOOLS.

Zeitschrift des Vereines deutscher Ingenieure.

The accompanying half-tones, Figs. 1 and 2, and the line cut Fig. 3, show the design and application of a universal table, the principles of which may be applied to many different classes of machine tools. It is primarily intended for

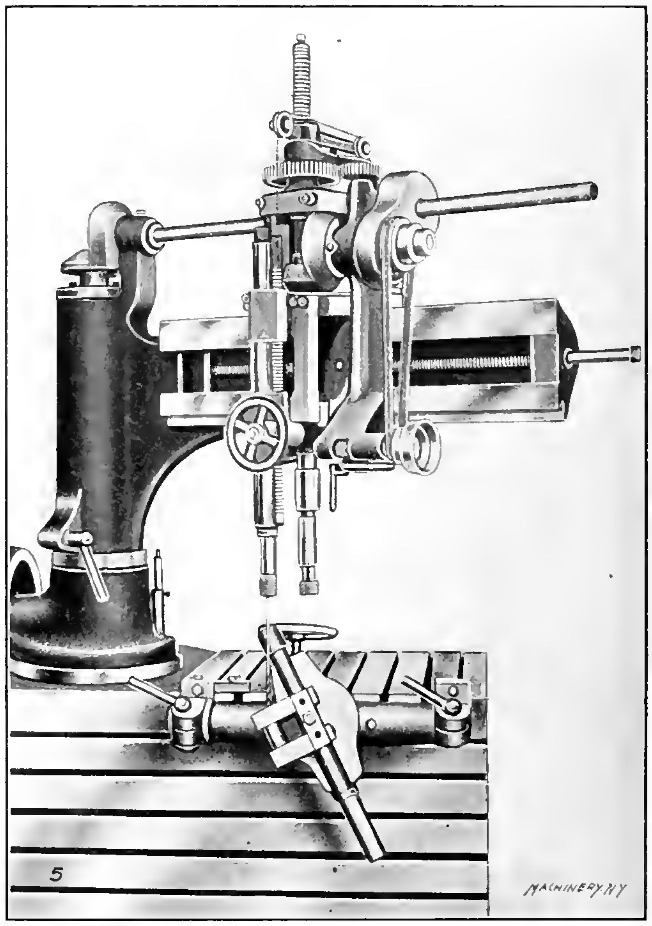
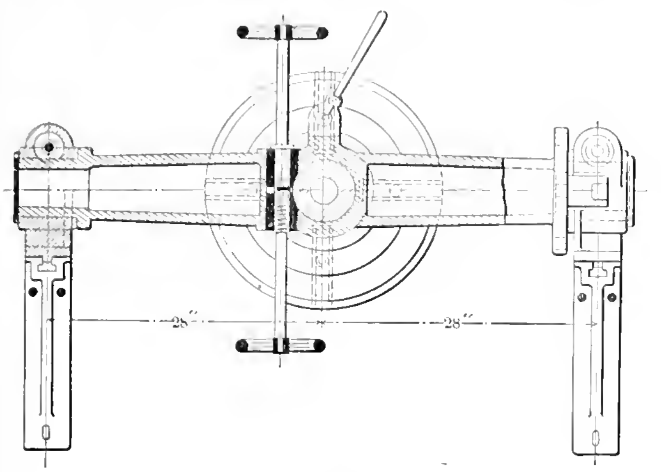


Fig. 2. Type of Universal Table used for Small Work.

pieces of work which have to be held in several different positions in drilling machines, or in special milling machines, permitting, as shown in the cut, the turning of the piece being worked upon to almost any position. The usefulness of the device in the radial drill press is most apparent from Fig. 1. The device may be mounted in different ways. In Fig. 3, for instance, it is mounted on two brackets, which are bolted to the side of the removable square table usually furnished with radial drill presses. These two brackets are provided with T-slots to which the device is clamped. This permits the device to be moved in and out along the ways on the brackets.

The device itself consists of a rotating arbor having trunnions mounted in bearings immediately over the brackets. By means of a hand-wheel, and a worm and worm-gear connection, the device can be turned to any position around the axis of the arbor. The table to which the work is clamped, is mounted at the center of this arbor, and can be swung around its own axis. The combination of this swivelling table and the rotating arbor make, of course, a perfectly universal device. The table, as well as the rotating arbor, is provided with suitable means for clamping, as will be seen in Fig. 3. There is one table provided for each side of the arbor, thus permitting work to be clamped on both sides. The half-tone, Fig. 1, shows the usefulness of this arrangement. The design of the device, as shown in Fig. 1, is not

exactly the same as that shown in the line cut, Fig. 3, but the principles applied are exactly the same. In the half tone, however, the tables are square, and are also capable of a longitudinal movement. In the cuts shown, two gas engine cylinders, cast integrally with their frames, are bolted to the tables. The half-tone, Fig. 2, shows the same kind of a device, but of the type used for small work. In this case, the whole device is clamped to the side of the drill press table, and a case of angular drilling is shown. We under-



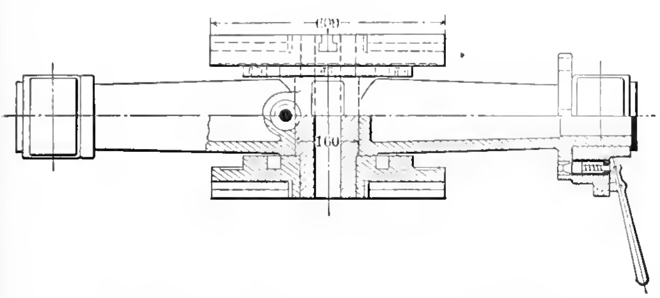


Fig. 3. Plan and Elevations of the Universal Table.

stand that this device is, at the present time, used with great success in the works of Gasmotorenfabrik Deutz, of Köln-Deutz, Germany.

NOTES ON THE MANUFACTURE AND UP-KEEP OF MILLING CUTTERS.

H. T. Ashton, before the *British Institution of Mechanical Engineers.*

Although the system of manufacture of milling cutters, detailed below, is suitable for general application, it has been developed more particularly to meet the difficulties of extending the use of high-speed steel to milling cutters of complicated shape. It is believed that these difficulties have been commonly met with, and that, owing to them, the general

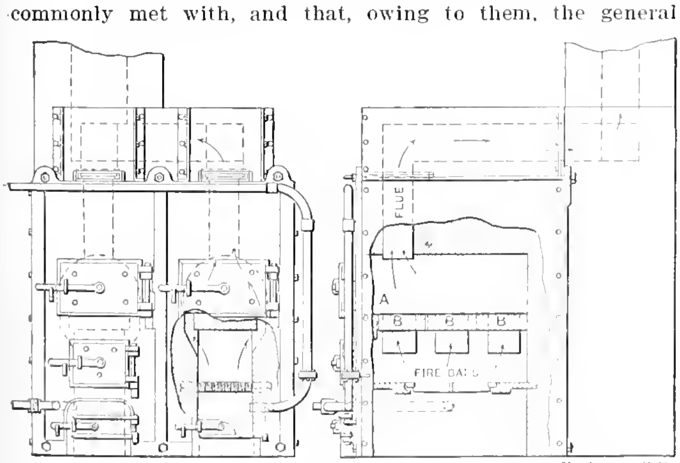
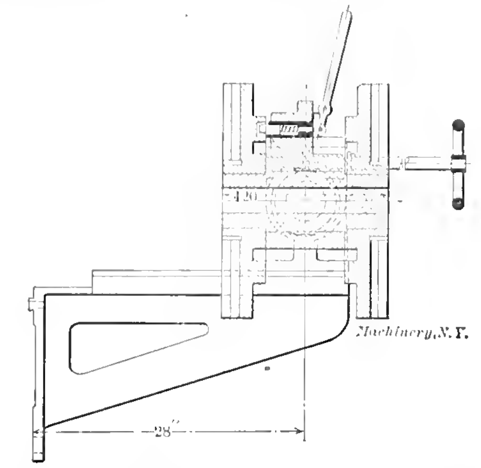


Fig. 1. Front and Side View of Hardening Furnace.

introduction of high-speed steels of the Taylor-White class has, so far, generally proved of less value for milling cutters than for any other form of cutting tool used in the shop.

Perhaps the advantages to be obtained by the use of high-speed steel; for such cutters are also not so obvious as they are for the heavy lathe or planer tools, where the almost red-hot chips, that they can be made to produce, appeal to the least observant onlooker. When, however, it is considered that this class of steel not only has the property of keeping a cutting edge for a reasonable time, when taking very heavy cuts at a previously unattainable speed, but also keeps its cutting edge when used with a moderate cut and speed for a far longer period than was previously obtainable, its advantages, if applicable to complicated milling cutters, are clearly just as great as for the simpler tools taking the heavy cuts.



For, although the nature of the work upon which the cut is taken and the finish required from the cut may not allow, in the case of the milling cutter, any great increase of speed or feed by the use of high-speed steel, and consequently little direct saving upon the time occupied in doing the work, as in the cases of the other classes of tools, yet an equally important saving is effected in the cost of supply of the tools themselves. The milling cutter is the most expensive of all the tools used in cutting metals. In the simplest milling cutter, the cost of workmanship so largely exceeds the cost of material that a moderate increase of life obtained by improvements in the raw material far outweighs a considerable increase in

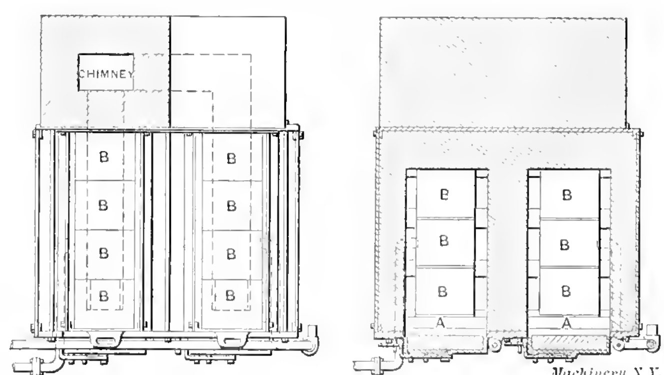


Fig. 2. Plan and Section of Hardening Furnace.

its original cost, provided that there is sufficient work in sight for the cutter to insure its being fully employed for its maximum possible life. Perhaps it is this ruling condition which has led to somewhat less attention being paid to the application of these steels to milling cutters in general machine shop practice than to other cutting tools. For in ordinary shops, with the exception of a few simple cutters generally useful for roughing out or for finishing simple profiles likely to recur, it has perhaps generally been more economical to make the cutters from ordinary qualities of tool steel, or even in some cases from specially case-hardened mild steel; hence the preparation of an elaborate milling cutter from high-speed steel has not received quite the same general attention as the preparation of other cutting tools of maximum endurance.

The case, however, is different in a number of shops where the interchangeable parts of many classes of apparatus and fittings depend very largely upon the use of formed milling cutters, and where the accuracy of the work so produced is directly dependent upon the accuracy with which the form of the cutter can be maintained for a prolonged period. It is desirable also that the cutters should have as long a life as possible in actual service, in order to minimize the first cost

and up-keep, and also to keep the output of the machines as continuous as possible, by reason of freedom from delays in changing the cutters. These points depend chiefly upon:

1. The quality of steel from which they are made.
2. The method of hardening adopted.
3. The care and accuracy with which the new cutters are made.
4. The facility and correctness with which the cutters can be ground when they have become dull or lost their accuracy.

The Steel Used.

There is, of course, nothing to compare with the recently developed high-speed steels as a material for cutters which are required to work at a high cutting speed and have the maximum possible life; and no difficulty is now experienced in obtaining work with a sufficiently satisfactory finish, provided care is exercised in the grinding and finish of the cutters, in the manner which will be described, and also if the cutting speeds and feeds are suitably arranged. Any of the best-known makes of this class of steel can be used in conjunction with the system to be described.

The steel is annealed by packing in spent powdered charcoal and steel turnings in cast iron pans with covers which are luted down. These are placed in the annealing furnace the first thing in the morning, and are gradually heated up to 1,300 or 1,400 degrees F.; this heat is usually reached by 1 o'clock and is maintained until about 5 o'clock, when the dampers are closed and the furnace is allowed to cool gradually for forty-eight hours. It is found that some makes of high-speed steel are satisfactorily annealed by the makers, but it is not the universal practice. Annealing in this manner is found to give thoroughly satisfactory results.

Method of Hardening.

The furnace used for hardening cutters is shown in Figs. 1, 2, and 3, and it has been found specially adapted for obtaining a soaking heat, together with the high temperature necessary in treating this class of steel, and freedom from oxidation. The furnace is coke fired, and has a forced draft, and temperatures up to 2,300 degrees F. can be obtained.

In using the furnace, the cutters are packed closely in powdered charcoal in sheet steel boxes about 6 inches by 6 inches by 3 inches. These boxes take from 2¾ to 3 hours to reach the necessary hardening temperature, the time taken varying with the weight of metal to be heated. The hardening temperature varies somewhat according to the class of steel being used, but may be said to be between 2,000 degrees F. and 2,100 degrees F. The exact temperature necessary for satisfactorily hardening any particular class of steel is previously determined in the laboratory by exact experiments, and the temperatures obtained in the furnace are checked by means of a Fery radiation pyrometer—also shown in Fig. 3. This pyrometer is itself tested against a standardized Callendar pyrometer, and has so far given extremely reliable results.

The cutters, when sufficiently heated, are quickly removed from the charcoal in which they have been packed, and are at once placed upon the hardening table shown in Fig. 4. This table is of a type frequently used in workshops for heating tools by gas, but when used for hardening cutters, air only is supplied through the two nozzles. These can be moved, as required, about vertical pivots, so as to cause the air blast to impinge upon the periphery of the cutters at any required points and simultaneously upon the vanes of the spindle upon which the cutter is placed, causing the whole arrangement to rotate and thus equalizing the cooling and hardening effect. The air delivered upon the cutter is drawn from a culvert which passes under the floor of the workshop and through which a stream of water continually flows; hence at all times of the year a supply of cold damp air of maximum cooling effect is available. The temperatures used in hardening are such that the edges of the cutters are almost fused, and although different makes of steel have been found to vary somewhat in this respect, the general statement remains true of all of them. At the same time, it is found that this fusing effect for a given heat is considerably minimized by the method of heating in closed boxes, as compared with the ordinary method of heating tools either in a muffle or directly in a gas flame, and even the scaling, which, with the latter systems, is frequently marked, is, with the method now described, so slight that the cutters can be wholly freed from scale by placing them momentarily under a revolving scratch brush.

All difficulties as regards the expansion of the hole through the cutters in hardening are met initially, leaving the bore slightly smaller than is ultimately required—on the average about 0.010 inch less than the finished diameter; the expansion

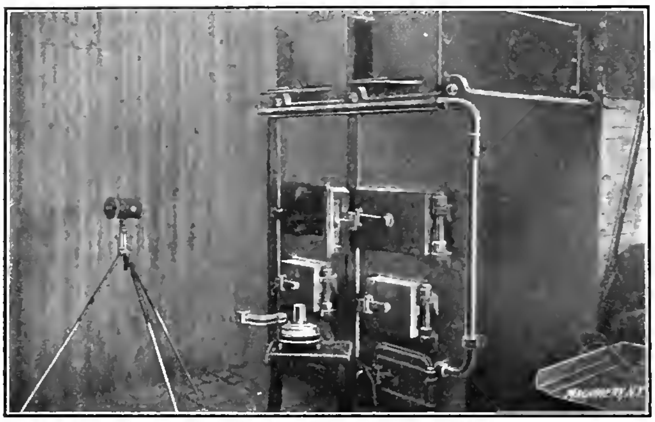


Fig. 3. General View of Hardening Furnace.

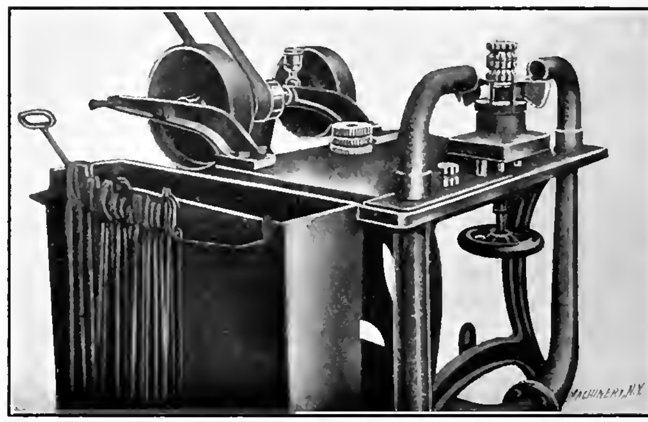


Fig. 4. Method of Hardening by Air Blast.

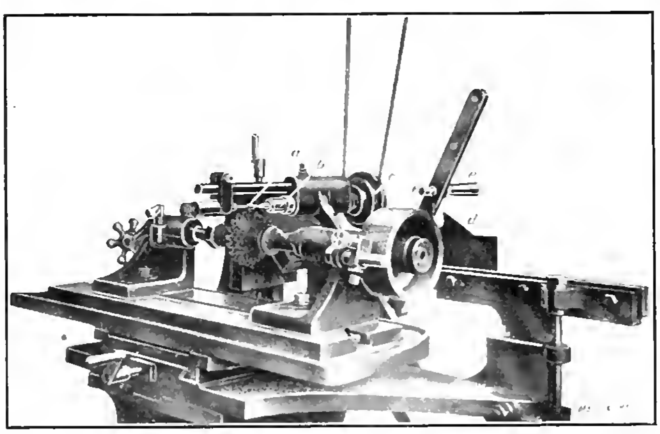


Fig. 5. Milling Teeth of Formed Cutters.

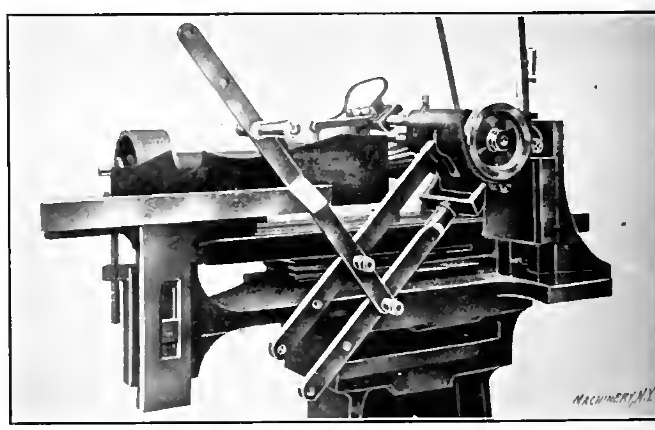


Fig. 6. Front View of Machine for Milling Teeth of Formed Cutters.

is usually about 0.003 inch to 0.005 inch, the average diameter of the mandrel being 1 inch. After hardening, the milling cutters are first chucked truly with the outside diameter in a self-centering chuck, and the internal bore is ground up truly to the finished diameter. After this, the hardened cutters are chucked upon mandrels and the teeth are finished upon the special machines to be described.

Forming Cutter Teeth.

Accuracy of form of the cutters is secured, both when being cut in the first place, and also when subsequently re-formed, by turning the blanks and milling out the teeth in the ordinary manner, and then backing them off in the machine shown in Figs. 5 to 8. In this machine, the cutter to be formed is carried on a dividing head, so that one tooth at a time can be presented to the small milling cutter *a*, Fig. 5. This is mounted upon the cutter spindle *b* driven by a pulley *c*, from which cat-gut cord runs through an overhead gear, allowing the spindle to be moved within the necessary limits. The small cutter spindle-frame forms part of a system of adjustable pantograph links, so that its movement is an exact reproduction in miniature of the movement of the tracing pin upon are either clutched together or clamped together upon plain faces, from which, after a particular grinding or series of grinding operations, the same amount is ground off as that by which the radial cutting edge has receded. Where the edges of the teeth are parallel or nearly parallel to the axis of the cutter, the profile is, of course, not appreciably affected by grinding back the faces of the teeth. A further means of avoiding such errors is also to be found in grinding the tops of the teeth in the manner subsequently described.

As it is found advantageous, in order to obtain a fine finish, to use helical teeth upon milling cutters, a fitting consisting of a sleeve with spiral slot—see Figs. 7 and 8—can be mounted on the same spindle as the milling cutter. A pin on a hinged arm centered above the backing-off cutter spindle is arranged to slide in the slot in this sleeve so that, as the frame carrying the copy and the cutter spindle is moved backwards and forwards along the axis of the cutter being backed off, the helical teeth are maintained in correct relation to the backing-off cutter, while at the same time they are backed off to the correct profile. Theoretically, of course, in such cases, the axis of the cutter being operated upon could be inclined to the axis of the backing-off cutter spindle at

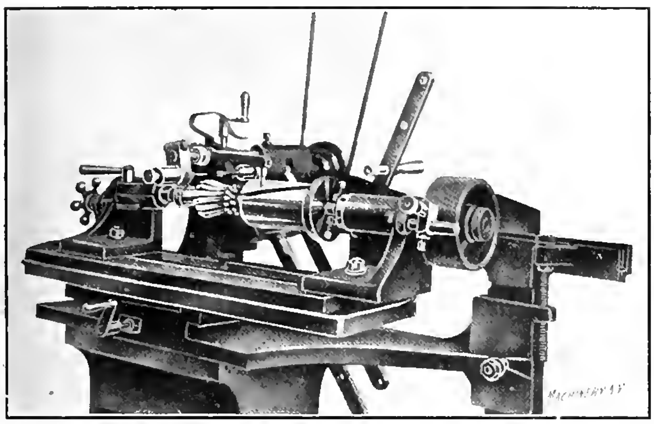


Fig. 7. Milling Spiral Teeth by means of Guiding Cam.

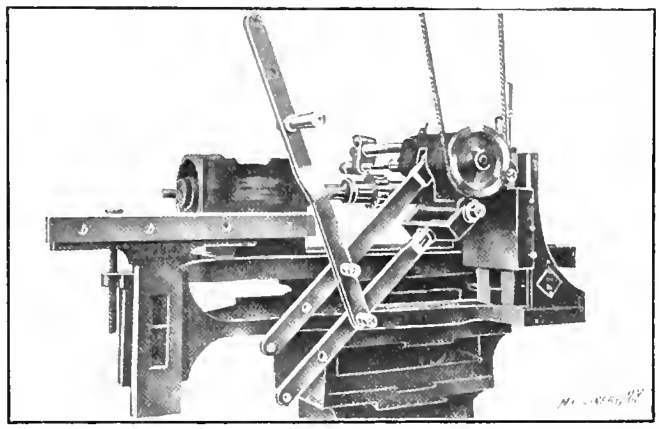


Fig. 8. Front View of Machine rigged up for Milling Spiral Teeth.

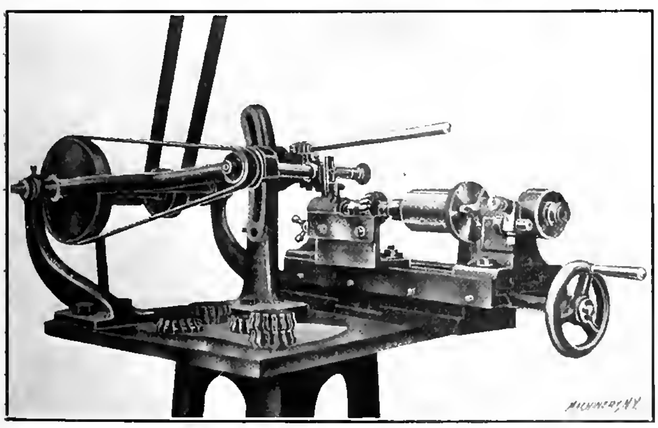


Fig. 9. Grinding Formed Cutters.

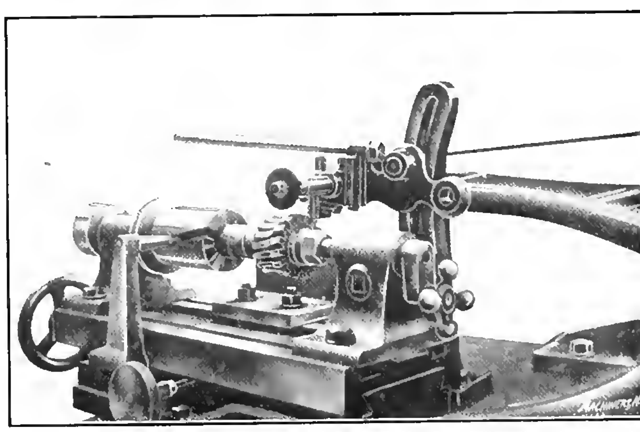


Fig. 10. Front View of Grinding Machine.

the former *d* fixed in front of the machine. The operator, by means of the handle *e*, moves the pin *f* lightly along the former, and consequently also moves the cutter over the tops of the teeth to a similar but smaller shape. The small cutter is enlarged in diameter toward one end, so that it cuts away the back of each tooth upon the cutter to the necessary extent. Commonly a conical backing-off cutter is used, the angle of the cone being 20 degrees, and the setting being such as to give an angle of relief of 10 degrees, that is, the axis of the cone is at right angles to the radial face of the tooth being backed off. It will be seen that this characteristic enables the machine to produce teeth of any form, upon a cutter backed off in every direction from the cutting edge, so that a clean cut can be taken with the sides as well as with the tops of the teeth.

In the case of those milling cutters in which grinding back the faces of the teeth so backed off might cause serious inaccuracy, owing to its throwing back the radial cutting edges of the teeth, the cutters are built up of annular sections which an angle equal to that of the spiral of the cutter being produced, but in actual practice it is found that this adjustment is very seldom necessary, as the cone angle of the backing-off cutter, and also the amount of material which can be removed from the cutting edge of the cutter being produced, are both, comparatively speaking, small.

This machine has been found not only capable of backing off satisfactorily cutters of a shape which could not be backed off along the whole length of their profile in an ordinary relieving lathe in one operation, but it has been found possible to do the backing off in, approximately, one-third of the time required on a relieving lathe, while at the same time a less expensive class of labor may be employed, and the finish of the teeth is found to be better.

Grinding Cutters.

Figs. 9 and 10 show the machine used for sharpening the cutting edges of the hardened milling cutters and subsequently regrinding their faces or edges as required from time

to time. This machine has a grinding wheel mounted upon a spindle suspended on a swinging frame, and follows the work by the use of a former, the profile of which is of the same magnitude as the one to be ground. In an ordinary way, this former would not have the exact outline of the shape desired on the finished cutter, corrections having to be applied for the diameters of the tracing roller and also of the grinding wheel, the latter item being, of course, itself, variable. This difficulty is overcome by using grinding wheels of special fast-cutting artificial stone, which will perform a considerable amount of useful work before being appreciably reduced in diameter, and by making the diameter of the tracing roller equal to the diameter of the grinding wheel; there is in addition, of course, an adjustment for raising or lowering the former.

The milling cutter being ground is, as before, mounted upon a dividing head, in the case of straight cutters, or upon a dividing head provided with helical sleeve in addition, in the case of helical teeth cutters, and all the teeth are first ground along the tops to profile and afterwards in the usual manner down their faces, the grinding wheel being, of course, set over to the angle of the spiral. The cutter thus finished has edges both of the maximum keenness and also of the maximum endurance due to correctly hardened high-speed steel, as only the thin skin partially oxidized in heating before hardening is removed.

Hitherto the apparatus employed for sharpening profile cutters for milling machines in repetition work, such as is produced in small arms factories and elsewhere, has required the handling and attention of men with considerable training and skill. The provision of simple machines, such as those described, now enables an unskilled man to regrind correctly all cutters brought to him with considerable rapidity and the minimum possibility of error. By standardization of the pitches of the teeth and their angles, and by the provision of suitable templets for each of the cutters commonly required, the use of these machines has been found to result in distinct economy, both in the up-keep of cutters and also in the quality of the work turned out.

Considerable advantages result from being able to re-form accurately the contour of the teeth, in addition to grinding the face. In ordinary use, the teeth of milling cutters are damaged not only on the face, but to an even greater extent on the top, and it has frequently been found that removing, say, 0.002 inch from the top has as beneficial an effect as removing 0.006 inch from the face, and with this additional advantage that, when a tooth has been ground to its fullest extent from the face, it can be further sharpened on the top while still retaining its correct figure, until the tooth is too short through not allowing the necessary clearance; and this consideration will, in many cases, lengthen the life of a cutter by 10 per cent.

The life of some milling cutters prepared by the methods indicated above has been extraordinary; for example, a cutter working in an automatic cross milling machine and operating upon the bodies of a service rifle at an average cutting speed of 69 feet per minute, with a feed of $1\frac{3}{4}$ inch per minute and a depth of 0.08 inch, and taking a cut of an average width of 1 11/16 inch and $7\frac{3}{8}$ inch long, has produced 39,170 bodies, and is still good for about half as many more. This particular cutter has been reground across its face twenty-five times. The composition of the steel upon which it operates is 0.5 to 0.6 per cent carbon, with an ultimate tensile strength of not less than 35 tons per square inch.

ELECTROPLATING IN QUANTITIES IN DRUMS.

Deutsche Metall Industrie Zeitung

In the last few years there have been made quite a number of apparatus for electroplating small articles in quantity. In most of these, the pieces to be plated are placed in rotating drums with perforated walls. The drums are partly constructed of non-conducting materials, and the objects to be plated are held by metal strips, which are put in electric connection with the source of current, in different ways. As such apparatus are now in very extended use, a few hints as to their practical employment should not be out of place.

Almost every one who works for the first time with a drum apparatus experiences more or less trouble therewith. As a rule, the apparatus is not to blame therefor; it is the fault of the operator, who is not familiar with its working. The greatest difficulty in using a drum apparatus is when the tension is not high enough. Ten to fifteen volts are necessary in order that the currents shall flow through the electrolytes in the drum. The reason for this is the resistance which the drum makes to the passage of the current. This is just the same as when a non-conducting substance comes between the anode and the piece to be plated. The current will not flow through the solution; and if this does not take place, no metal will be deposited.

For some kinds of work a six-volt dynamo will suffice; but the results obtained therewith are, however, not especially good; also, the deposit does not take place so rapidly as with higher voltage. In such case only a small number of articles can be placed for plating in the drum. Where there are too many, the deposit takes place too slowly, and with great irregularity. With higher tension, the desired amount of metal is deposited in a short time on the articles.

Of equal importance with the current voltage is the strength of the solution. It is useless to try to electroplate with a weak solution. The resistance of the solution, in combination with that of the drum itself, prevents the passage of the current. For instance, a nickel solution of 5 to 6 degrees Beaumé, which is strong enough for ordinary electroplating, is not suitable for drum work. In the latter case, either the articles will not be covered, or only their edges will be plated. If, however, a solution of 8 to 9 degrees Beaumé, or a saturated solution, be used, the deposit will be made with success. The same is the case with brass and copper solutions. Electroplaters who get the best results with the drum apparatus, always employ strong electrolytes.

The rotation speed is of no very great importance. It is only necessary to keep the articles in motion. If the speed is too high, however, the objects have a tendency to fly to the walls of the drum and lie there, where their entire surface is not subjected to the action of the current. Special care must be taken to have all the electric connections perfectly clean and properly arranged. If this is not the case, it will be impossible to pass the necessary current through the solution; and the deposit of the metal will in such case be irregular. The same is to be noted in connection with the drum; the holes or slits therein must be kept free from salt crystals and foreign substances. It is often found that imperfect deposit is caused by stoppage of the holes through which the electrolyte and the current pass.

In plating with copper, bronze or brass, there are no conducting salts which can be added, but none are needed; it is only necessary to have the solution as strong as possible. In nickel-plating, it is recommended to use two conducting salts, as for instance ammonia, with either ammonia sulphate or common cooking salt. These salts increase the conductivity of the electrolytic solution. No definite quantity of these can be mentioned as necessary, but the electrolyte will need only a small quantity of these salts. The usual rule is to take as much as the nickel solution will dissolve.

The surfaces of the anode in a drum apparatus should be large, and so arranged that they surround the drum on all sides. In this manner the solution can work the best. A nickel solution requires constant watching. If the electrolyte is too acid, as is often the case, there must be added, to reduce this acidity, nickel carbonate. Boracic acid is used in the drum apparatus in the same way as with other nickel solutions.

In the regular drum apparatus, bars, chains, etc., cannot be plated with advantage, because, by reason of the rotation of the drum, they bend and tangle so as to make a knot that can hardly be loosened, and the regular plating of which is impossible, and they also may cause short-circuiting in the drum. For such articles special apparatus should be employed, of the so-called swinging type, which do not cause these difficulties. These latter have a half-drum of non-conducting material with a swinging motion, and a fixed anode, and permit the articles in the bath to roll from one side to the other, which prevents tangling. R. G.

THE A. C. A. AUTOMOBILE DYNAMOMETER.

The accompanying illustrations show a very interesting apparatus recently installed by the Automobile Club of America on the eighth floor of its new reinforced concrete garage and club house at 247-259 West 54th Street, New York, for testing the tractive power, speed and internal resistance of automobiles. The need of a reliable and official testing apparatus for demonstrating the power and speed of motor cars has been keenly felt. The claims of agents and builders, in many cases, have been open to suspicion, and buyers have felt with good reason that their purchases by no means fulfilled the promises made. The apparatus shown in the illustrations was designed under the direction of Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Co., Ampere, N. J., who is vice-president of the Automobile Club of America. In 1904 Dr. Wheeler was requested to design and build a testing apparatus which would meet the practical requirements of automobile testing and at the same time be so designed as to avoid criticism of the captious-minded. The requirements were scientific accuracy, convenience of use and the indication of the results in terms that the ordinary layman could understand. For the past four years the engineers of the Crocker-Wheeler Co. have been working on the problem, and the result apparently leaves little to be desired.

The general appearance of the testing floor is indicated in Fig. 1. The automobile is driven in facing the large horse-power chart shown on the wall, and to such position that the rear wheels will stand on the rollers or drums sunk in the floor. It is then hitched to stops fastened in the floor both front and back, the stop in front showing directly underneath the brake horse-power chart. The construction of the testing apparatus is similar in principle to that employed in locomotive testing machines such as are in existence at Columbia University, New York, and in the Pennsylvania R. R. testing plant at Altoona, Pa., so far as the absorption of power is concerned, but in addition it has apparatus of unique design never before applied to such use.

The rotation of the rear or driving wheels of the automobiles drives the drums, which are mounted on a shaft below the floor, as shown in Fig. 2. Upon this shaft are mounted an Alden absorption brake and a pendulum having a weight of 1,600 pounds. The traction of the wheels transmitted through the absorption brake rotates the weight-arm to an angle dependent upon the force exerted. This is indicated diagrammatically in Fig. 3. In line with the same shaft is mounted a motor which can be connected to the traction shaft by a clutch. The object of the motor is to determine the power consumed by internal friction of the engine and driving apparatus, the consumption being indicated in amperes and volts on the indicating electrical apparatus. Right here it may be said that the internal resistance of most automobiles is high, being about 25 per cent of the indicated horse-power. Machines have been tested wherein the resistance was much higher, being, for example 18 horse-power in the case of a supposed 50 horse-power car. The section of the shaft on which the weight-arm is mounted is fitted with two dash-pots connected by bell-crank levers, as shown at the left in Fig. 2. The object of these, of course, is to prevent violent fluctuations of the weight-arm under the influence of unsteady driving.

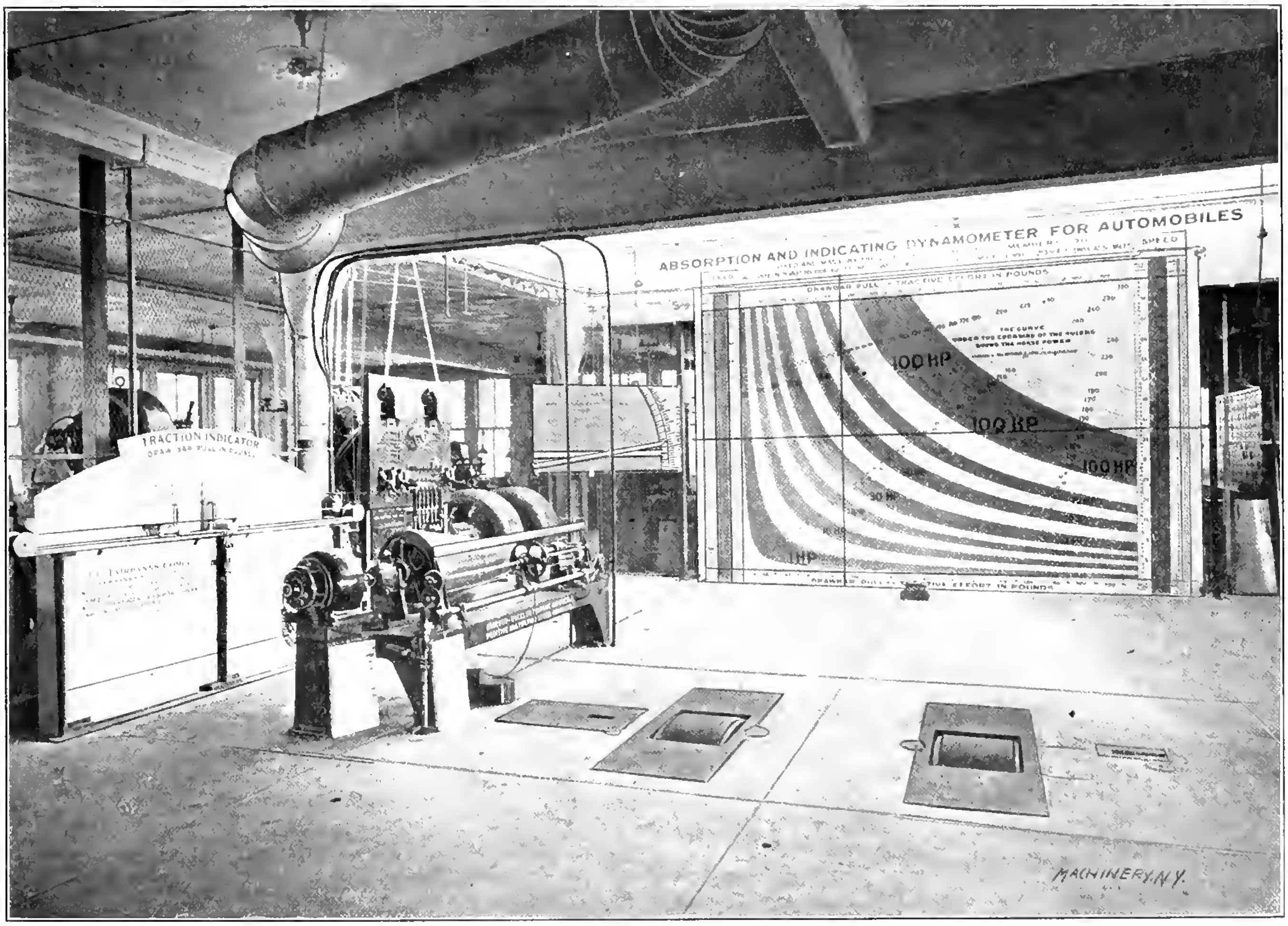


Fig. 1. General Appearance of the Testing Floor of the Automobile Club of America, New York.

The results of the tests are plainly evident to the driver, being indicated by the horizontal and vertical rulers, plainly visible on the horse-power chart in Fig. 1. This chart is ruled with hyperbolic lines and these sections are alternately shaded white and green, thus making the readings at intersecting points of the rulers plain. The horizontal ruler indicates miles per hour, and the vertical ruler gives the draw-bar pull or tractive effort in pounds. The horse-power is the component of the speed, generally computed in feet per minute in engineering calculations, and the draw-bar pull in pounds, but the chart is figured to indicate the horse-power by the more convenient formula:

$$\text{H. P.} = \frac{\text{pull, in pounds} \times \text{speed, in miles per hour}}{375}$$

The capacity of the apparatus is from 1 to 75 miles per hour and from 0 to 213 horse-power at 50 miles per hour. The chart was ruled by plotting the curves with the apparatus working under known conditions, the traction pointer arc being graduated at the same time in accordance with calibrations made by the Fairbanks Scales Co.

The tractive force of the automobile being indicated by the angular displacement of the weight-arm, it becomes very desirable that it shall encounter no other resistance than that due to gravitation. If the friction of the indicating apparatus were added, it would produce a variable and, therefore, uncertain resistance that could not be accurately predicted. To overcome this the apparatus is so arranged that it provides the force to move the traction indicator (horizontal bar on the chart) entirely independent of the displacement force exerted by the automobile drivers. As the vertical pointer shown at the left of the half-tone, Fig. 1, moves along the graduated arc it makes an electrical contact on one of the small slides or carriages shown on the horizontal track, whereupon a small motor (beyond the traction chart) called "traction follower motor" winds up a thin steel wire cable causing the carriage to follow the pointer and at the same time moving the traction ruler on the large chart to the correct position. The moment it reaches this position, the electrical contact is broken, and if the motor over-travels, another contact is made which reverses it, thus keeping the carriage in constant attendance to the vertical pointer. When testing an automobile, in backing, the vertical traction pointer moves in the opposite direction and a twin carriage is provided which acts in the same manner in the opposite direction. To prevent injury to the apparatus because of violent fluctuations that the dash-pots cannot control, the vertical pointer is provided with a spring connection to the brake shaft which unhooks in case of a violent jerk and permits the pointer to fall behind the angular position of the weight arm and to catch up with it under the influence of a coiled spring. Thus the follower motor is given time to traverse its carriage and indicator without causing undue stress. The resistance of the drum shaft to rotation in its ball bearings is about 25 ounces, starting from rest without load of the automobile superimposed.

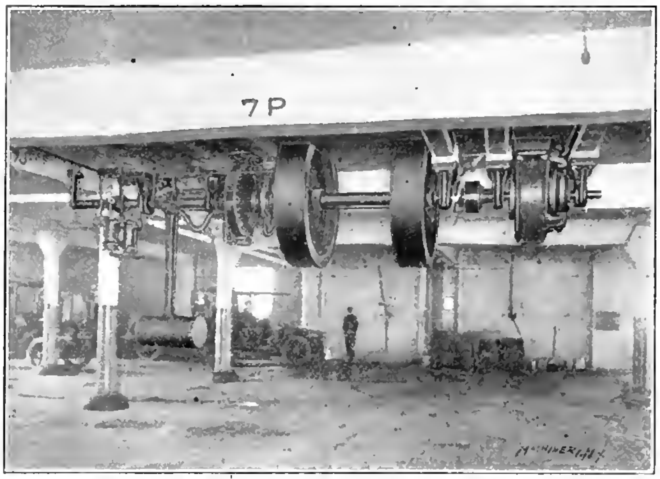


Fig. 2. Drums, Drum-shaft, Electric Motor, Alden Absorption Brake, Etc., underneath Testing Floor.

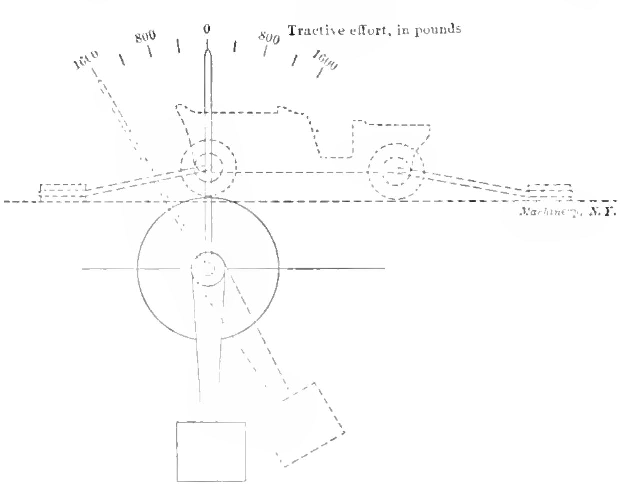


Fig. 3. Diagrammatic Elevation of Automobile on Testing Apparatus, showing Traction Indicator.

The same general principle as just described is employed to indicate the speed in miles per hour, but as the element of time enters, the apparatus is somewhat more complex. The machine shown in Fig. 4 is solely for this purpose, and has been ingeniously worked out. It consists of a conical drum driven by a constant-speed motor at the rate of 200 revolutions per minute. The rate of rotation is fixed by a sensitive centrifugal governor mounted in the large end of the cone, and a timing bell is provided which rings each half-minute, or at each one-hundredth revolution. Thus, a stop-watch can be used to check the timing bell and the speed of the cone. Parallel with the cone surface is mounted another shaft called the speed shaft, upon which is mounted a thin friction disk. The disk is not firmly held to the speed shaft, but, between the limits of the stops formed by electrical contacts, it is driven by the friction caused by the pressure of a small coil spring forcing it against a shoulder on the splined bushing upon which it is mounted. Thus, within the narrow limits of oscillation permitted, it tends to run at the peripheral speed of the cone shaft at the section with which it is in contact. The speed shaft is driven from the drum shaft, which is beneath the floor, by a chain, bevel gearing and a vertical shaft not very plainly shown in Fig. 1. At the right of the machine is a small motor designated as the "speed follower motor." The function of this motor is to traverse the disk and its mounting on the speed shaft to such position on the cone that the disk peripheral speed is the same as the cone peripheral speed at the point of contact. If the disk runs either faster or slower, the difference in speed causes the disk to shift relatively to the speed shaft and make an electrical contact, front or back. These contacts actuate the motor which shifts the disk either to the right or left as is required to make its peripheral speed the same as the cone peripheral speed. The shifting of the disk actuates the vertical ruler on the horse-power chart shown in Fig. 1. Therefore, this ingenious arrangement also imposes no additional load on the dynamometer shaft; it simply follows up the indication of the speed shaft substantially as does the vertical traction ruler follow the vertical traction pointer over its graduated arc.

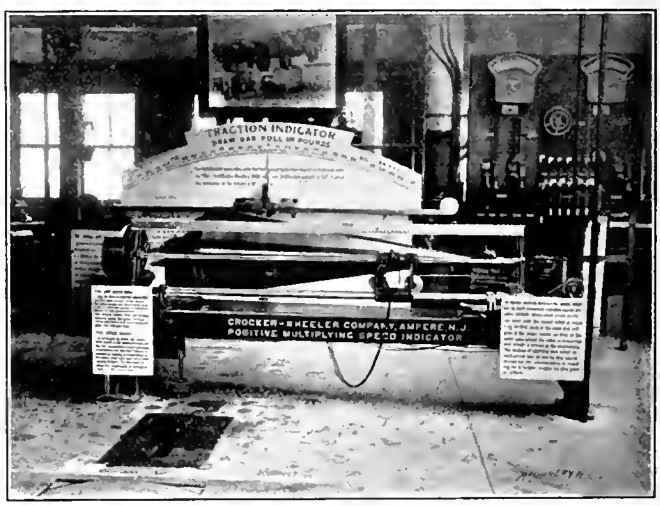


Fig. 4. Crocker-Wheeler Multiplying Speed Indicator.

At the left of the horse-power chart, Fig. 1, is a grade meter indicator, the object of which is to show the angle of inclination of grade that the car would climb if there was no wind resistance, slipping or track resistance. To use the grade meter, the sliding poise is set upon its beam at the point representing the weight of the car. This change of the sliding poise changes the point of contact of the beam with a horizontal ruler (between it and the board backing) that is raised and lowered by small wire cables from the traction indicator. The grade as indicated is proportional to the tractive effort, being expressed by the formula:

$$\text{sine of grade angle} = \frac{\text{tractive effort}}{\text{weight of car}}$$

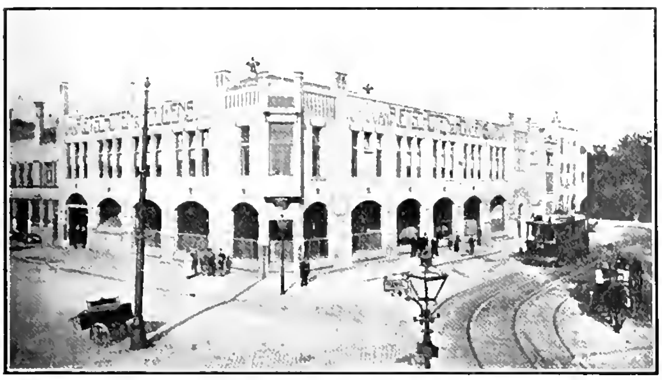
The indicator also shows the grade in per cent, the formula being:

$$\text{Grade in per cent.} = \frac{100 \times \text{pull}}{[(\text{weight})^2 - (\text{pull})^2]^{\frac{1}{2}}}$$

* * *

HANDSOME MACHINERY HOUSE IN ROTTERDAM.

The accompanying half-tone shows the handsome building recently constructed by Van Rietschoten & Houwens, Rotterdam, Holland, for a machine tool depot and showroom. The attractive appearance of the building is in decided contrast with the usual American structure built for such purposes. It was designed with much taste, and is a creditable ornament to any commercial district. It is built of hard pressed brick of light tint, the name of the firm being picked out near the top in dark-colored brick. Incidentally the half-tone shows the remarkable cleanliness of city streets in Rotterdam, this characteristic being common to Dutch cities. Holland suffered much in the depression of 1907 and money was at a high premium, consequently little business was done, and 1908 so far shows small prospects. Notwithstanding the discouraging times, the concern built these warerooms, believing that the "harder the times the stronger the push" should be. The sentiment is one well worth attention by American concerns.



New Machine Tool Depot and Showroom in Rotterdam, Holland.

* * *

Brass manufacturers are, as a rule, not very eager to use fluxes for protecting the metal, in melting, from the action of the air and the gases of the fire, because most of the fluxes used attack the crucible. The *Brass World* says, however, that there is no question about the value of the fluxes, and that glass has proved to be suitable for this purpose, and that it is used to a large extent by rolled brass manufacturers, who by this means are able to get their spelter loss considerably lower than one per cent. The reason for the excellence of glass as a flux in melting brass is that it does not become actually liquid, and therefore does not attack the crucible. It becomes pasty, and thus covers the metal, but is readily skimmed off, a difficult operation with a liquid flux. When the metal is ready to cool, the glass will be found on the top in the form of a soft "pan-cake," which may be easily skimmed off. The cheapness of glass and the fact that the crucible is not attacked, render its use attractive, and many manufacturers have been accustomed to employ it. Its good effects, however, are not generally known.

* * *

The beneficial effect of safety appliances is well exemplified by the results obtained by the constant application of means of prevention of accidents in British mines. Fifty years ago the death rate was 5 per 1,000 of the mine employes. Safety appliances, however, have gradually reduced this figure to 1.4 per 1,000 employes. While the difference between the figures fifty years ago and now may be greater in this industry than what could be effected in other less dangerous occupations, there is no doubt whatever but that nearly all of our industries could cut down their casualties to one-half, were proper appliances for safeguarding of life and limb universally used.

HEAVY SPIRAL CUTTING ON THE MILWAUKEE MILLER.

In Fig. 1 is shown a Milwaukee milling machine, built by the Kearney & Trecker Co., of Milwaukee, Wis., engaged in a milling operation on a piece of work which weighs something over $1\frac{3}{4}$ ton. This piece is the blank for a roll used for forming the tie-plate shown in Fig. 2. This tie-plate is rolled from a steel strip, and has flanges and ribs on its under side, and herring-bone corrugations on the upper surface. There is also a ledge on top for aligning the plate with the rail. All of these projections and grooves are formed by rolling. In the lower roll, of course, it is simply a matter of turning the proper shape on the surface of the roll. The upper roll is more complicated. It is shown diagrammatically in Fig. 3. The acting surfaces are composed of herring-bone projections, separated into sections by the triangular grooves which form the ledge for the flange of the rail. These grooves and projections are milled from the solid, and it was for this operation that the fixtures and attachments seen in place on the machine in Fig. 1 were made.

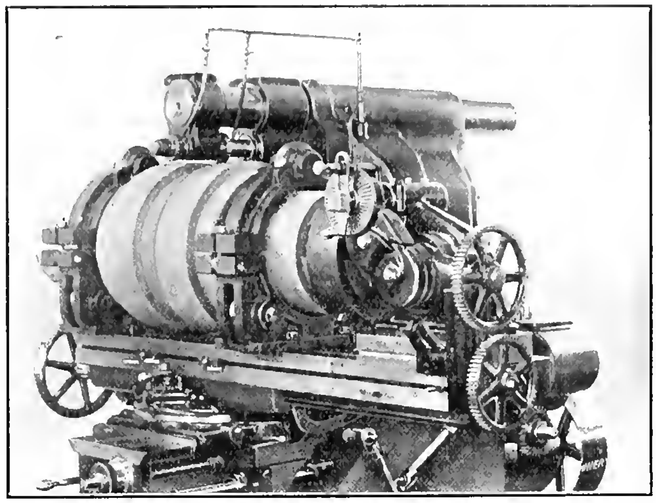


Fig. 1. Milwaukee Miller arranged for Cutting Cross-grooves in a Heavy Roll.

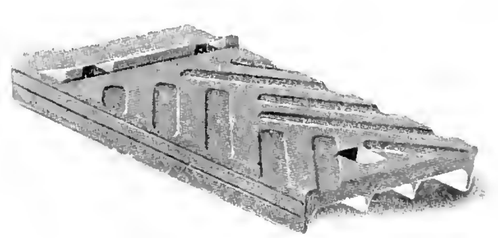


Fig. 2. The Tie-plate, which is the Product of the Roll.

It was seen that the work was so large as to exceed the vertical capacity of the machine. For this reason it is necessary to provide a supplementary cutter spindle which brings the arbor and cutter closer to the overhanging arm. This arbor is carried on special bearings clamped to the overhanging arm, and is connected by stout spur gearing with the regular spindle of the machine. As shown in Fig. 1, the machine is set with the table at right angles for cutting the straight cross grooves which form the ledge for the rail flange. The cutter for this operation is shown centered with the work.

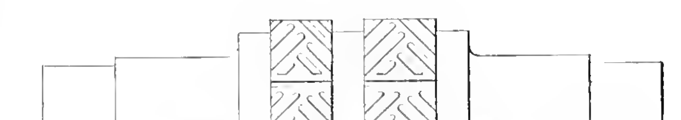


Fig. 3. Diagram of Acting Surface of the Roll.

The diameter of the roll was so great that it was necessary to block up the indexing head as shown. Owing to the great weight and size of the roll, it was, of course, impossible to support it by ordinary means. The arrangement devised for the purpose is clearly shown in Fig. 1, and in the line drawing Fig. 4. The work D is mounted in a pair of holders, built on the back rest plan, with bases E fastened to the milling machine table. The work is centered and revolved upon three rolls G on each side, two being carried by each base E, and the others by the upper portion F of each support, which is hinged so that it can be swung back out of the way for removing or replacing work. For taking the thrust in the spiral cutting operation shown later in Fig. 5, rollers H and H on each support are provided, bearing against the shoulder of the journals of the work. To obviate the necessity for accurately centering the work with the dividing head A, a flexible driving arrangement is used, consisting of a collar C clamped to the driving neck of the roll, and a fork or driver B, fastened to the nose of the dividing wheel spindle. This driver engages the block shown, pivoted to collar C. It will be seen that this arrangement allows for a slight misadjustment of the axis of the work either vertically or horizontally.

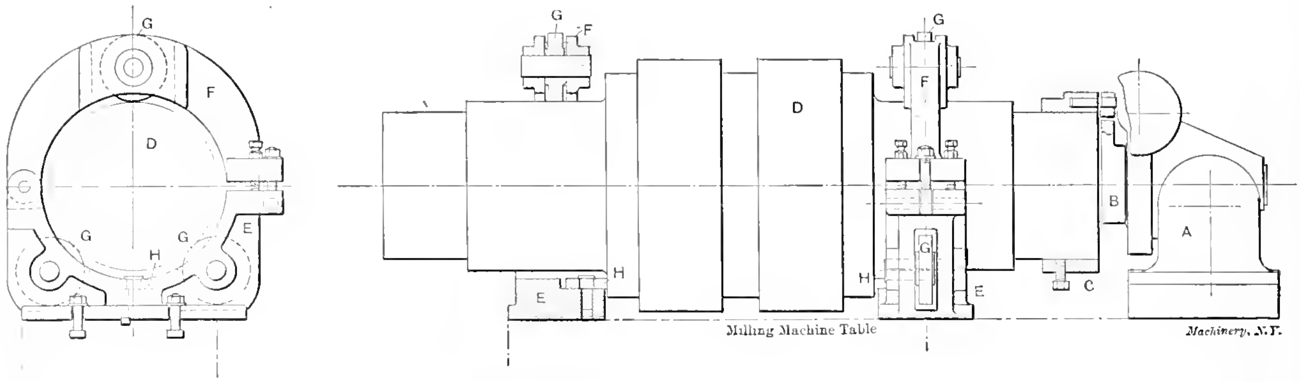


Fig. 4. Arrangement of Supporting and Driving Devices for the Roll shown in Place on the Miller in Figs. 1 and 5.

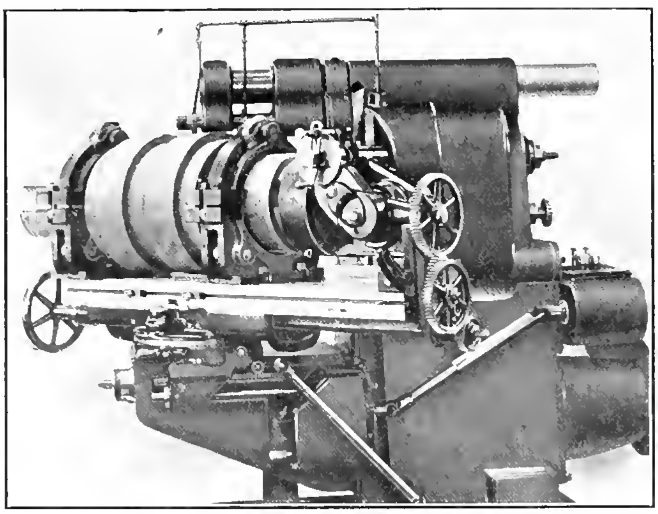


Fig. 5. Milling out the Stock from between the Herring-bone Projections of the Roll.

The device as arranged for milling the stock from between the spiral or herring-bone projections, is shown in Fig. 5. The same supplementary spindle is used as in Fig. 1, but the table is brought out to center with the work of the cutter on the opposite end of the arbor. Rollers H, shown in Fig. 4, now come into action in taking the thrust of the cut while the work is being revolved by the spiral mechanism of the miller.

The machine used is of the regular type built by this firm, which we have previously described in MACHINERY (see "New Machinery and Tools," February, 1907). The drive is through change gearing to give the required speeds and feeds, all of which are obtained from a single-speed pulley. Another feature of the tool is the provision made for constant lubrication of all important bearings by the use of an oil pump and piping system. So far as we know, this firm is the only one to permanently discard the cone pulley and back geared type of machine.

SPECIAL LATHE AND TOOL EQUIPMENT FOR TURNING CONE PULLEYS.

WM. F. GROENE.*

Perhaps some of our friends, who advocate all geared heads or single pulley drives, may consider the subject of this article an antiquated one. Still, here at the R. K. Le Blond Machine Tool Co., we yet have some faith in the cone pulley, and expect that this style of drive will continue to be preferred by most of our customers for some time to come. For this reason, we have been induced to design a machine for doing certain operations in our cone pulleys, and this machine we have recently installed in our shop.

The accompanying half-tones and line engravings, together with the following paragraphs of description, will make clear the construction and operation of this machine, and the tools used with it. The general principle of using multiple tools for turning cone pulleys is not a new one, by any means, but we believe we have embodied in this scheme features and details which are entirely new. The great aim was to produce work of a very high degree of accuracy and truth, at a reasonable labor cost.

The machine used (see Fig. 1) was one of our 30-inch lathes, with head- and foot-stock, "raised in the sand," to swing over the carriage the largest cone pulley we use. This includes all the milling machine cones, and all the lathe cones from 12 to 20-inch swing. The only alterations in the lathe consist in providing a forming attachment for crowning

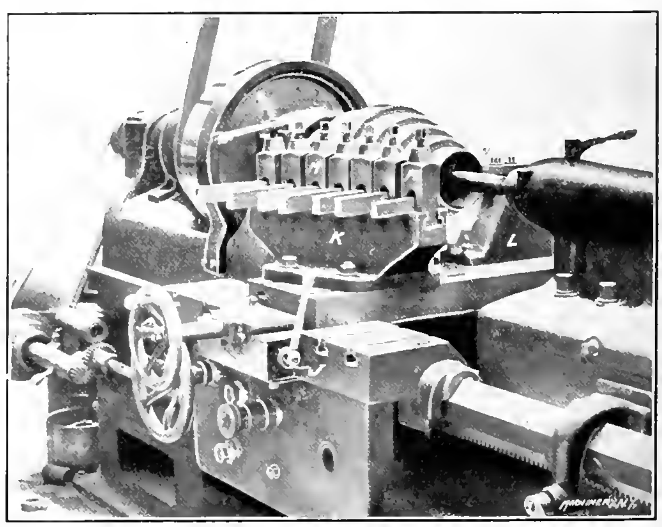


Fig. 1. Lathe with Special Forming Attachment and Tool-holder for Turning Cone Pulleys.

the pulleys, and a multiple tool-holder for finishing the various steps, together with means for holding and driving the work.

The forming attachment will be best understood by reference to Fig. 1, in connection with Fig. 2, which shows a plan and cross-section of the carriage. The cross slide screw A is not mounted in the carriage, as usual, but in a square sliding bar B, which is seated in a corresponding rectangular recess in the carriage dove-tail, over which the cross slide fits.

* Address: 1311 Delta Ave., Cincinnati, O.

This square bar B carries at its rear a pivot, on which is mounted a grooved pulley C, which, by a wire rope and a system of idlers, supports the weight D, which constantly tends to draw B toward the rear. A bracket E is fastened to the rear of the lathe bed, having a planed top with a T-slot, in which is clamped former F, which has an outline agreeing with the outline of the crown it is desired to turn in the pulley.

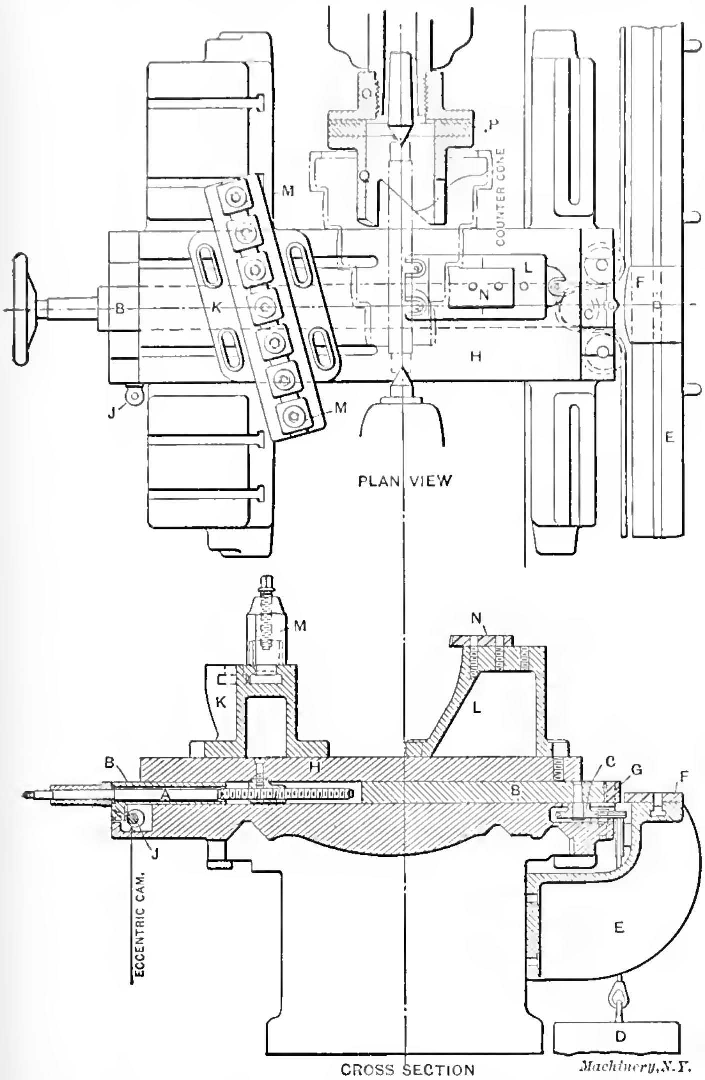


Fig. 2. Plan and Section of Carriage of Special Forming Lathe.

A finger, G, screwed to the rear of sliding bar B, (see also Fig. 4) is pressed in contact with this former by the weight D, so that B is moved in or out to agree with the contour of the former, as the carriage is operated to the right or left, carrying with it, at the same time, the cross feed screw A, and through A the cross slide H, carrying the tools. An eccentric cam J, whose handle is plainly seen in Fig. 1, bears on a downwardly projecting lug at the front of bar B, and is used to withdraw it against the pressure of the weight from contact with former F.

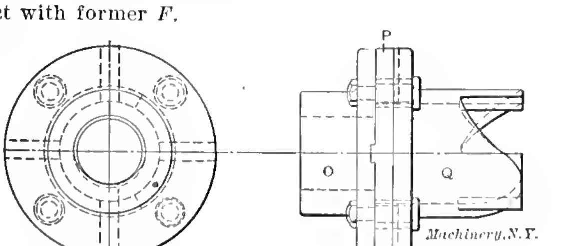


Fig. 3. Equalizing Driver used for Ribbed Counter-shaft Cones.

Two tool-holders are provided; the one in front, K, is set at an angle approximately corresponding to the angle of the cone. It carries a T-slot in its upper face, in which are placed a series of tool-posts M, each carrying a tool for one of the steps of the cone. The other tool-holder L is mounted at the rear of the work, and carries a forming tool N for finishing the steps.

The cones are first chucked true with the inside, in one of our 24-inch chucking lathes, and are then bored out with the turret tools. Then, while the outer end of the pulley is supported by a pilot held in the turret, the outside surface of the cone is scaled off all over, with tools held in the turret tool-post on the cross slide. No attention is paid to dimensions, the operator merely following the contour of the casting, taking off about 1/32 inch all over. The pulleys are then hand reamed, after which they are ready for the finishing machine.

The method of turning the counter-shaft cones is shown in Fig. 1, and is also indicated by the dotted lines of Fig. 2. The work is mounted on a plain lathe arbor, as shown, and driven by an equalizing device from the spindle. This compensating driver, shown in detail in Fig. 3, consists of a face-plate O, threaded to the nose of the spindle, an intermediate plate P, and a driver Q having three jaws, adapted to engage with corresponding ribs in the cone. The intermediate plate P has horizontal tongues, fitting loosely in corresponding grooves in O, at the left. At the right, it has vertical tongues, loosely fitting in corresponding grooves in the flange of Q. The clamp bolts which hold O, P and Q together fit loosely. It will thus be seen that Q adjusts itself horizontally or vertically, until all three of its driving faces are bearing with equal pressure on the three ribs of the cone, which is thus rotated absolutely without eccentric strain.

Seven tools are shown in place in the tool-holder, turning the five steps of the counter-shaft cone in Fig. 1. Of these seven, five are used to turn the five steps, while the other two are employed to finish the edges of the rim at the largest and smallest steps. The tools for turning are set to a master cone. The slide is raised from the former by eccentric J, the tools are set central with the face of the pulley, and the former is set central with the finger, this being done for each new piece of work. The carriage is then moved to the left, the eccentric released and a cut taken over the pulleys.

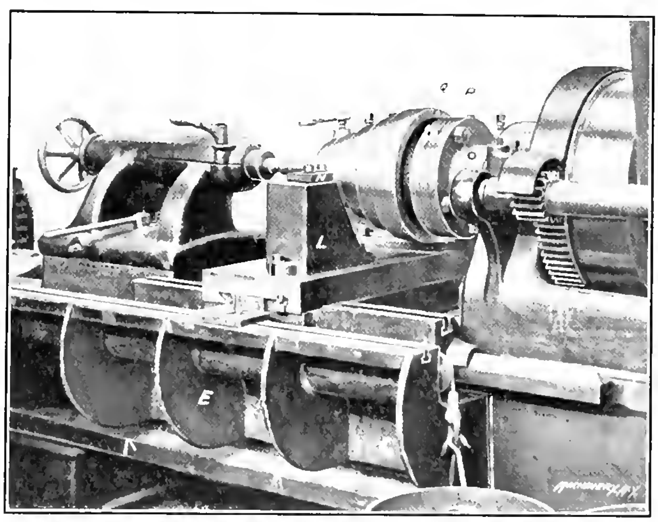


Fig. 4. Rear View of Carriage, showing Form Tool Holder and Form Copying Mechanism.

The next operation consists in scraping the surfaces of the steps with the flat forming tool N, mounted at the rear. This tool is ground to exactly fit the previously turned face of the pulley, and takes off about 0.005 inch, enough to remove the tool marks and give a fine finish. It will be seen that this forming tool also has a small lip formed on its left side. This is used for undercutting the sides of the cone steps for belt clearance. By moving this tool slightly sidewise, the proper clearance is cut. This tool, together with the former F, and the finger G bearing against it, are best seen in the rear view of the lathe in Fig. 4.

In turning the head cones, practically the same turret lathe operations are gone through with as in the case of the counter-shaft cones, the work being chucked and then roughed all over the outside to remove the scale. In addition, the inside is turned, and the step for the cone pinion is bored. The cone pinion is then pressed in, and the pulleys are ready for the finishing machine.

As shown in Fig. 5, the head cones, with the cone pinions

in place, are mounted on the shoulder arbor *R*, and held there by nut *S*. This arbor has a shank at one end fitting the tapered hole in the spindle, while in the other is driven a bronze taper bushing, running on a special hardened center *T* in the tail-stock spindle. The cones are driven from the face-plate *U*, screwed to the spindle, and provided with three driving pins, fitting accurately jigged holes in the inner flange of the cone. These holes are the ones made for the lock plungers.

It will be seen in Fig. 5 that only the four larger steps of the five are turned by the tools in the multiple tool-post. The former does not have to be set centrally with the work for each new piece, as in the case of the counter-shaft pulleys,

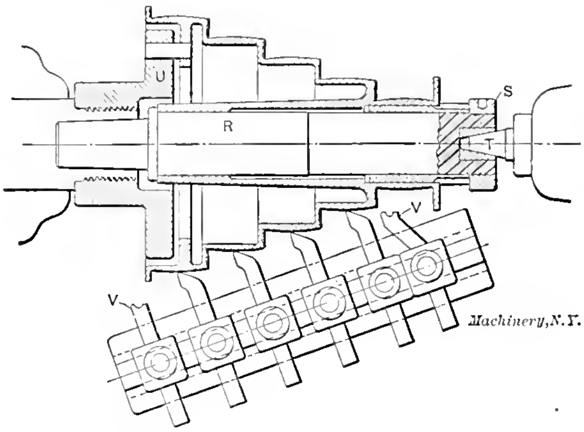


Fig. 5. Method of Driving Head Cones, and Layout of Tools.

since the work is located endwise by the shoulder on arbor *R*. Two extra tools, *V* and *V* are used for finishing the large and small end flanges of the cone. The forming tool *N*, in Fig. 2, is used as before, to finish the crowned surfaces and recess the sides of the steps for the belt clearance. In addition, it turns the periphery of the smallest step, the work being supported stiff enough at this point to allow this heavy forming cut to be taken.

The cones come true to within 0.002 inch, leaving an excellent finish; they require absolutely no filing and practically no polishing.

* * *

Work was begun on the first Hudson tunnel in November, 1874, and continued intermittently until the Hudson Tunnel Co. acquired the franchise and other valuable franchises for tunnels under the Hudson and contiguous shores. The first tunnel projected is rapidly nearing completion, and the opening to traffic from Hoboken to Hudson street took place February 25. Notwithstanding the fact that work was begun on the first tunnel under the waters surrounding Manhattan Island over thirty-three years ago, the first bore to be opened to the public is that under the East River joining Bowling Green with Borough Hall, Brooklyn. This tunnel was opened January 9, and is run in connection with the New York subway. Certain subway trains continue their trips into the Brooklyn district. The new service has to some extent relieved the Brooklyn Bridge congestion, and is the first step in providing more adequate transit facilities between New York and Brooklyn.

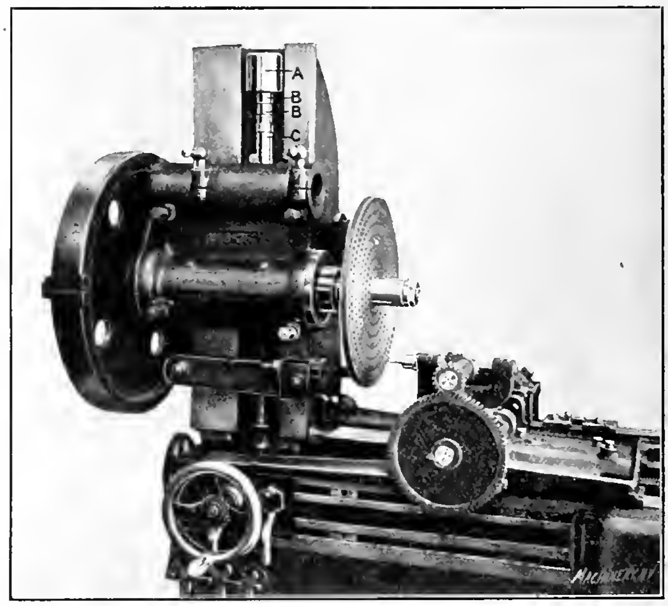
* * *

More than ten years ago, experiments were undertaken by the firm Gabellini, in Rome, Italy, to make boats out of reinforced concrete. Since that time, the firm has built a number of boats for different purposes from this material, these boats having a displacement of from 100 to 150 tons. The frames of the boats are constructed from reinforced concrete, and are covered on the outside and inside with a concrete covering, reinforced with wire netting, water-tight compartments being thus formed between the two layers of concrete. The outside is covered with pure cement, giving a highly finished surface. It is claimed that boats made in this manner have the following advantages over boats built in the usual manner: They can be built quicker and cheaper; the maintenance becomes smaller; they have a high capacity for withstanding outside forces; and, as compared with wooden boats, they are fireproof.

AUTOMATIC FEED-PLATE DRILLING ATTACHMENT.

The accompanying half-tone shows an interesting use for a Brown & Sharpe automatic gear-cutter, it being transformed into an automatic indexing and drilling machine. The scheme is in use in the new shop of the Mueller Machine Tool Co., Cincinnati, Ohio, and is employed for drilling the feed-plates of the variable speed box of the Mueller radial drill.

The drilling fixture is bolted to a No. 3 Brown & Sharpe gear-cutter, the cutter spindle of the latter having a large spur gear, mounted as shown, which drives the small pinion and the drilling shaft at high speed, through the medium of miter gears. The drilling fixture travels automatically back and forth with the machine carriage, in the usual manner, the same as when cutting gears. A lot of 50 or more feed-plates is usually drilled, all in the same circle, and then the index is changed to suit the next concentric circle of holes. The method of making the change is novel. The dial for elevating the dividing head is not used, but instead the exact measurements are obtained by the use of collars or bushings of the exact width required between the concentric rows of holes. A five-pound weight *A* is loosely fitted on top of the elevating screw, and when it rests upon the end of the screw it, of course, turns with the screw when the head is raised or lowered. Between this weight and the elevating screw nut there



Automatic Feed-plate Drilling Attachment.

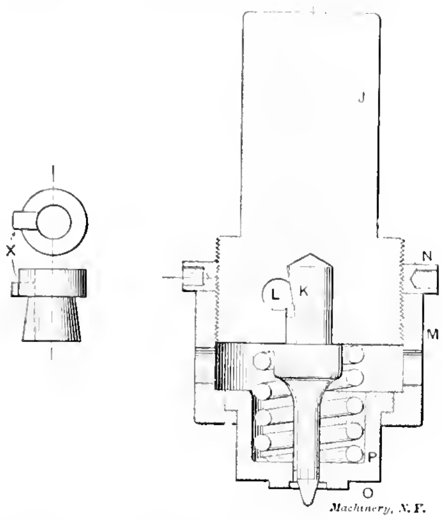
is placed a long collar or bushing *C* having a narrow space knurled. This collar has the exact length required for the elevation of the lower face of the five-pound weight above the elevating feed screw nut when drilling the largest circle of holes. When the next circle is to be drilled in a lot of plates, a collar 0.834 inch in length (which is the distance between the concentric circles) is placed between the long collar and the weight. The method of adjustment is as follows:

The operator holds the knurled collar with one hand and turns the hand-wheel with the other in the direction to lower the dividing head and work spindle. This causes the weight which is supported by the collar and the elevating screw nut, to descend until it touches the end of the elevating screw. The moment it comes in contact it begins to turn, thus notifying the operator that the limit of travel is reached. The same procedure applies for drilling the next concentric row of holes, one of the narrow collars then being interposed between the weight and the long collar. The illustration shows two of these collars on top of the long collar supporting the five-pound weight. It will be observed that the drill is in position for drilling the third row of concentric holes. This method of gaging the width between circles has been found to be close, it being easily possible to space them within 0.001 inch of exactness. It has the advantage of eliminating the mistakes which are always possible in reading graduations on a dial plate.

LETTERS UPON PRACTICAL SUBJECTS.

PUNCH PRESS FORMING JOB.

The accompanying cut shows a rather interesting piece of work done on the punch press. The work to be made is shown in an enlarged scale in Fig. 1. The operation performed with the tool shown consists in forcing the metal out on one side of the piece to form a key, as shown at *X*. The die of the device with which this is done consists of a cast iron block *A*, Fig. 3, bored to receive the tool steel ring *B*, which is tapered on the inside to fit spring collet *C*. The



Figs. 1 and 2. Enlarged View of Piece to be made, and Punch for Forming Key.

set-screw *D* acts as a key and allows the collet to move up and down, but prevents it from turning. The plate *E*, on the top, acts as a stop for the collet, which is forced upward by the spring *F*. Finally, four screws *G* fasten the ring *B* and the plate *E* securely to the die block. The plunger *H* is used for ejecting the piece, being actuated by the spring *I*.

In Fig. 2, the punch-holder is represented by *J*. Into this, tool steel punch *K* is fitted, the punch being driven into its holder, and secured by the taper pin *L*. The sleeve *M*, made

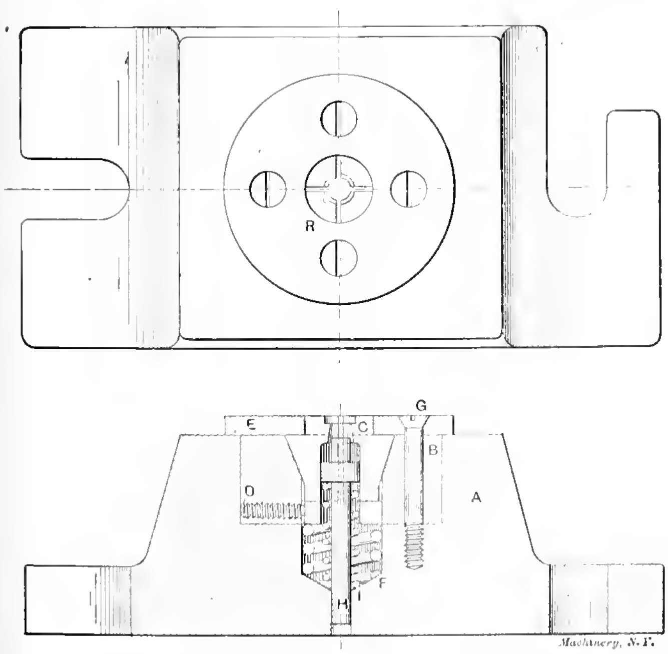


Fig. 3. Die for Forming Key on Piece shown in Fig. 1.

of machine steel, is threaded on the punch holder for adjusting the spring *O*. This sleeve is locked in position by the nut *N*. The cup-shaped piece *P* acts as a stripper, and also closes the collet *C*, Fig. 3, when the punch descends.

The operation of this punch die is as follows: The piece or work, as received from the automatic screw machine, is set into the collet, which is sufficiently open to admit the large end of the tapered part of the work to be put in. The press is then operated. The point of the punch enters the piece, bringing it concentric. The part *P* then strikes the collet, forcing it into the taper ring *B*, and thus the work is held securely while a shoulder on the punch strikes the metal on one side of the piece, forcing it out into the pocket *R*, in the collet, and by this means forms the desired key.

Candiac, Canada. S. A. McDonald.

WEIGHTS NOT THE EQUIVALENT OF SPRINGS.

Your editorial in the February issue reminds me of the experience of a friend who builds many kinds of hydraulic presses and who, one day, discovered a place in which a weight was by no means the equivalent of a spring.

Some of his presses are equipped with a by-pass valve designed to open when the maximum pressure is reached, and thus prevent accidents. This valve had always been held to its seat by a weighted lever, and had always "functioned" without trouble.

But one day he put to the shop test a press which he had built for a leather-belt manufacturer. It had a large platen for wide belts, and was designed to press together the cemented joints of leather belts in process of manufacture.

In such work the pressure in the cylinder would go up from practically nothing to the maximum, in something like half a stroke of the pump, and then the by-pass valve had to open quickly. It did this by bending the lever on which the weight was placed, the weight itself offering too much resistance to the very quick acceleration required.

The weight was replaced by a helical spring, which was the equivalent of the weight so far as holding the valve to its seat was concerned, but was a very different affair when there was a call for quick opening of the valve, because the mass of the spring was so small as to offer only a negligible resistance, and the valve, though held to its seat by the same pressure, was permitted to open as quickly as was necessary.

On the paper-perforating machine which forms a part of the "monotype" outfit for setting type, there is a suspended weight, which, by its descent, operates certain mechanism intermittently, as the keys of the machine are manipulated. But to the eye, the weight seems to descend, not intermittently, but with a perfectly steady motion when the keys are played rapidly. This is because a portion of the weight-suspending member is a helical spring, which, when the mechanism is released, contracts, and when the mechanism is stopped, expands. Thus the pull is practically uniform, instead of being very small at the beginning of motion and very heavy at the end of it, as it would be if the suspending member were rigid.

The result is another very pretty example of the fact that a weight and a spring are by no means equivalent. I think, generally, when the claim is made that they are equivalent it is meant for the particular case under consideration only; not that the one is broadly the equivalent of the other.

Center Bridge, Pa. Fred J. Miller.

DRILLING AND REAMING IN THE LATHE.

Your shop operation sheets Nos. 16, 17, and 18 show the old reliable way of drilling and reaming a hole in the lathe. Allow me to offer a quicker, more modern, and even more reliable method of performing said operation.

Take a lathe with a large hole through the spindle and fit to it an up-to-date 3 or 4-jaw geared scroll chuck. These chucks have been wonderfully improved in strength and wearing qualities, and are at present infinitely superior to the old style ring-and-pinion universal chucks. Fit a No. 2 or 3 Hartford or similar drill chuck to the taper hole of the tail-stock spindle, and we are ready to go ahead.

Put the work into the large chuck and face it true. Put a large combination center drill (one with a 7-16 inch body) in the drill chuck and run it in as far as possible—easily at first to make sure it runs true. Follow this with a 1/4, 5-16, or 3/8 inch drill, according to the size of hole wanted. By thus removing the stock which would otherwise have to be almost

pushed away by the point of the large drill, it is a comparatively easy matter to enlarge the hole to reaming size by means of a twist drill held by the same drill chuck in the tail-stock.

Now about the reaming: I have been told lots of times that a reamer held in the chuck would cut larger than standard, but my experience in this line has taught me that if everything is in line, as it should be, the hole will be straight, true, and as near to size as it is possible to get it by any method. The work may now be turned to size on the outside if required without further adjustment, and if you are one of those fortunate ones who know how to use a cutting-off tool without breaking it, you can finish the piece in one operation without rechucking or placing on a mandrel.

The one point which I would like to bring out most clearly is the utter fallacy (in my estimation) of feeding a drill, reamer or any boring tool into a revolving piece of work by holding it against a pointed center. H. J. BACHMANN.

New York.

LINING LOCOMOTIVE GUIDE BARS FOR LATERAL WEAR.

While visiting several railway repair shops during the past summer, I was particularly struck with the various ways in which the same job was performed. For instance, the manner of fastening liners to steel guide bars, for taking up lateral wear, was accomplished in some places by drilling clear through the guides, and then riveting the liners in place. This takes considerable time, and when a bar requires a liner on each side, some difficulty is met with in getting them both

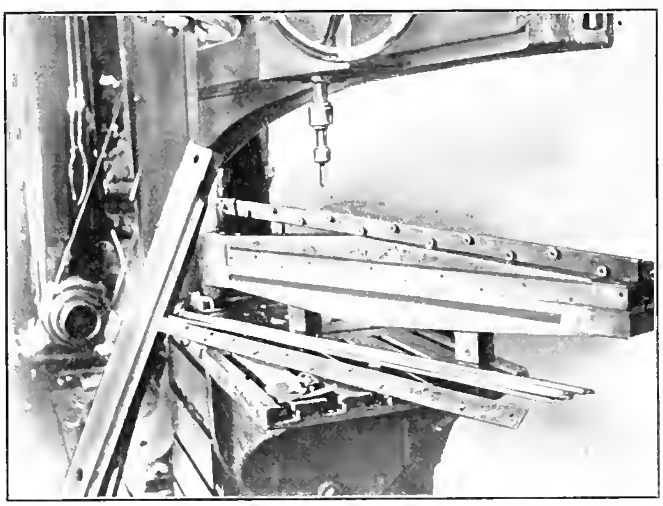


Fig. 1. Guide Bar planed for Liners, and Jig for Drilling the Liners.

tight when using the one rivet for both sides. Others drill and tap holes about one inch deep, then fasten the liner in place by screwing into these holes a length of threaded iron, which is cut off to proper length and then riveted. This does not always make a tight job, and frequently a tap is broken in a hole. Then again, others used countersink screws for holding the liners in place, or, instead of using liners, babbitted the sides of the guides. Of course, in all previously mentioned methods the bars had first been planed certain depths to make room for the liner. I was informed that the babbitted liners wore much longer than the original bar did, and were quickly put on and machined. If this is correct, I am inclined to think this method is better than the others mentioned.

After considerable experimenting, I find the method illustrated in the accompanying cuts to be very satisfactory. In Fig. 1 is shown a bar which has been planed for liners on both sides, the planed surface being 7/32 inch deep and 2 inches wide. Steel liners, 1/4 x 2 inches, are drilled to the jig shown, then clamped to the guide bars and the bars drilled with a 3/8-inch twist drill to a depth of 3/4 inch. A short twist drill that has been ground so that it is much smaller 1/8 inch back from the point than at the point, and also ground off the center, is inserted in the hole already drilled, and the hole drilled about 1/4 inch deeper. A drill ground in this way will produce a hole similar to the one shown in Fig. 2. After countersinking the liners with a long taper countersink, a 5/16-inch steel ball is dropped in the hole and either a brass or soft iron rivet is driven in. While riveting up the top end, the ball is forcing itself up into the slot, which has been sawed in the end of the rivet, causing the rivet to spread and fill the enlarged part of the hole. These liners, if of common rolled bar stock, should be planed after being riveted on; if cold rolled stock is used, this is not necessary, and the recess in the bars should be planed the proper depth

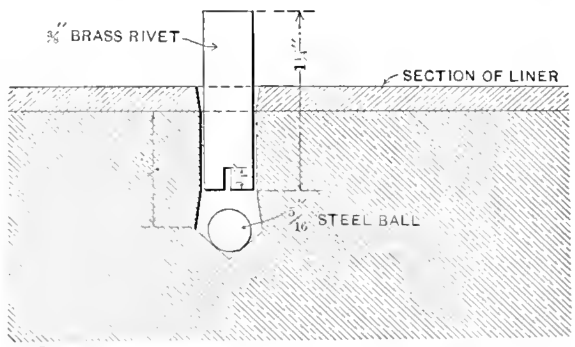


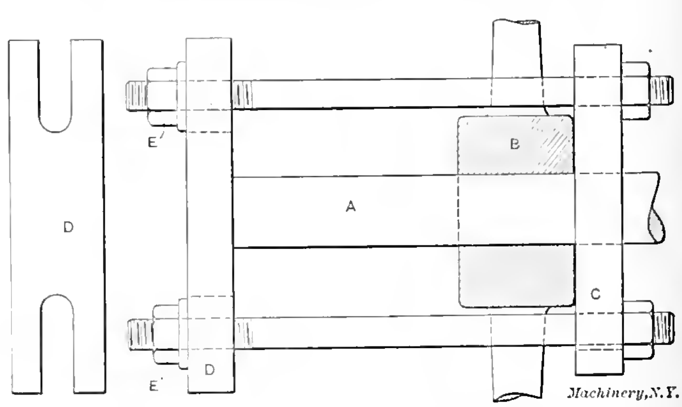
Fig. 2. Method of Fastening Liners to Guide Bars.

to suit the thickness of the liners. This is an inexpensive method ,as the steel balls used do not cost over one-half cent apiece, and there is no tapping of holes or turning and threading bolts or rivets. One end of the liner should be made to butt up against the cylinder head, and the other end to bear tightly against the end of the planed recess in the bar, thereby preventing any shearing strain being put on the rivets. While these liners are not so tight that they cannot be taken off by driving a flat chisel between them and the bars, still, properly fitted endwise, they have held for two years to my knowledge, or until they have had to be removed through wear. M. H. WESTBROOK.

Port Huron, Mich.

TO REMOVE PULLEYS FROM SHAFTS.

The first thing to do when pulleys are to be removed from shafts is, of course, to loosen the set-screws, if there should be any. These are sometimes rusted in, and in such a case it is necessary to use a wrench and pull with a steady pull to avoid breaking off the heads. If the heads of the screws should break off, the only thing that can be done is to drill out the screws. Should the screws be hardened, they can be annealed by means of a blow torch. To remove keys, procure a short, stiff key drift and a heavy sledge. Strike with as heavy blows as possible; light blows are likely to upset the end of the key and make it harder to remove. If it is found impossible to remove the key by this process, a key gun, such



Device for Removing Pulleys from Shafts.

as described in the December issue of MACHINERY, may be used to advantage. If nothing of this kind is at hand, a swinging ram, if there be room to work it, may be used. This may consist of a piece of round iron or steel about six inches or more in diameter, and two feet, or more, long. There should be two eye-bolts in the upper side of this bar, by means of which the ram is suspended from above by a rope, or chain, in such a position that it can be drawn back and swung against the drift. If the key cannot be driven out in this

manner, on account of lack of space, but it can be reached with a drill. It is then necessary to drill it out.

When the key is removed, if the pulley is not very large, or does not stick too hard to the shaft, it may be driven off with a swinging ram. Larger pulleys often have to be pulled off by means of a jack and a long chain; in such a case place the bottom of the jack on the end of the shaft, put the middle of the chain over the top of the jack, and hook the ends around two opposite arms of the pulley, provided these are strong enough to stand the strain; otherwise, place a heavy strap back of the hub, and attach the chain to this. When enough pressure is brought to bear on the jack, a blow with the sledge is likely to start the pulley.

Sometimes a more elaborate rig is required, such as is shown in the cut. In this, *A* represents the shaft; *B*, the hub of the pulley to be removed; *C* is a heavy U-strap; and *D* is another similar strap made as shown in the end view. The size of the bolts and straps used for this rigging, of course, depend upon the size of the work. Three-inch bolts are, as a rule, large enough for any ordinary work, and a wrench may be used, say 10 feet long. The outer ends of the bolts should have a long threaded portion, and suitable washers should be used under the nuts. It is plainly seen from the cut how the pulley is removed, the nuts *E* being tightened up until the hub of the pulley gives away from the shaft. If, however, the hub cannot be started by tightening up the bolts, it may be necessary to heat the hub. Waste dipped in kerosene, charcoal, or blow torches may be used, when necessary, for heating. The rim of the pulley may be protected from the heat by pieces of sheet iron, and the shaft should be kept cool with water.

When a heavy pressure is secured on the shaft, a jar with a heavy sledge is most likely to start the pulley. If, however, the pulley is still fast on the shaft, and no appliances for removing it can be easily secured, then the hub had better be split, and the hole wedged open far enough to let the pulley come off. The pulley can afterward be made "as good as new" by shrinking bands around the hub.

Portland, Me. H. K. GRIGGS.

DRIVING AXLE CENTERING TOOL.

The accompanying cuts illustrate a centering device which may be of interest to the readers of MACHINERY. This attachment is used in the Sedalia shops of the Missouri Pacific Railway. The idea is original, and I do not believe that this device is in use elsewhere. On account of heavy wheel lathe service, we are required to put a 60-degree center, measuring

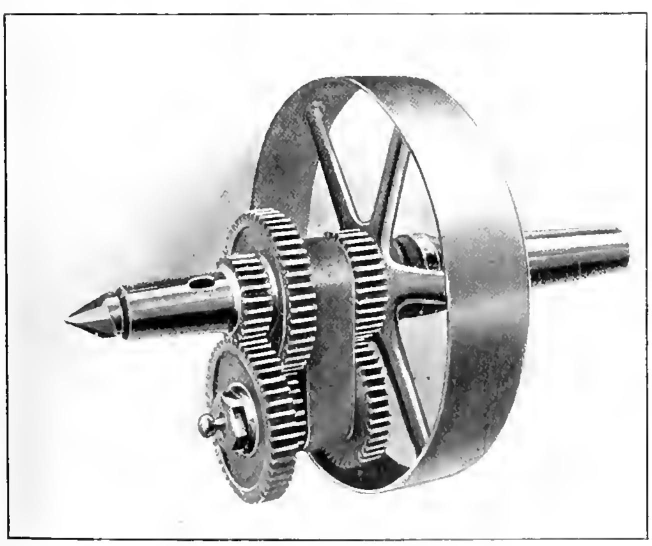


Fig. 1. Lathe Attachment for Centering Heavy Work.

1½ inch in diameter, in all locomotive driving axles. The process of drilling them in with a ratchet was too slow and laborious, and not having a regular centering machine, the attachment shown in Fig. 1 was devised. This attachment works perfectly, producing two large smooth-cut centers in fifteen minutes. The way in which this device is attached to a lathe is clearly shown in Fig. 2. The lathe center is removed, and the spindle of the machine is inserted into the tail-stock of the lathe. A separate counter-shaft is provided with a "Sim-Pull" starting device, and by changing the posi-

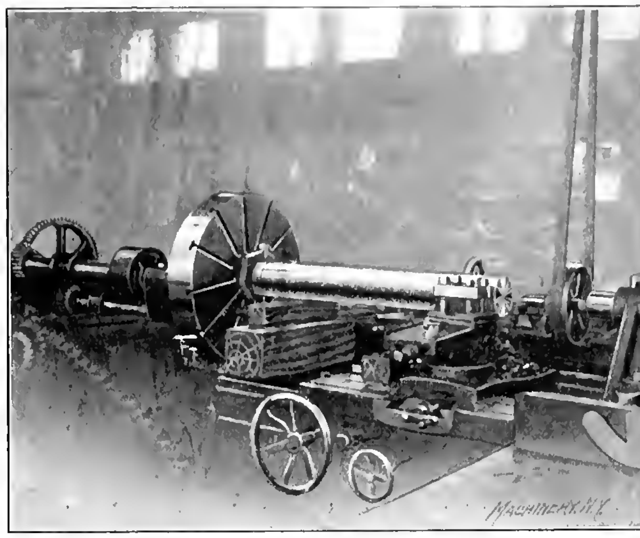


Fig. 2. Centering Tool attached to the Lathe.

tion of the pin *A*, shown in Fig. 3, two speeds are obtainable, one giving 75 revolutions for the countersink, and the other 300 revolutions for a ⅜-inch drill which precedes it. A 2½-inch belt is used for driving, and as there is but four inches

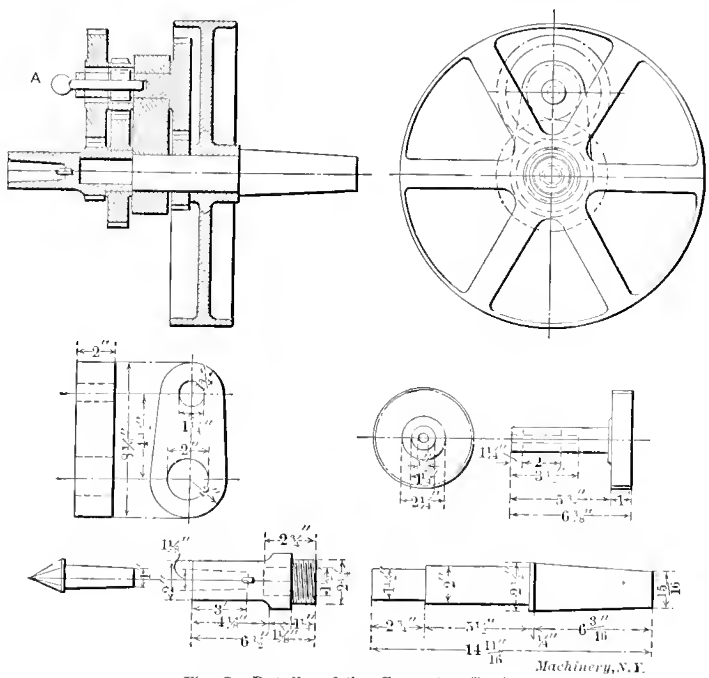


Fig. 3. Details of the Centering Tool.

difference in the length of all the axles in use here, a 10-inch face fully on the counter-shaft gives ample room for the variations. W. W. WILLIAMS.

Sedalia, Mo.

MAKING A SLEEVE WITH AN ACCURATE KEYWAY.

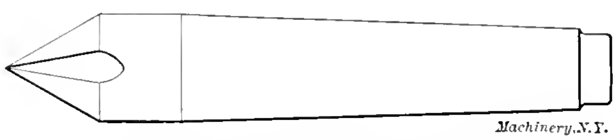
One day a job came up requiring the making of four high-percentage chrome nickel-steel sleeves, 9 inches long, having a 1¼-inch bore, with keyways 3/16 inch wide by 3/32 inch deep. The sleeves must be made so that they would slide on the shaft freely, and yet have no play. The bore was to be within 0.0005 inch of the correct size and the key way to be exactly parallel with the bore. This job was completed in the following manner. The bar steel for the sleeves was held in a chuck near the end and rough-turned on the outside, and provided with a 1 3/16-inch drilled hole. It was then taken out of the chuck and a 1-inch bore collet was fitted to the taper in the spindle of the lathe, and a cast iron boring bar holder fitted to the carriage and bored with a 1 inch drill, held in the chuck,

so as to be parallel with the head-stock. A piece of cold rolled 1-inch shafting was then provided with a square cutter held in place by a set-screw on the side and fed out by a set-screw on the top of the bar, acting on the end of the cutter. The sleeves were then rechucked and bored to 1.240 inch diameter, and then the cutter bar was inserted in the boring bar holder and brought carefully to the center, and the carriage clamped to the gib screws. A slotting cutter, ground to gage, was inserted in the bar, and the set-screw on the side was tightened just enough to hold the cutter firmly in place and yet allow it to be pushed out by the adjusting screw after each cut to provide for feed. The carriage was then run forward and back by hand, each cut taken being about 0.003 inch deep, using lard oil on the cutter. The sleeves were then placed on a mandrel and finished on the outside. The bore was lapped to size with a lead lapping bar cast on a tool steel mandrel, turned to about 1.180-inch in diameter. This procedure resulted in a perfect job.

Schenectady, N. Y. ROBERT MAYHEW.

CENTER USED WHEN FACING THE ENDS OF WORK.

I have been greatly interested in the letters in MACHINERY regarding the squaring of the ends of work on centers, and it may be of interest to some readers of MACHINERY to see the simple center that I use for this purpose. This center may not be new to everybody, but I have never seen this idea published in any trade paper before. On the side of the center is a half round groove as indicated in the cut. This groove



Center with Groove to receive Point of Tool.

is made by a round file, and while the efficiency of the center for ordinary work is hardly impaired at all, it is possible to use a tool that is quite blunt on the end when facing work; by feeding the tool to the bottom of the groove, the work can be cleaned perfectly at the end. The edges of the groove should be slightly rounded, so as to prevent all tendency for cutting or reaming the center hole of the work.

Newburyport, Mass. R. H. MARSH.

NOTES ON CENTERING.

The remarks by "Allan" in the October, 1907, issue regarding centering work for turning has just caught my attention, and I would like to add a few words. What "Allan" writes is all very good as far as it goes, but in my estimation "the half has not been told." The balance of the story is this: Keep handy a punch ground accurately to 60 degrees and fairly long and stout. After the center has been reamed, clean out the hole thoroughly, then set in the punch so that it stands vertical, and give it a hard blow or two with a fairly heavy hammer. To prove that this method is necessary, center a shaft, omitting the punching. Take a heavy cut half way over the piece. Turn it end for end and start another cut. Where the cuts meet, it will be shown that two ends of shaft are not concentric in nine cases out of ten. Now, take another piece and punch as described above, turn as in the other example, and you will find the result more satisfactory.

Another kink I always use and which I believe is not widely known (having been asked by different foremen more than once, "Now, what are you doing that for?"), is to grind a fine, narrow groove lengthwise on the dead center. Set the center with the groove on top or a little to the rear. This prevents disagreeable happenings in the shape of pieces dropping down between the lathe ways when you are loosening the center to oil it, or when the center gets hot. With this groove you can oil the center at any time and its life is much prolonged.

As "Allan" aptly remarks, the centering is of the utmost importance. The angle of centers must be perfect because of the extensive use of the grinding lathe in modern manufacturing, and the attendant changing of the shaft from one machine to the other. Where there is a grinder it is best to have a special collet or bushing in which to grind lathe centers. Some argue that a center should be ground while in place in the spindle, but in modern lathe building practice it is waste of time, for the center will invariably run true without having to be scratched or center punched to correspond to a certain place on the lathe spindle.

PLODDER.

[We are impressed by "Plodder's" faith in the absolute concentricity of lathe spindle taper holes with their bearings, but think that it is wise to demonstrate the fact on each lathe before accepting it as the gospel. In a later letter "Plodder" explains that the use of the special 60-degree punch is to condense the metal around the center hole and thus prevent rapid wear. If the practice is followed it is obvious that great care should be taken to set the punch perfectly in line with the piece being centered so as not to distort the center.—EDITOR.]

FACING WORK ON CENTERS.

Having noticed, recently, several suggestions relative to the facing of work on centers, it has occurred to me that a method I have used for some time may be of interest to the readers of MACHINERY. After drilling the centers and before countersinking, put the piece in the lathe and face as close to the center as is convenient with an ordinary side tool; then finish the center, cutting off the thin shell that is left around the drilled hole with the countersink. By this method one avoids using an extra center, and the work is square on the end before the countersinking is done, which is a considerable advantage, since, if such is not the case, the high side tends to push the countersink out of line with the drilled hole. Another way is to face the ends while the piece runs on punched centers, before they are drilled, and sometimes this does very well, saves a little time, and makes an end square enough for the purpose, but it is not as accurate as the former method, since it is not at all certain that the center, when finished, will have the exact location of the punched hole.

C. H.

A RULE FOR OBTAINING THE HEIGHT OF THE MIDDLE ORDINATE OF AN ARC.

In the December issue a correspondent asked how to obtain the height of the middle ordinate of an arc, having given the chord and the angle at the center. Here is my rule:

Divide half the chord length by the sine and by the tangent of half the angle at the center. The difference between these

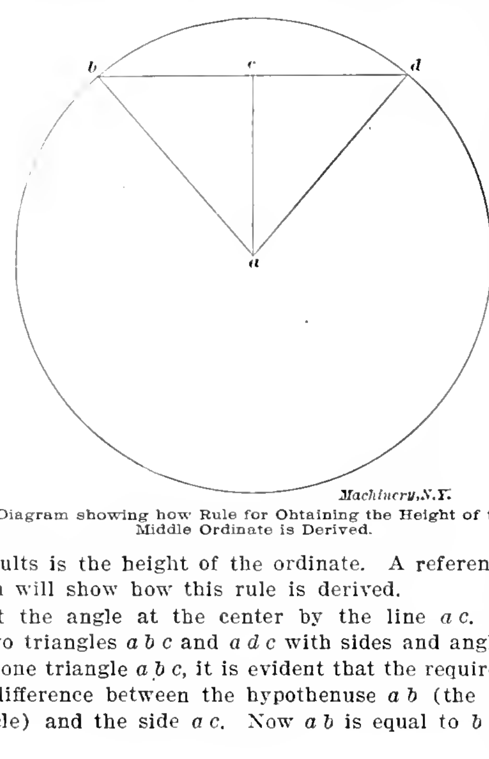


Diagram showing how Rule for Obtaining the Height of the Middle Ordinate is Derived.

two results is the height of the ordinate. A reference to the diagram will show how this rule is derived.

Bisect the angle at the center by the line $a\,c$. We now have two triangles $a\,b\,c$ and $a\,d\,c$ with sides and angles equal. Taking one triangle $a\,b\,c$, it is evident that the required height is the difference between the hypothenuse $a\,b$ (the radius of the circle) and the side $a\,c$. Now $a\,b$ is equal to $b\,c$ divided

by the sine of the angle $b\,a\,c$. And $a\,c$ is equal to $b\,c$ divided by the tangent of the angle $b\,a\,c$.

In the problem which you used as an illustration, the chord was equal to 10 feet and the angle at the center 36 degrees. Using these values, $b\,c$ equals 5, and angle $b\,a\,c$ equals 18 degrees. Now 5 divided by 0.30902, the sine of 18 degrees, equals 16.1801. You obtained 16.55 for this value. This was erroneous, the error being made in solving the equation $0.30902\,R = 5$. Dividing 5 by the tangent, 0.3249, we have 15.3892 as the length of the side $a\,c$. Subtracting, 16.1801 minus 15.3892 equals 0.7909 foot, the height of the ordinate.

F. M. S.

[The method given by F. M. S. is undoubtedly the more elegant of the two, although the operations are the same in number, *i. e.* three. It is generally easier to multiply numbers than to divide them, especially when the divisors contain five or six figures, part or all of which are decimals. For this reason some may prefer the method given in December.—EDITOR.]

SHADING DRAWINGS.

To what extent it is desirable to shade the curved surfaces shown on working drawings, giving more or less resemblance to the appearance of a wood engraving, is a question occasionally calling for a decision in the drawing-room. The question is usually decided by the chief draftsman in favor of no shading at all, in view of the appreciable amount of the draftsman's time required to do the extra work, involving an additional labor cost. The additional advantages of a judicious amount of shading is entirely lost sight of in the light of the extra drawing-room expense incurred. While it is important for commercial reasons that labor cost should be kept at a minimum, it is questionable economy to keep down this cost at the expense of absolute clearness, especially so when the resulting drawing may go distances varying from 300 feet to 300 miles, or more, away, passing into the hands of unknown workmen, with more or less doubtful ability to properly read and comprehend all of the details involved. There are many to whom the lines and details of a working drawing are a meaningless mass of confused lines and figures, entirely beyond comprehension, while a wood engraving is clearness itself, instantly presenting the object in an unmistakable manner, with the least possibility of misunderstanding. It is unquestionably a fact that the major part of all machine drawings would be a great deal clearer, easier and more quickly read were a judicious amount of shading properly done in their preparation. The slight extra cost being many times offset by the saving in correspondence and time used in asking questions, and in running about making the necessary explanations, which, were proper shading done, would be, to a large extent, eliminated.

Being in charge of drawing-room on a class of work requiring many complicated assembled drawings, which are distributed among men of varying degrees of ability in the quick and accurate reading of drawings, the need has been felt for some means of bringing out more clearly the forms of the various parts, which has been done with very satisfactory results by the adoption of a generous amount of shading of curved and irregular surfaces. This resulted in a very marked decrease in the number of inquiries received, and explanations necessary to be made, and also in a considerable saving in the time of a high grade man, which was formerly used to an appreciable extent in running around a large factory in the capacity of a walking encyclopedia. While it is not practical to duplicate a wood engraving in its completeness, yet there is undoubtedly a point between this extreme and that of the ordinary working drawing which it is economical to reach, notwithstanding the extra drawing-room cost incurred.

H. D. PENNEY.

Pittsfield, Mass.

[The time required in the drafting room to make simple shade lines to indicate the lower and right-hand edges of solids is time well spent. When a drawing is properly dimensioned, every distance that the workman will need to know being given, there can be no objection to such shade lines other than the time required to make them. The time dwindles into insignificance when the clearness and attractiveness of drawings properly shaded is taken into account. In the course of a year we see a great variety of drawings made by all kinds of draftsmen trained under all sorts of conditions. The difference in clearness is amazing, and it is easy to see that simple shading and proper cross-sectioning are really very important. The drawing that possesses snap and life is an inspiration, and it is a real pleasure to work from it. The unshaded drawing has a weakness and dullness that is discouraging. It requires more mental effort or concentration to understand it, and the chances for error of interpretation are greater, we believe, than with shaded drawings. As to shade lines for rounded surfaces, however, we doubt that they are generally advisable. Unless such shading is *very well* done, the result is decidedly amateurish in appearance. If it is well done the effect is, of course, pleasing and the subject stands forth clearly, but unless for some very special cases, we would not favor it.—EDITOR.]

GERMAN MANUFACTURERS HELPED ONLY BY REDUCED FREIGHT RATES ON EXPORTS.

In your leading editorial in the November issue, 1907, entitled "The French Machine Tool Trade," you claim that the German tool manufacturers receive an allowance from their government on all machinery sales for export. This statement is certainly not based on fact, and it seems to have emanated from certain sources which constantly endeavor to create ill feeling against the nation that is one of America's best customers.

The only way in which the German government favors export is by allowing a slightly more favorable *freight* rate on goods exported than on those imported, which, however, is quite a negligible quantity, and it certainly does not handicap the American builders. The import of American machine tools in Germany and other continental countries is, as you must be aware, more handicapped through the excessive American duties which have made treaties on a mutually fair basis practically impossible. The result is that American machinery has lately been deprived of the very advantageous tariff rates ruling under the "most favored nation" clause, and pays now here in German nearly double the former rate. I note that the National Association of Machine Tool Builders lately decided to maintain prices regardless of the falling-off demand; while such a move may be practicable in the United States, it is essential for the maintenance and development of the American machine tool trade in Europe that such artificial prices based on an excessive tariff and resulting high cost of material and labor, are not imposed upon the European market.

FAIRPLAY.

Charlottenburg, Germany.

WRITING TO GERMANY.

Referring to item on page 232, engineering edition, in regard to foreign postage for replies; why not use a postcard with paid reply (cost 4 cents), or get, at your local post-office, an international reply coupon for six cents, which will buy a 20-pfennig or a 25-centime stamp in the country of the receiver? United States stamps are of no use to Germans. What would Americans do with German stamps? If Americans would pay full postage on their sendings, it would be better. Many a letter containing an offer is refused because the addressee will not pay 40 pfennigs on a sending of unknown contents.

ROBERT GRIMSHAW.

Dresden, Germany.

HARDENING SPRING COLLETS.

In reading an article by Mr. J. J. Voelcker, in the December issue, regarding the making of spring collets, it occurred to me that it might be of interest to some of the readers of MACHINERY to know how the writer hardens them. I have been hardening tools of this character for the past eight years, and have had no trouble with breakage, which I attribute to slow and even heating.

In the first place, the collets are heated evenly all over, using a section of pipe closed at one end, if heating in a forge. I then take the collets, one at a time, put them on

end, and insert a taper plug in the hole, pressing it in until I get the required expansion, in a manner as shown in the half-tone, Fig. 1.

Sometimes one slot will not open as readily as the others, the reason for this being that the collet is slightly cooler in one portion than in other parts, making it somewhat stiffer. To overcome this, I insert a thin chisel in the narrow slot, carefully pressing inward until I get the slots about equally open. I then leave the plug in the collet until the latter is cold. When I heat them for hardening, I set them on end in the furnace. If heating them at the forge, I make a small taper piece of iron, about one inch long, and insert this in the hole at the jaws, previously having taken out the expanding taper plug. This small piece keeps the sections of the collet from closing up, which they naturally would do if placed on their sides in the forge. They should be frequently turned around in order to heat them evenly. When the collets are hot, the plug is easily and quickly pushed out from the back end with a rod or wire; then the collet is dipped into the bath.

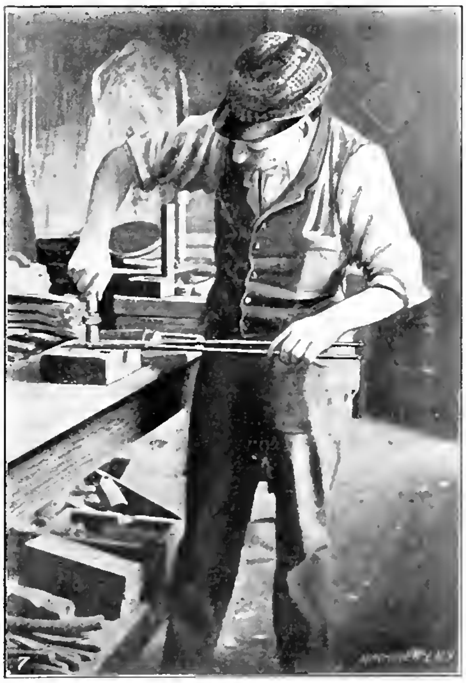


Fig. 1. Inserting Taper Expander into Collet.

When dipping, the collets should be immersed in the bath up to the shoulder or a little more, and when cold enough to have secured the necessary hardness, they should be withdrawn quickly from the bath and plunged in lard oil. When cold, they are polished from the shoulder to the back end, and then drawn to 400 degrees F. in the oil furnace; finally, the back end is drawn to a dark blue on a heated plate, running this color about half way up on the collet. Then the collets are cooled in oil.

Machine steel collets are expanded in the same manner, and then packed in a suitable box, as indicated in the line cut, Fig. 2, the packing consisting of a mixture of No. 2 raw bone and burnt bone, that is, bone that has been used once. The collets are packed in pairs, about one-half inch apart, and there should be about one inch of packing between the collets and the walls of the box. The cover is then put on the box, and luted with fire-clay. The box is then put in the hot furnace and heated slowly to 1300 degrees F., and kept at that temperature for about three hours. It is then removed from the furnace, the cover taken off, and the jaws of the collets plunged first in water and then in lard oil. When cooled off, the collet is polished, drawn to a deep blue, leaving the jaws as hard as when they came from the bath. Care should be taken that the heat does not exceed 1300 degrees F., as it makes the collets brittle if subjected to a higher heat. If the collet is a long one, the color is drawn to about 1½ inch above the end of the slots. The writer's experience indicates that machine steel collets give fully as good satisfaction as tool steel collets when the cost and the greater ease of making is considered.

It may be somewhat difficult to get the right heat when case-hardening the collets. A good method is to drill two or three holes in the top of the box and insert some nails long enough to reach to the center of the box. These nails can be withdrawn when it is estimated that the box is heated all through, the heat of the nails observed, and the heat inside the box estimated accordingly.

The box used may be made very simply and inexpensively from sections of 3, 4, 5, or 6 inch pipe, as the case may be, and should always be two inches longer than the work to be hardened. A cover is welded on one end, and the other end has a cover with a lug or eye riveted to the center, making it easy to handle. These pipe boxes, if flattened, as shown

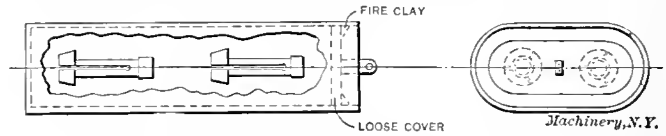


Fig. 2. Method of Packing Machine Steel Collets for Case-hardening.

in Fig. 2, become somewhat more useful. It is well to pack the collets with the back ends toward the open end of the pipe, as it makes it easier to take them out and dip them. Care should be taken, when pulling out the collets not to uncover those still remaining, but if one of them becomes exposed, cover it with hot bone dust, so as to keep the heat until ready to remove the next collet. GEO. T. COLES.

Decatur, Ill.

KILLING MEN AND FINING EMPLOYERS.

As to killing men and fining employers, referred to in the December issue on page 233, engineering edition, the majority of fatal accidents are caused by the men. As a boy I lived near a gunpowder works. The men were forbidden to enter a grinding mill before stopping the machinery from the outside; to wear boots with iron-pegged soles; or to use iron hammers in coopering up the powder. They did all three (smuggled iron hammers in under their blouses) and caused many explosions. They wrecked part of 15th Street, Wilmington, Del., by smoking in one of three eight-mule wagons loaded with gunpowder. I have known workmen in rubber-mills to put pennies on the rolls and bet 10 cents that they could get them out before they went through. Sometimes they didn't, and lost an arm. ROBERT GRIMSHAW.

Dresden, Germany.

DIE FOR BENDING COLD ROLLED STEEL PIECES.

The tools shown in the cuts herewith are designed for bending ⅜-inch round cold rolled steel pieces to the shape shown at *E*, Fig. 1. The chief consideration in the manufacture of these parts is the reduction of the cost, and the elimination

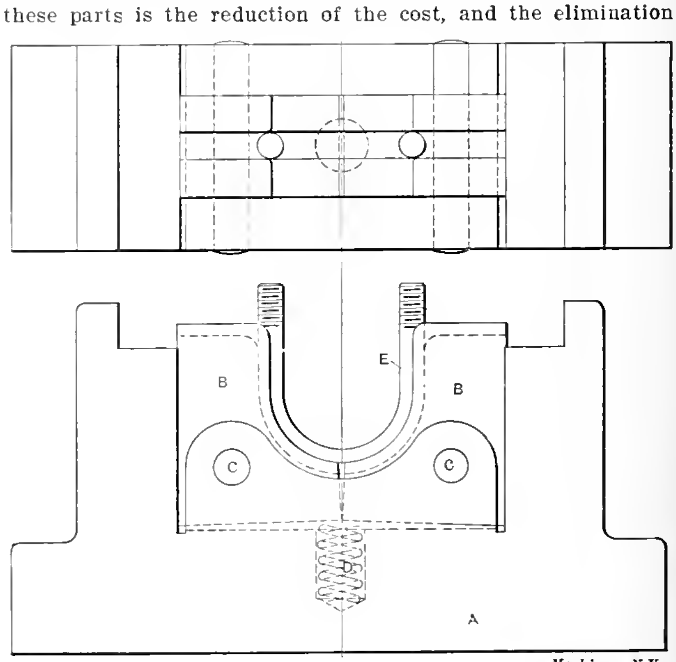


Fig. 1. Die with Completed Work in Place.

of as many operations as possible, yet maintaining the accuracy required, which, in this case, is very close, the opposite sides of the work having to be almost parallel, the ends not to be spread more than 0.002 inch. The type of die shown, for bending the piece in one operation, is being applied with great success, and can be highly recommended for its pur-

pose. While the tool was devised primarily for the purpose of bending the work mentioned, it can be used to advantage for flat work of similar shape, especially for metals of an elastic nature, when it becomes necessary, in order to obtain desired results, to make allowance for the spreading of the ends after bending.

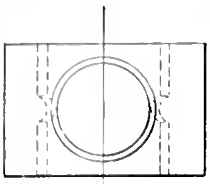
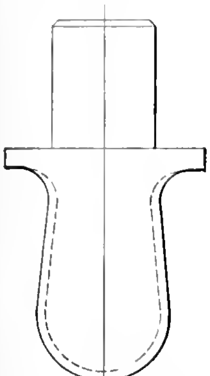


Fig. 1 shows the die, consisting of the cast iron holder *A*, the upper parts of which are machined to act as a gage for the stock, the steel jaws or dies *B B*, which are made of tool steel, hardened, and ground to dimensions, and have the holes lapped to an easy fit on pins *C C*; and the spring *D*, which is required to open the die as the punch ascends. The holder should be machined to permit the opening of die sufficiently to release the work, and permit the easy removal of the finished piece by the operator. Fig. 2 shows the punch, made of high carbon steel and hardened, and having a groove on the sides and lower end, of a radius to accommodate the work. The cuts show very plainly the construction and action of the device. It may be further stated, however, that, in adjusting the press ram, it should be brought down sufficiently to tip the die members, and bend in the ends of the work a certain distance. This is required to compensate for the springing back of the metal when the punch ascends.



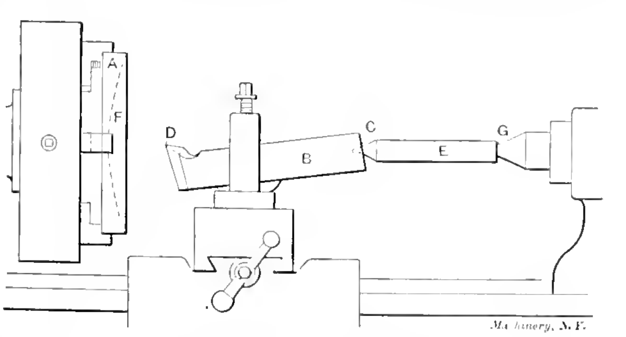
Machinery,N.Y.

Fig. 2. Punch for Bending Cold Rolled Steel.

ENGINEER.

FACING CONCAVE WORK IN THE LATHE.

It is quite often necessary in machine shop practice to turn out concave disks for various purposes. This work of course, can be done on turret lathes with the aid of forming tools, but the manufacture of an outfit for this purpose is too expensive when only a small number of pieces are to be made. The following method will be found to be very satisfactory and cheap, as the apparatus, if constructed properly, will finish the work so closely that it will require little or no scraping to fit it to gage: Chuck the piece *A* in the required position, and after centering the tool *B* at a point *C*, set the tool so that points *D* and *C* are in line with the head- and tail-stock centers. Take a piece of cold rolled steel *E* the same length as the radius of the concaved surface *F*, and point one end the same as a center, and center-drill the other end. Move carriage of lathe so that tool *B* is close enough to the work to take a cut of sufficient depth. Place the point of the piece *E* in the center *C*, and draw up the



Machinery, N.Y.

Facing Concave Work in the Lathe.

tail-stock bringing the center in *G*. Clamp the tail-stock securely. Start up the lathe and feed the cross-slide either by hand or power. The piece *E* may be made in two parts by using a right- and left-hand union nut with check nuts to hold the union nut in position. This will allow of adjustment in the piece *E*.

W. J. SANSOM.

Madison, Wis.

[Of course it will be seen that if the lathe has a compound rest it is not strictly necessary to place the radius piece between the end of the tool shank and the tail-center, although this is the most convenient position, no doubt. We, therefore, venture to suggest a variation of this ingenious scheme that has an obvious advantage. If we make the radius piece pointed at each end, and support it in prick-punch marks in the cross-slide and tail-stock base, it will guide the tool point in exactly the same arc as though used in the manner illustrated, provided it is properly aligned to begin with. This being so, the same plan may be followed in turning convex surfaces, by simply placing the double point radius piece between the cross-slide and the head-stock. It will not work so well because the pressure of the cut will tend to push the carriage from the radius piece, whereas on concave facing the pressure of the cut is against the radius piece. However, for light finishing cuts it should work fairly well.—EDITOR.]

CONSTANTS FOR FINDING SPEEDS OF DRILLS.

The accompanying table contains constants which have been figured for facilitating the calculation of the speeds of drills. These constants will be found useful for finding the speed in feet, when the number of revolutions is given, or the number of revolutions, when the speed in feet is given. Thus, the figure in the column opposite the size of drill will, when multiplied by the number of feet per minute, give the required number of revolutions for the given speed in feet for this size of drill. Used in the reverse order, when the number of revolutions is given, dividing by the number opposite the size of drill will give the speed in number of feet per minute. Suppose, for instance, that it is wanted to run a 3-inch drill, at 40 feet per minute; then, multiplying 40 by the constant 1.27, given opposite the size of drill in the table, gives us 50.8 revolutions per minute. In the same manner, if it were known that a drill was running at 51 revolutions per minute, by dividing by the constant 1.27, for a 3-inch drill, we would get the running speed as 40 feet per minute, approximately.

TABLE OF CONSTANTS FOR FINDING SPEEDS OF DRILLS.

$$\text{Constant} = \frac{12}{\text{size of drill} \times 3.1416}$$

$$\text{Constant} \times \text{speed in feet} = \text{number of revolutions.}$$

$$\frac{\text{Number of revolutions}}{\text{constant}} = \text{speed in feet.}$$

Size Drill.	Constant.	Size Drill.	Constant.	Size Drill.	Constant	Size Drill.	Constant.
$\frac{1}{8}$	30.55	$\frac{15}{16}$	4.07	$1\frac{3}{4}$	2.18	$2\frac{9}{16}$	1.49
$\frac{3}{16}$	20.35	1	3.81	$1\frac{13}{16}$	2.10	$2\frac{5}{8}$	1.45
$\frac{1}{4}$	15.27	$1\frac{1}{16}$	3.59	$1\frac{7}{8}$	2.03	$2\frac{11}{16}$	1.42
$\frac{5}{16}$	12.22	$1\frac{1}{8}$	3.39	$1\frac{15}{16}$	1.97	$2\frac{3}{4}$	1.39
$\frac{3}{8}$	10.175	$1\frac{3}{16}$	3.21	2	1.91	$2\frac{13}{16}$	1.36
$\frac{7}{16}$	9 09	$1\frac{1}{4}$	3.05	$2\frac{1}{16}$	1.85	$2\frac{7}{8}$	1.33
$\frac{1}{2}$	7.64	$1\frac{5}{16}$	2.91	$2\frac{1}{8}$	1.79	$2\frac{15}{16}$	1.30
$\frac{9}{16}$	6.78	$1\frac{3}{8}$	2.77	$2\frac{3}{16}$	1·74	3	1.27
$\frac{5}{8}$	6.11	$1\frac{7}{16}$	2.65	$2\frac{1}{4}$	1.70	$3\frac{1}{16}$	1.24
$\frac{11}{16}$	5.55	$1\frac{1}{2}$	2.54	$2\frac{5}{16}$	1.65	$3\frac{1}{8}$	1.21
$\frac{3}{4}$	5.08	$1\frac{9}{16}$	2.42	$2\frac{3}{8}$	1.61	$3\frac{3}{16}$	1.20
$\frac{13}{16}$	4.69	$1\frac{5}{8}$	2.35	$2\frac{7}{16}$	1.57	$3\frac{1}{4}$	1.18
$\frac{7}{8}$	4.37	$1\frac{11}{16}$	2.26	$2\frac{1}{2}$	1.53	...	....

Worcester, Mass. PETER PLANTINGA.

COMMENT ON UNIVERSAL VISE.

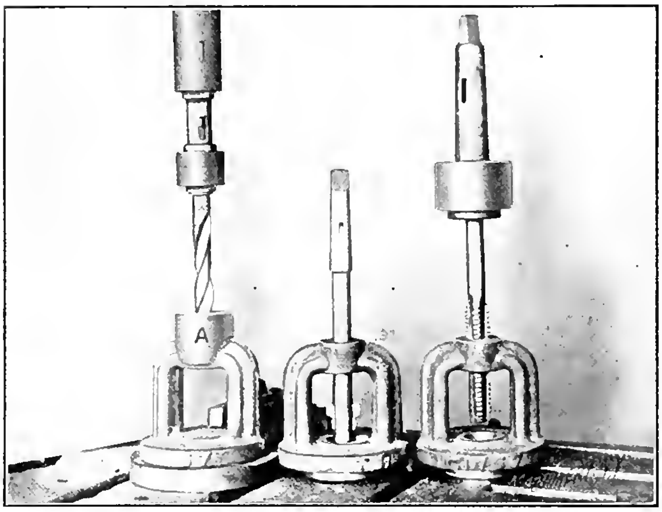
A machine vise having a ball and socket joint like that illustrated in the January issue of MACHINERY was used by the writer in 1887 in Battle Creek, Mich. The vise was employed principally in drill press work, and while the idea was apparently all right from a theoretical standpoint, the thing did not work satisfactorily in practice. In leveling up work, a blow of the hammer in one direction nearly always caused the vise to go down in a slightly different direction, making it a tedious job to get a piece of work properly adjusted. The trouble was probably due to some irregularity in the ball. In making such a vise, the ball should be turned in connection with the compound rest, or with a ball-turning attachment. If neither of these is available, the gage that is used to test the ball should be bored true in the lathe rather than filed to marks. The bearing in the socket may be made by pouring babbitt around the ball, and probably it would be a good idea to tighten the clamping bolts slightly while the babbitt is cooling.

W. S. LEONARD.

Atlanta, Ga.

DOING LATHE WORK ON A DRILL PRESS.

The accompanying cut illustrates how a cast iron hydrant yoke, which was formerly machined in the lathe, is done on a drill press with a great saving in time and money, the cost being reduced from fifty cents to five cents each. By referring to the cut, the method of doing the work will be readily understood. First a cast iron plate was turned to fit the hole



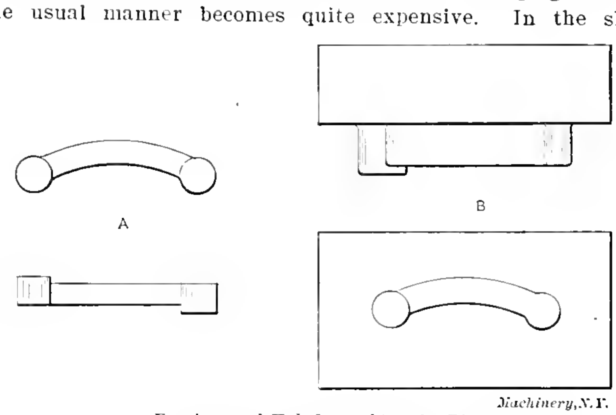
Method of Drilling, Boring and Tapping Hydraulic Yokes on the Drill Press.

in the drill press table, and the upper surface of the plate recessed to receive the projecting bottom of the yoke. When a yoke is to be machined this casting is driven into the table, and the yoke securely bolted to it. The steel cap *A*, which fits around the boss on the yoke, is then placed on it as shown, and a hole drilled central for threading. A bar is then put in the spindle and passed through the hole, and a high-speed steel cutter is inserted into the slot, and the stuffing-box bored. Next, the special tapping socket is put in the spindle, and the hole tapped, the tap being taken out through the hole in the table. The base-plate and table are securely fastened in one place during the operation, and it is not necessary to move the drill spindle sideways after once starting the job. The castings were afterwards placed on a mandrel and the bottom faced off in a lathe. This is but one of many instances where I have found that by paying attention to special devices, I have been able to do good every-day lathe work on the drill press at less than one-fourth the cost.

Port Huron, Mich. M. H. Westbrook.

HOB FOR FORGING DIES.

In the accompanying cut, a forging of which a great number is to be made, is shown at *A*. As dies for making this forging, it being produced in such great quantities, have to be renewed quite frequently, the making of forging dies in the usual manner becomes quite expensive. In the shop



Forging, and Hob for making the Die.

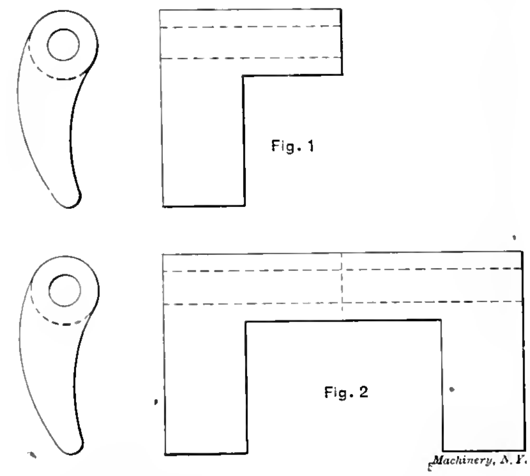
where these pieces are manufactured, however, the expense of making new dies is greatly reduced by making a hob, such as shown at *B* in the cut. This hob is made of tool steel and hardened, and has a projection of exactly the same shape as the piece to be forged.

The block for the forging die, in which the shape of the piece to be made is to be formed, is placed, together with the hob, in correct relationship in a hydraulic press, and the hob forced into the die block the required depth by hydraulic pressure. By forcing the hob into the die block, the metal displaced is thrown up around the side of the hob. This surplus metal is removed, and the die is hardened. By making dies in this manner, it is possible to renew the dies at a fraction of the cost of dies made in the ordinary way. For irregular shaped forgings it is sometimes necessary to make two hobs, one for the top and one for the bottom die. Fred R. Carstensen.

Montreal, Canada.

AN EXAMPLE OF MISPLACED ECONOMY.

The accompanying cut shows an example of how the mad rush to try to accomplish a saving in the cost of a product, when accompanied with too little forethought, often plays a trick on its originator and causes an additional, rather than a reduced expense. Things of this kind, perhaps, do not happen very often, but the case in hand has actually taken place



The Piece to be made, and the way the "Saving" was accomplished.

in one of the largest machine shops in the country. A little detail, such as shown in Fig. 1, was required to trip a lever on an automatic machine. The foreman of the department detailed to make these pieces, who, by the way, receives a liberal allowance on the contract price for the work carried out, provided he can cut down the expense of producing the work to a low limit, conceived a brilliant idea of making these pieces "two in one." The pieces were first to be drop forged, being finished only on the portions that worked against other surfaces, and he placed an order for drop forging dies to make pieces such as shown in Fig. 2. When cut apart in the middle, on the dotted line, there would evidently be two pieces made practically at the cost of one, if the price of material is not considered. Enormous quantities of these little details were drop forged, machined, drilled, cut apart, and case-hardened, when it was finally detected that one-half of the number of pieces became left-handed, and therefore, by necessity, had to make a bee-line for the scrap box. T. O. Olmaker.

TOOLS MADE FROM FILES SHOULD BE ANNEALED.

Among the "Practical Don'ts for Machinists" published in the January, 1906, issue, we found one that said: "Don't forget that a fairly good center-punch can be made from a piece of round file." This statement should be qualified by the caution that the end which is to be struck with the hammer should be annealed. The danger of striking hardened steel with a hammer is well known. Three machinists with whom we are acquainted here in Waterbury each lost an eye by striking hardened steel with a steel hammer.

Waterbury, Conn. Henderson Bros.

[The above caution applies to almost all tools made from old files. The temper should always be drawn before they are used, if subject to hammering, like a center-punch, chisel or other percussive tools, and preferably for any purpose, on account of the brittleness of the tool if left "file hard."—Editor.]

FINISHING PISTONS AND PISTON RINGS ON THE GISHOLT TURRET LATHE.

The making of pistons and piston rings for gas engines, particularly for automobiles, is done on so large a scale that the expenditure of considerable thought and time is warranted in designing the tools, fixtures and machines by which the work is done. Figs. 1 and 2 show the operations developed by the Gisholt Machine Co. of Madison, Wis., for doing this work in its turret lathe. As will be seen from the engravings and the following description, the tools used are simple and inexpensive, and the operations comparatively few.

As is often advisable with work done in large quantities, the rough castings are made with extra projections so arranged as to assist in holding the work, these extraneous parts being removed when the piece is completed. In the case shown (Fig. 1), a ring, about 1¼ inch long and of a diameter a trifle less than that of the piston itself, is formed at the head end of the piston. The piston *A* is held in suitable chuck jaws *B* by the inner diameter of this ring. The set-screws in these special jaws are then set down on the work, clamping it tightly between the points of the screws and the jaws, in such a way as to make it safe to take heavy cuts on the outer end of the long piston without loosening it. It will be seen that this method of holding, besides being secure, also permits the whole exterior of the piston to be turned, since all of it projects beyond the chuck jaws. This is the object aimed at in providing the piston with the ring by which it is held.

The first operation, which is shown in action in Fig. 1, consists in rough-boring the front end of the piston. The double-ended cutter *N* is held in boring-bar *M*, which is in turn supported by a drill holder, clamped to one of the faces of the turret. This bar is supported in a bushing in the drill support shown, which is attached to the carriage, and may be swung into or out of operating position as required. After this cut is completed, the turret is revolved half way around and the piece is finish-bored in a similar manner, with double-ended cutter N_1 held in bar M_1, the drill support being used as in the previous case. The support is then turned back out of the way to allow the turning tools in the turret tool-post to come into action.

The outside diameter of the piston is next rough-turned with tool *K* in the turret tool-post, which is revolved to bring this cutter into action. The post is then turned to the position shown, in which the outside diameter of the work is finish-turned by tool *J*, which takes a broad shaving cut. The turret tool-holder is again revolved to bring form tool *L* into position for action. This cuts the grooves in which the piston rings are to be located. Suitable positive stops are, of course, provided for both the longitudinal and cross movements of the turret tool-post.

In the second operation, the work *A* is reversed and held in soft jaws, which are used in place of the hardened jaws *B* shown in the illustration. These jaws are bored to the outside diameter of piston *A*, so that when closed, they hold the work truly with the first chucking. In this operation, the chucking ring by which the piston is previously held is cut off, and the end of the piston is faced. If the crank-pin hole is to be finished, still a third operation is necessary, a self centering chuck-plate and the necessary boring tools being used for this. These are not here shown, however.

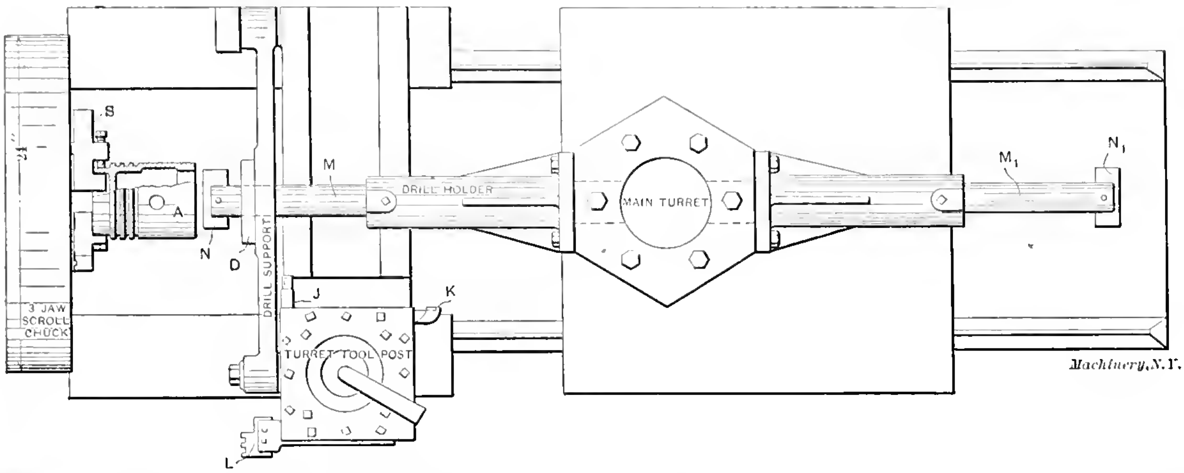


Fig. 1. Method of Boring and Turning Pistons in Gisholt Lathe; note the Ring cast to the Work, by which it is held, and the Special Chuck Jaws used.

The method of making piston rings is shown in Fig. 2. In this case, as in the previous one, the casting is one having a special form to facilitate holding it in the turret lathe. The piston rings are cut from a cast iron cylindrical piece which has three lugs (seen at *B* in Fig. 2) cast on one end and so arranged that they may be held by these in a three-jawed scroll chuck. This cylindrical piece is about 10 inches long, and when the rings are to have their inside and outside surfaces concentric, the casting is held by them in the regular jaws furnished with the chuck. The arrangement used for eccentric turning and boring, which is that shown in the illustration, will be described later.

The casting *A*, from which the rings are made, is first rough-bored with double-ended cutter *N* in boring-bar *M*, after which it is finish-bored with cutter N_1 in bar M_1. While taking these cuts, the bars *M* and M_1 are supported by their for-

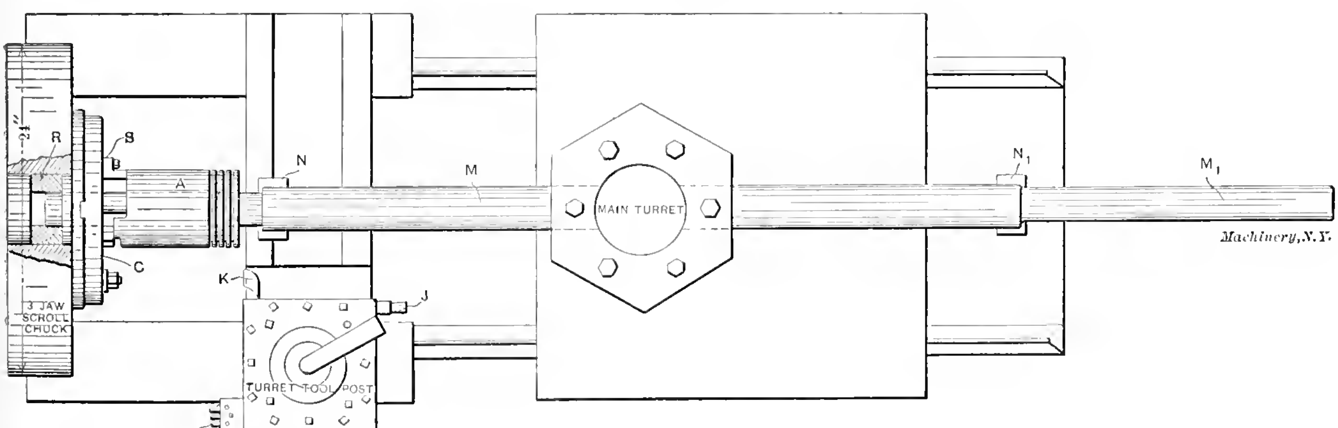


Fig. 2. Special Chuck and Tools for Turning, Boring and Cutting Off Eccentric Piston Rings in the Gisholt Lathe.

ward extension in bushing R, located in the central hole of the chuck. This furnishes a rigid support for the cutter, so that a heavy chip can be taken.

The periphery of the piece is next rough-turned with tool K, held in the turret tool-post. This tool-post is then revolved to bring tool J into action, by which the outside of the work is turned true to size, a broad shaving chip being taken. The turret tool-post is again swung around, to bring the cutting-off tool-holder L into use. This, as shown, contains four blades set the proper distance apart to give rings of the desired width. Each blade is also set a little ahead of the preceding one, so that the rings are cut off one after the other, each ring supporting the cut being taken on the outer side of it, until that cut is completed. After the first four rings are cut off, the carriage is moved ahead again to a second stop, and four more rings are severed, the operation being continued until the casting A has been entirely worked up into rings.

When the bore of the ring is to be eccentric with the periphery, the holding arrangement shown in the cut is used. The casting A is bolted to a sliding chuck-plate C, and the periphery is rough turned with tool K in the tool-post. Finishing tool J is then brought into action, and the outside diameter is turned accurately to size. Then the sliding chuck-plate C, carrying the work, is moved over a distance equal to the eccentricity desired, and the work is rough bored with cutters N and N_1 as in the previous case. The turret tool-post is next revolved and the cutters L brought into play, when the rings are cut off, as before. The reason for finishing the periphery first in this case is apparent. To secure good clean work in cutting off, this operation should evidently be done when the work is running concentric with the bore, rather than with the exterior surface.

It will be evident that this method gives a far greater out put of rings than is possible by finishing them in the more primitive way on engine lathes. The faces of the rings may be finished in a second operation if desired, or they may be ground, depending on the method in vogue in the shop where the work is being done.

* * *

SHOP ELEVATORS, AND OTHER THINGS.

CON WISE.

A few months ago I went into two shops in the same city. At the first one I found a sign at the door "Blank Mfg. Co. upstairs." At the top of the first flight I found another just like it and so on till at the top of the fourth I read the welcome one, "Blank Mfg. Co., one flight up." Needless to say the discounts that I had planned to offer grew less at each sign, and if I had been buying instead of selling, I would have given up the climb altogether. When I arrived, I tried to get a chance to look around the factory. I was not refused, but it was painfully evident that it was an unusual thing for them to see a visitor in the works. The workmen acted as if we were a lot of wild animals on exhibition, and it was almost impossible to pick our way around among the piles of work and rubbish.

At the second shop I asked at the office downstairs for permission to look around, and was promptly given a pass card, shown the shop door and told that I would probably meet one of the proprietors somewhere. I found it a rambling place full of odd corners and turns, but I wandered around rather aimlessly for an hour without a question or look of inquiry from anyone. After a time I saw two men in overalls get off an elevator. The sight was so odd that I sauntered over and asked the boy who engineered the thing—where he went to when he went down. "The engine room," he said. "Nice plant there; don't you want to see it?" Needless to say I did. Another man in overalls got on too. I looked at my pass to see if there was anything about talking to the help, and then asked him how it happened that they were allowed to ride on the elevator, and how they liked it. "It's all very nice," he said, "but it is all the same to us whether we ride or not. If we ride and save any time we have to get out enough more work to make up. They don't let you blow your nose but just so many times a day here, and they calculate to get us just so tired at night. It pays them all right, but we don't ask about elevators when we are out looking for jobs."

I could not help comparing the two places, and then inquiring about both. It turned out that in the first shop they never expect to see a customer from one year's end to another. They go out to buy their stock themselves and they can carry a full line of samples in an overcoat pocket. They are not bothered by agents or solicitors to see their help. They pay their workmen by the piece and never have any trouble getting all the help they want. They are making money, and the proprietor thinks that if he can stand the stairs, no one else has a right to complain.

In the other shop they seldom sell to a new customer who does not come and look them over. Consequently they are always on exhibition. They are accustomed to visitors and they know that it will not do to walk a silk-hatted, short-winded customer up and down stairs long enough to see the plant; hence the elevator. The elevator being there, why not make it pay dividends? Man power costs more than steam power every time, so why not let the men ride and then get enough more work out of them to make it pay? It is fine advertising to show the silk-hatted fraternity what philanthropic citizens they are and how thoughtful of the welfare of their humble brethren. And it takes all right because the "silk-hat" never thinks of approaching a workman from a point of view that gives him a chance to feel that he can talk freely.

These chaps in the shops care precious little about but two things. One is, how much money they can carry home pay night as compared with the time they spend away from their wives and children to get it, and the other is whether their work is congenial.

This latter does not have as much to do with flower gardens and ambulance corps or any such things, nor does it have much to do with labor-saving devices which are only used to save the employer on his production cost. It does have a great deal to do with means of lightening the actual brute strength required from an operative in a day, and a great deal more with the decency with which the foremen treat the help. A great many foremen do not know that it is possible and profitable for them to be gentlemen and yet get the work out, and a great many employers do not realize that it pays to get gentlemanly foremen, nor that such foremen attract the best help.

The average employe understands perfectly that he has no legal right to share in the profits brought about by another man's brain work, but he cannot see why all men are not as brotherly toward him as he is toward his neighbor on the next lathe. Did you ever see a rich man that would do as much for famine sufferers or neighbors in distress as a $15-a-week machinist will, in proportion to his means?

A man in the shop cannot see and cannot be made to see, and I am glad of it, why a man, as soon as he gets more money than he needs for his own daily use should not look around for some one in need to help a little; not to insult him with money, or to patronize him, but to help him carry his burden easily.

Now all this does not mean that I nor the men in the shops do not believe in the uplifting influences of all the flower gardens or pleasant homes, nor that we are looking for the dollar to the exclusion of everything else. Not at all! What we would like would be to feel that all these uplifts were ours, that if we wanted to lie down on the grass we could do so, and that we could have a feeling of proprietorship in the cosy cottages that are held out to us as inducements to move. But in almost every case we find that these things have strings on them, and even when we feel that we are paying for all the extras, we find that they are liable to be yanked back if anyone in authority gets a bit on his ear at us. In a word, independence was worth fighting for years ago, and it is worth something now.

* * *

The spring convention of the National Machine Tool Builders' Association will be held at Atlantic City, N. J., Tuesday and Wednesday, May 19 and 20, with headquarters at the Hotel Chalfonte.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

SELECTING CUTTER FOR FLUTING CONCAVE MILL.

M. E. M.—The accompanying cut (Fig. 1) shows a milling cutter having a concave surface, and it is required to find an angular milling cutter for milling the teeth in this concave mill so that the width of the land y will be the same both at the center and at the outside edges of the mill. The problem may be stated thus: If the number of teeth, the width and diameter of the mill, and the radius of its concavity are given, to find a cutter which will mill the teeth so that the width of land y remains constant for the full width of the mill.

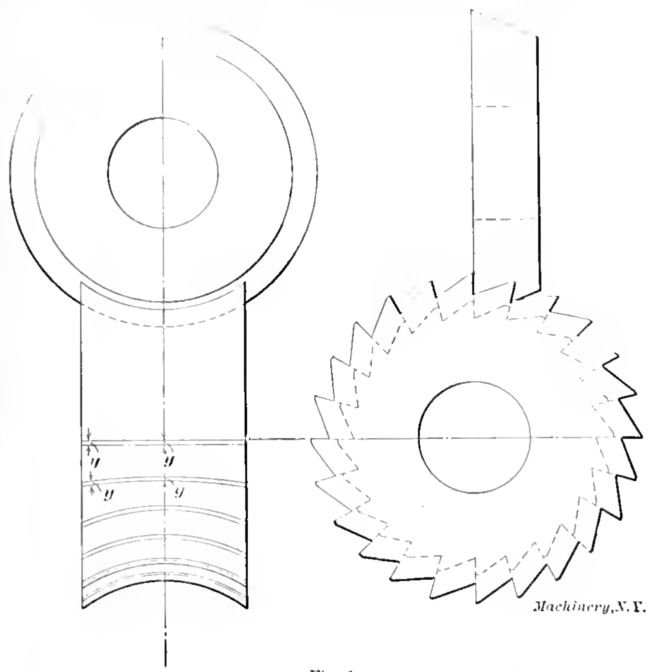


Fig. 1.

A.—Theoretically, this problem is one the conditions of which do not permit of a solution. Suppose, for instance, that the width of the land of the teeth be infinitesimal; this will make it easier to state the case in a clear manner. In Fig. 2, the cutter surface of the cutter for milling the teeth, being that of a cone, is represented by ABC, the cutter being imagined as extending out to a sharp point at the apex C of the cone. The mill to be provided with teeth is represented by the half-circles KL and MN, the latter being the line at the bottom of the circular groove at the center. Assume that DE is the pitch of the mill at its largest circumference. Then, a plane OH passed through the point E from the center of the mill produces a circular arc EFE where it intersects with the surface of the blank of the mill. The section produced by this plane in cone ABC, however, is an ellipse. As a circular arc and an ellipse never can fully coincide, it is evident that the problem contains conditions which make it impossible. If, however, the pitch DE is very small in proportion to the radius OE of the mill, so that the section FG of the cone nearly resembles a circle, then a cutter may be determined that will cut the teeth to agree *approximately* with the conditions given. What is then necessary is that the diameter of the cone, or angular cutter, at point F shall be as nearly equal to the diameter of the circle forming the outline of the mill blank as possible.

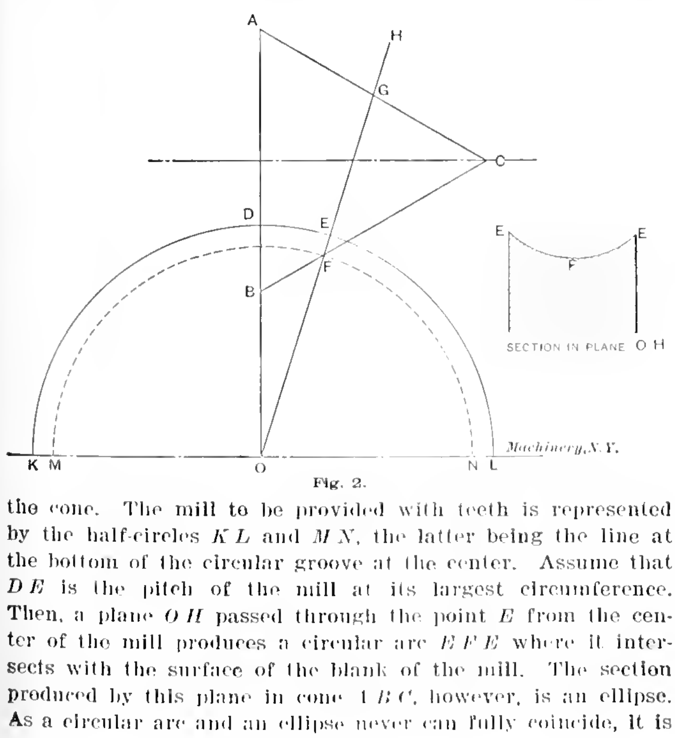


Fig. 2.

In practice the problem is usually solved by the cut and try method, approximate results only being obtained. Approximate formulas no doubt could also be worked out, and if some of the readers of MACHINERY who meet with this class of work have adopted any special rules which they follow, we would be pleased to place them on record.

TO OBTAIN FACE ANGLE OF BEVEL GEARS.

E. H.—Please tell me how to obtain the face angle, measured as shown in Fig. 1, for two bevel gears, 25 and 50 teeth, 10 diametral pitch. The shafts are at right angles.

A.—To find the face angle for a pair of bevel gears, proceed as follows, using the reference letters below in addition to those shown in Fig. 2.

N = number of teeth in gear;

n = number of teeth in pinion;

ϵ = face angle, as usually measured.

First we get the pitch cone angle of the gear

$$\tan\beta = \frac{N}{n} = \frac{50}{25} = 2.000 = \tan 63° 26', \qquad (1)$$

then we obtain the addendum angle

$$\tan\delta = \frac{2 \times \sin\beta}{N} = \frac{2 \times 0.89441}{50} = 0.03578 = \tan 2° 3' \qquad (2)$$

Adding together (1) and (2), we get

$$\epsilon = \beta + \delta = 63° 26' + 2° 3' = 65° 29'$$

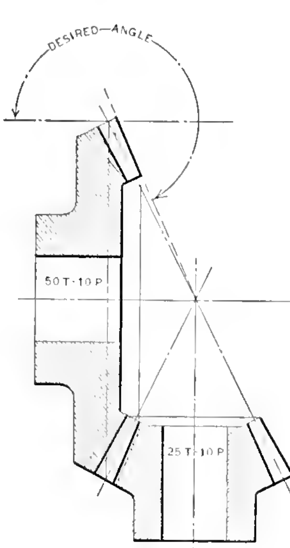


Fig. 1.

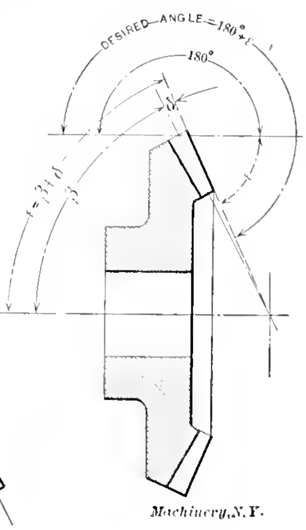


Fig. 2.

The face angle is usually measured as shown in Fig. 2; the angle you call for is 180 degrees more than this.

$$\text{The desired angle} = 180° + 65° 29' = 245° 29'$$

The pitch cone angle of the pinion is found thus:

$$\beta_p = 90° - \beta = 90° - 63° 26' = 26° 34'$$

The angle as usually measured will then be

$$\epsilon_p = \beta_p + \delta = 26° 34' + 2° 3' = 28° 37'$$

So that for the pinion we have

$$\text{The desired angle} = 180° + 28° 37' = 208° 37'$$

Rules and formulas for obtaining the various measurements of miter and bevel gears of various kinds will be found in the data sheet published with the May, 1907, issue of MACHINERY.

* * *

A speed of 44 statute miles, or 38.3 knots per hour, was attained over a mile course last December by the British torpedo boat, *Tartar*. This is the highest speed that has ever been attained by a craft of this class.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

WOODS ENGINEERING CO.'S UNIVERSAL TOOL AND CUTTER GRINDER.

In Figs 1 to 6 we show, performing various operations, a tool and cutter grinder built by the Woods Engineering Co., Alliance, Ohio. The machine is the result of long experience with tools of this class, and it comprises a number of useful features not found in other designs.

As may be seen, the grinding head is mounted on a stationary column rising from a broad, stiff base which is bolted to the floor. The upper part of this column is turned to a smaller diameter, and has fitting over it a sleeve which can be set at any angle throughout the full circle. This sleeve supports the knee on which the work table is carried. Clamping the sleeve to set the work table at the proper angle with relation to the wheel, does not interfere at all with the vertical adjustment of the knee on the sleeve, the movements being independent. The two bolts on the lower flange of the sleeve are used for clamping it at the desired angular adjustment. The emery wheel spindle has two speeds, is made of

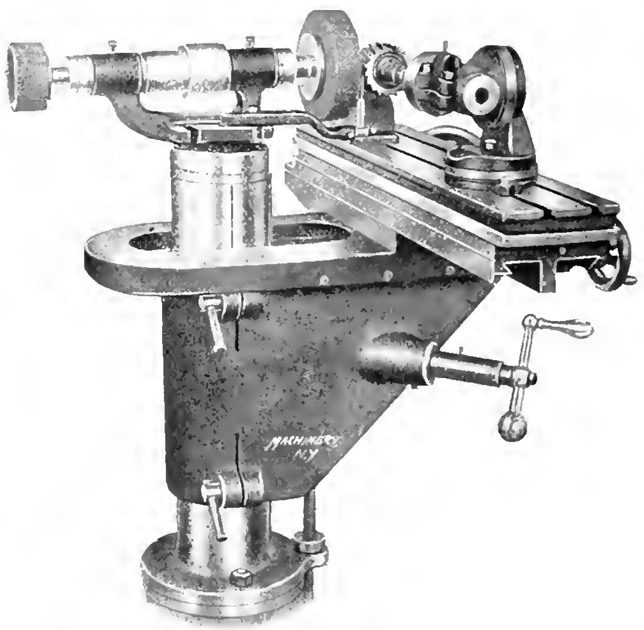


Fig. 1. The Woods Cutter and Reamer Grinder, sharpening a Spiral Mill.

tool steel, ground to size, and runs in phosphor bronze bearings which are adjustable for wear, and are as nearly dust proof as it is possible to make them.

A saddle is adjustable in and out on the knee, and the work table has a horizontal movement on the saddle, the arrangement being about the same as in the orthodox type of milling machine. These three adjustments, the vertical, cross and longitudinal, are obtained by hand-wheels and a crank which are so set as to be within convenient reach of the operator, and yet not interfere with each other in any position. The connections for the cross and vertical feeds are obvious. For the longitudinal feed of the table, the hand-wheel shaft is provided with a spiral pinion, meshing with a rack fast to the under side of the table. The bearing surfaces on which these various sliding movements take place are all carefully protected from emery. The protection for the bearing of the saddle on the knee is best seen in Figs. 1, 2, and 4. It consists of the guard which practically forms a part of the saddle and encircles the column at the rear, covering the surfaces at all times, no matter what the setting of the parts. The sides of the table are brought down below the bearings by which it is gibbed to the slide, so that these are also protected. The guards may be seen in the end views Figs. 1, 2, and 4. The slides all have 45-degree bearing surfaces. Both elevating and cross-feed screws are provided with micrometer dials reading to 0.001 inch.

The other structural features of the machine can perhaps best be understood by referring to the operations shown in progress in Figs. 1 to 6. In Fig. 1 a spiral mill is being ground. This is mounted on an arbor between the head and foot-stock centers as shown. The tooth being ground by the

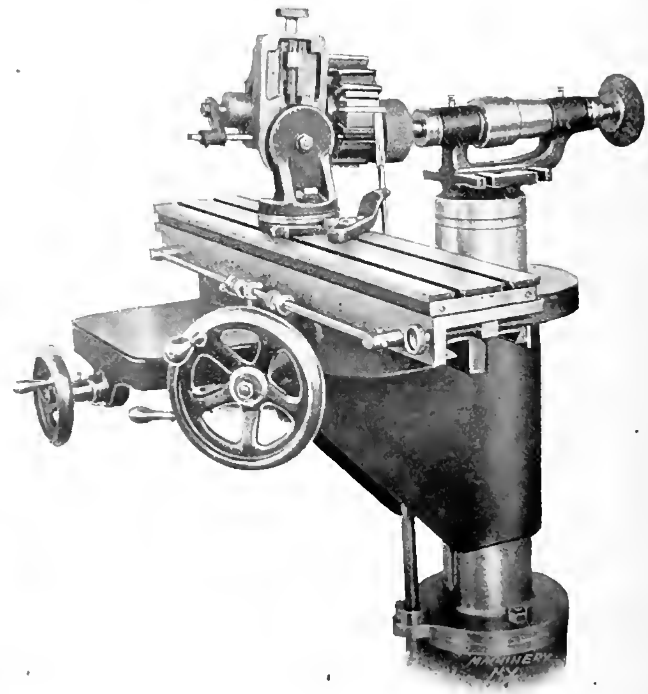


Fig. 2. Sharpening a Face Mill, whose Shank is held in a Universal Taper Holder.

cup wheel rests on a tooth support immediately beneath the grinding point. As the cutter is moved back and forth by the hand-wheel, the face of the spiral cutter is kept pressed on the tooth rest so that it is properly presented to the wheel. The tooth rest, it will be noted in this case, is clamped to a shelf at the side of the grinding head. It will be seen that

Fig. 3. The Machine arranged for Plain Cylindrical Grinding on Dead Centers.

the head-stock has a universal swiveling adjustment. This comes into play in grinding angular mills of all kinds, these being generally held on taper shanks or arbors pressed into the taper hole of the head-stock spindle. This spindle runs in dust-proof bronze bearings, and is adjustable for wear.

In Fig. 2 a universal taper holder is shown in place, clamped to the head-stock swivel, from which the spindle head has been removed. This attachment is adapted to holding taper and cylindrical shanks of larger size than can be held in the taper of the regular spindle. The face mill shown is having its teeth ground on the face, the tooth rest being in this case fastened to the table. Stops are provided for limiting the traverse of the table. These are plainly shown in this view. They consist of collars which are clamped to the rod shown extending along the front of the table. They engage a stop piece fast to the knee, which may be thrown up between them, or dropped out of the way if it is desired to run the carriage beyond the stop. Another view of this arrangement may be had in the next figure.

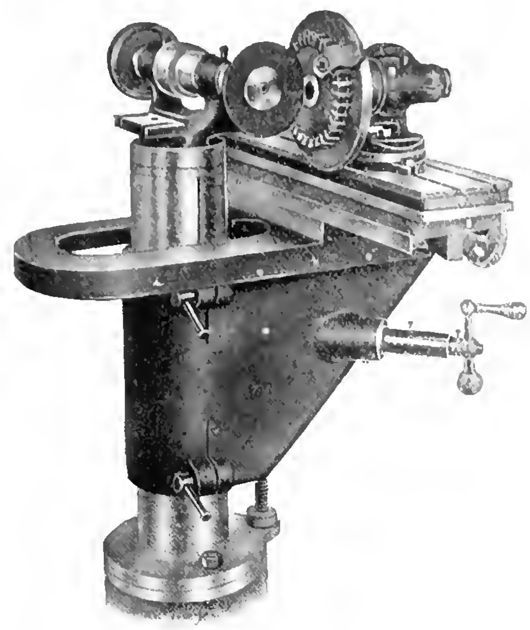


Fig. 4. Grinding the Hub of a Cutter on the Face-plate.

Fig. 3 shows the machine as arranged for plain cylindrical grinding. A center, carrying a loose pulley whose flange forms the driving face-plate, has been inserted in the taper hole of the head-stock. The spindle of the head-stock, to which the rear pulley is keyed, is locked by a plunger as shown, having a point entering holes in the rear flange of the driving pulley. When the spindle is thus locked, the work revolves on dead centers, as is usual in cylindrical grinding. The locking plunger and the holes in the pulley flange also serve as an indexing device for use when grinding broaches, punches, etc., in square, hexagonal and other shapes.

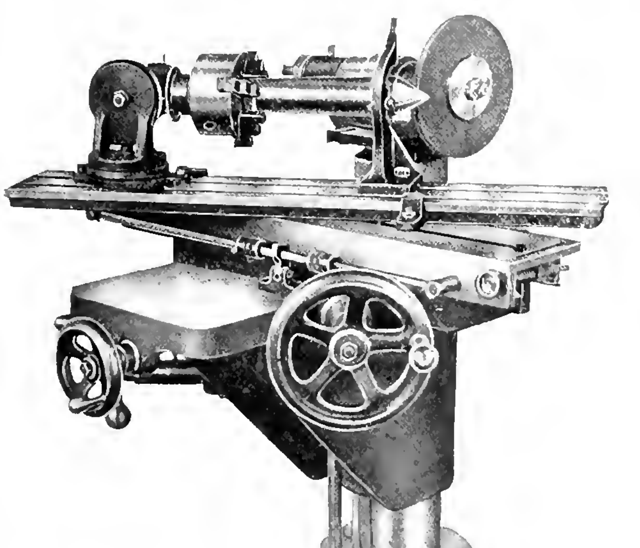


Fig. 5. Truing a Large Center, with the Table swiveled for the Angle.

The tail-stock spindle has a spring center, to take care of the expansion of the work due to heating; the center may be locked, however, for work which requires it. It will be noted in comparing Figs. 2 and 3 that the knee and table have been swung around 90 degrees between the two operations.

In Fig. 4 is shown a face grinding operation. A hardened cutter is mounted on a face-plate attached to the head-stock spindle, which is revolved by a belt from the counter-shaft. The work is traversed across the wheel by the regular table feed, and is fed in to depth by the cross slide hand-wheel in an obvious manner.

The top of the work table is pivoted, as shown in Fig. 5, to permit the grinding of tapers on centers, or in the follow rest as in this case. For comparatively small tapers this adjustment may be obtained very accurately by means of the screw and nut arrangement shown at the end of the table. This is disconnected in Fig. 5, the upper half of the platen being swung at a much greater angle than that connection allows. To clamp the platen to the table under these circumstances, two dogs are provided, as shown, one on each side. The large lathe center being ground is held at one end in a chuck which is part of the equipment provided, while the other end is held by the regular center rest furnished with the machine.

Fig. 6 shows the internal grinding attachment. This is mounted in a frame which is bolted to a shelf at the side of the grinding head. The hardened cutter on the face-plate is having its central hole ground to size. The internal grinding spindle is speeded up from the main spindle as shown, the ratio between the two pulleys being sufficient to give a suitable velocity for internal grinding. The spindle has a bearing next to the emery wheel, thus doing away with vibration due to long over-hang.

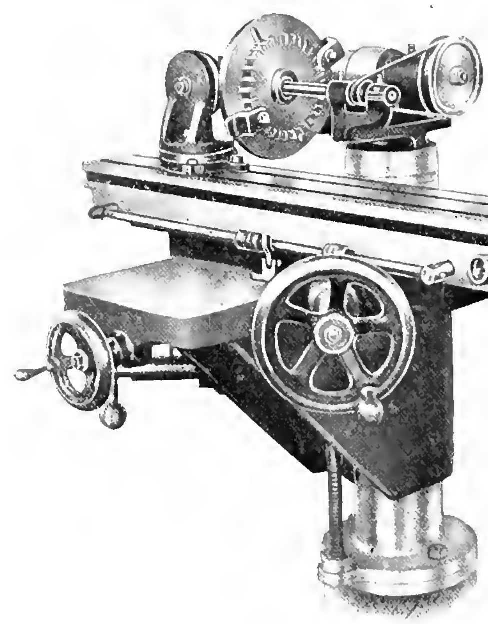


Fig. 6. The Internal Grinding Attachment in Use.

Other uses for this machine can readily be imagined from inspecting the examples we have shown here. For instance, the tool is well adapted to surface grinding. For this purpose, a universal swivel chuck is provided, which can be adjusted to any angle in three different planes, so that angular work of any conceivable shape can be ground true. When so working, the table is swung around so that its travel is at right angles with the axis of the grinding spindle. The changes from one operation to another can be made easily and rapidly, owing to the convenience of the various adjustments. The emery wheel spindle has two speeds, is made of tool steel ground to size, and runs in phosphor bronze bearings, adjustable for wear, and as nearly dust-proof as it is possible to make them.

The longitudinal travel of the machine is 22 inches, the cross feed 7½ inches, and the vertical adjustment 9 inches. It will take 22 inches between centers, and swings 9 inches

over the table. Various wrenches, dogs, tooth rests, and attachments are provided, as well as wheels suitable for the work of the machine. The weight without the counter-shaft is about 700 pounds.

LIBBY TURRET LATHE.

The turret lathe illustrated in the three accompanying half-tones is built by the International Machine Tool Co., of Indianapolis, Indiana. It is the design of Mr. Chas. L. Libby, who has had extended experience in work of this kind in both this country and Europe. It is intended for the general run of chucking and turning work for cast iron and steel parts up to 20 inches in diameter.

Spindle Driving Mechanism.

An inspection of Fig. 1 will show that the machine is built in the heavy, rigid style necessary for the effective use of modern high speed steels. The head-stock and bed are cast in one piece, and the bed is unusually deep and rigid. The spindle is of large diameter, with journals suitably proportioned, and with a $3\frac{5}{8}$-inch hole through its center. It is driven from the two-step cone pulley shown at the outer end of the head-stock, through a mechanical speed changing mechanism enclosed within the head-stock and operated by the two levers at the front of the main bearing. These levers give four changes of feed, which are multiplied by the two obtained from the driving pulley, and these in turn by the three obtained from the three-speed counter-shaft, giving 24 changes in all. The speeds vary in geometrical progression from 5 to 180 revolutions per minute.

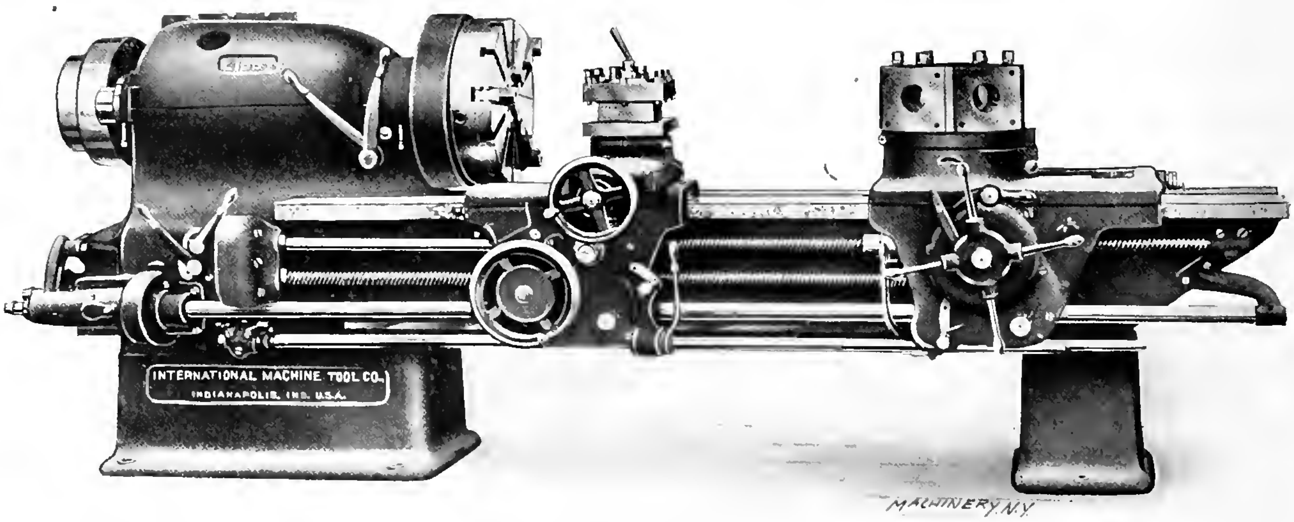


Fig 1. Libby Turret Lathe, made by the International Machine Tool Co., Indianapolis, Ind.

One of the features to which attention is called is the provision made for changing the machine from belt to motor drive independent of the builder. This can readily be done without having to rearrange the head-stock for each type of motor, thus avoiding delay and extra expense. Any motor having a speed range of at least 2 to 1 can be used. It may be mounted on the finished pads provided on the head of the machine, and connected with the driving shaft by gearing, or it may be mounted on the floor and belted to the machinery. It will be seen that the change can be made at a very low cost.

Tool-post and Turret Slides.

The tool-post carriage is of unusual construction. It does not extend across the bed, but is supported by the front way and by a V-guide at the bottom of its apron, bearing on a corresponding way on the lower edge of the bed. A long taper gib fitted to the carriage on the inside of the bed takes up the wear. As shown in Fig. 2, the tool-post carriage may be moved past the chuck toward the head-stock. This permits the use of the turret close up to the chuck, avoiding the overhanging tools usually required to reach over the tool-post cross slide. It is evident, also, that nearly the full capacity of the lathe can be swung over the carriage.

The six-sided turret is supported on a spring pivot bearing which is adjustable to its load, and takes the weight of the turret and tools off the annular bearings, thereby reducing the friction and the wear, and permitting it to be indexed easily. The clamping device acts at the outer edge of the turret, bringing it down firmly to the annular bearings after the indexing has taken place. The same lever that tightens and releases the turret clamp operates the turret locking pin. Throwing the lever in one direction releases the clamp and withdraws the locking pin. The turret may then be swung to the desired position. By throwing the same lever a little further over, the locking pin is released and the turret located. By again bringing the lever back to its original position, the turret is once more rigidly clamped.

Feed Mechanism.

The feed motion is operated from the spindle through change gearing and a quick change apparatus. Eight changes may be obtained by operating the two levers shown beneath the head-stock, and eight changes more are regularly provided for with the detachable gears furnished with the machine. Either English or metric threads can be cut without changing the screws. The feeds and screw threads obtainable vary from 1 to 200 revolutions of spindle per inch of slide movement.

The feed connections for the tool-post carriage and turret slide are entirely separate, so that the feed of either apron can be reversed without interfering with the other. Both carriages may be shifted independently by quick traversing devices. This movement can be operated at any time by the action of a single lever, the setting of the feed not interfering with this. The rate of movement of the quick traverse is about 25 feet per minute. The screw cutting and power feeds are applied to both carriages. In the tool-post carriage

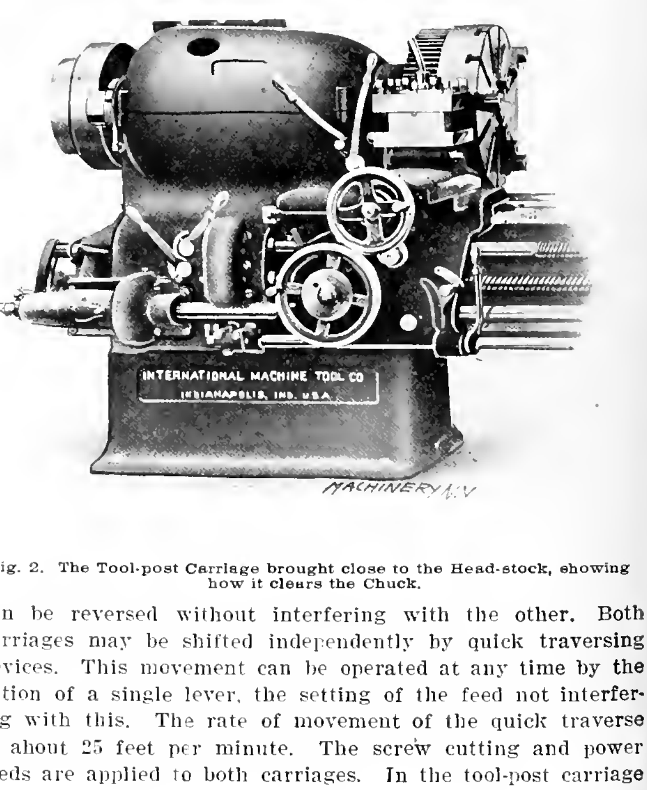


Fig. 2. The Tool-post Carriage brought close to the Head-stock, showing how it clears the Chuck.

the cross and traverse feed screws have the same lead. All the handles for operating the various changes, both of the speeds and feeds, are within easy reach of the operator, as he stands in working position. All the moving parts, as may be seen, are encased to prevent injury to the mechanism or the operator.

Automatic stops are provided for feeds in all directions. In connection with these stops, there is an indicator or moving pointer which registers the exact position of the turret cutting tools. This can readily be seen by the operator, and makes possible the attainment of duplication of work to a degree of exactness that would otherwise be difficult. The gearing of the turret apron is so arranged that one revolution of the pilot wheel gives only $\frac{1}{2}$ inch of movement to the

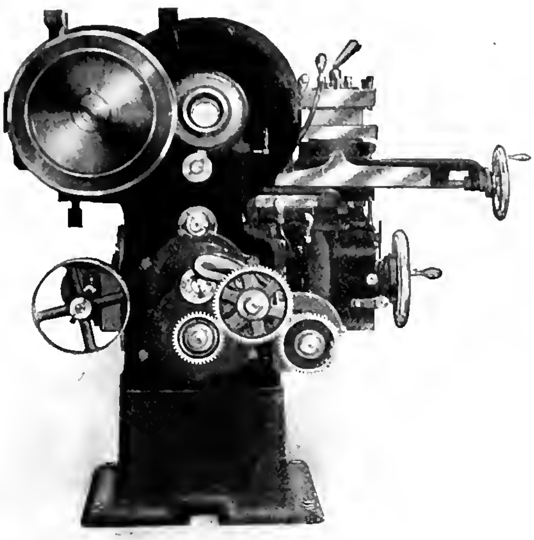


Fig. 3. End View of the Libby Turret Lathe.

slide. With this ratio, the operator has sufficient leverage to bring the tool up to a heavy facing cut without exerting himself unduly.

Method of Operation.

The makers are prepared to design and construct special tools for doing work to the best advantage. The ordinary method of procedure may be described as follows: The rough casting is grasped in the hard steel jaws of the chuck, where it is bored and reamed. Then a bushing, which fits the supporting arbors used with the facing heads on the turret, is inserted into the hole just made. The facing heads, which are made to carry a variety of tools, are next run up to the work, which is shaped to the dimensions required. In most cases two facing heads are used, one for roughing and one for finishing. Owing to the fact that the reaction of the cutting strain is taken directly in the work itself, there is very little deflection of the tools under the pressure of the cut, and heavy chips can be taken.

If a second chucking is required to finish the part complete, the hard jaws are removed and a pair of soft jaws substituted. These are set down to a little less than the size of the piece to be held, and are bored out to the exact size of the work, so that when this is again clamped in the chuck the jaws are in the same position as when being bored, and the work runs truly if the first operation is carefully done. This procedure applies to the general run of cast iron work.

The arrangement for supporting the drill or boring-bar is different in this type of machine from that ordinarily used. The support is located at the back of the machine, and is entirely independent of the carriage, so that while it is being used to guide the drill or boring-bar, the carriage can be used for turning. This often makes considerable difference in the output of a machine of this kind.

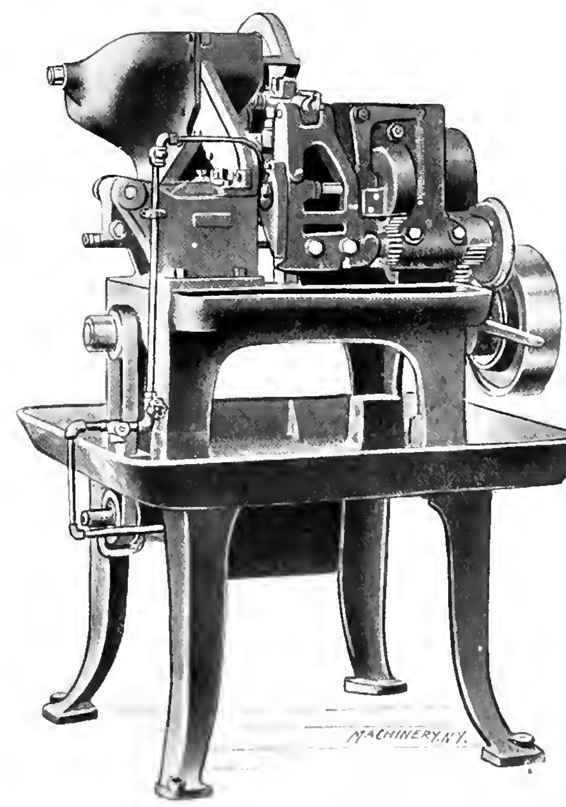
The machine is evidently suited for finishing on the interchangeable plan such parts as gear blanks, small fly-wheels, automobile cylinders and parts, couplings, rope drums and other similar work within its capacity. It will swing 22 inches over the ways, and 20 inches over the carriage. The traverse of the turret slide is 60 inches, and the hole through the spindle is $3\frac{5}{8}$ inches in diameter. The turret holes are $3\frac{1}{2}$ inches in diameter. The 2-step cone pulley has faces of the proper width for a $3\frac{3}{4}$-inch belt. The machine will be furnished with oil pan and pump, when desired, for steel work. It is 12 feet 8 inches long over all, and has a shipping weight of about 9,000 pounds.

WATERBURY-FARRELL AUTOMATIC SCREW SLOTTING MACHINE.

The tool shown in the accompanying engraving, built by the Waterbury-Farrell Foundry and Machine Co., Waterbury, Conn., is an improved automatic slotting machine for work on screw blanks for filister-head screws, stove bolts and other similar products. The experiment and study spent in the designing of this machine were directed toward obtaining accurate work at rapid rate of production, special attention being paid to rigidity, with the corresponding increase of output possible for a slotter.

A hopper feed is used, which automatically presents the blanks, as they are required, to a toggle carrier slide, which brings them into position in front of the saw. Here each blank is gripped securely between a die and a carrier slide, for the slotting operation. The saw spindle is mounted on a swinging bracket, which is well braced and guided to prevent chattering. The saw is swung on this in cutting the slot. To cut off the burr which forms on the head when the saw is dull, a chip shaver is furnished. This is a small cutting tool which passes over the head of the blank as the saw returns, and smooths off the burrs.

The machine is driven by a friction clutch pulley, through change gears which give a wide variation in the number of blanks that can be slotted per minute, thus making it suitable for varying sizes and kinds of screws.



Automatic Hopper-fed Machine for Slotting Screw Blanks.

An oil pump is provided to give a uniform flow of oil over the work, and suitable guards are furnished to keep the saw and dies clear of dirt, chips and other foreign matter. A pan under the machine collects the lubricant, strains it from the chips, and returns it to the tank and the pump. When desired, the machines can be mounted in groups, instead of on single bases as shown. When this is done, a long table is used, which also forms a drip pan, all the machines in the group being driven from a single pulley.

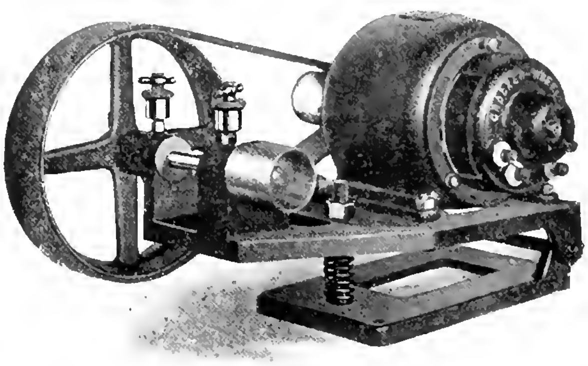
The machine shown will take screws from 3/16 to $\frac{3}{8}$ inch in diameter up to $2\frac{1}{2}$ inches long. It will operate on

thirty-five 3/16-inch blanks per minute, the saw used being $2\frac{3}{4}$ inches in diameter. This capacity may be exceeded on shallow slots and brass screws. For a single machine, the floor space occupied is about 44 x 41 inches, and the weight of the machine is 1,240 pounds. The floor space occupied by a group of six machines is 44 inches by 19 feet 10 inches, and the weight of the six machines is 7,540 pounds.

COUNTER-SHAFT BELT TIGHTENER FOR USE WITH CROCKER-WHEELER MOTORS.

We show herewith an arrangement of motor and self-contained counter-shaft which is being installed by the Crocker-Wheeler Co., of Ampere, N. J., for driving light machinery. Though designed primarily for driving the linotype, it can be used to advantage with other machinery requiring a slow speed drive.

A cast iron sub-base is used, provided with lugs to which is pivoted the cast iron base on which the motor and counter-shaft are mounted. Tension between the pulley on the armature shaft of the motor and that on the counter-shaft, is maintained by the usual plan of shifting the motor on the base, with the aid of an adjusting screw. For the belt connection between the small pulley of the counter-shaft and the driving pulley of the machine, the tension is regulated by an adjusting nut bearing on the pivoted base, which forces the front end of the latter downward, thus increasing the center distance of the pulleys over which the belt runs. A spring is provided at the front end to support the tilting base in case the belt breaks.



Motor mounted on Base Plate with Self-contained Counter-shaft.

As compared with the ordinary idler, the use of this intermediate counter-shaft avoids the usual great difference between the size of the driving and driven pulleys, so that the belts make better arcs of contact with the pulleys, resulting in a consequent decrease of slippage. The motor shown is the "L-type," made by the builders in sizes from 1-20 to 5 horse-power. It has a neat appearance and is compact in design, being especially suited for direct connection with small tools, printing presses, pumps and other light machinery. By applying covers for the openings in the frame, the motor can easily be made dust and moisture proof, for service where the open type would be out of the question.

INGERSOLL HORIZONTAL MILLING MACHINE WITH SUPPLEMENTARY VERTICAL SPINDLES.

In Figs. 1 and 2 are shown front and rear views, respectively, of a horizontal milling machine whose cross rail has been arranged to support a pair of vertical spindles, to be used in conjunction with the horizontal spindle of one of the regular line of horizontal spindle, planer pattern millers, made by the Ingersoll Milling Machine Co., of Rockford, Ill.

The vertical spindles, as may be seen in Fig. 2, can be adjusted to any position between the housings, by means of the rack and pinion arrangement with which they are provided. The spindles also have independent vertical adjustments. They are driven by spiral gearing, encased to run in grease, from a horizontal shaft which extends along the cross rail, and is connected by spur gearing with the main spindle of the machine. Cutters up to 8 inches in diameter may be used on the vertical spindle, there being no interference in any way with the action of the horizontal cutter.

This arrangement is useful in milling work in which vertical and horizontal cuts have to be taken that would otherwise require the use of expensive gang cutters, but which, in

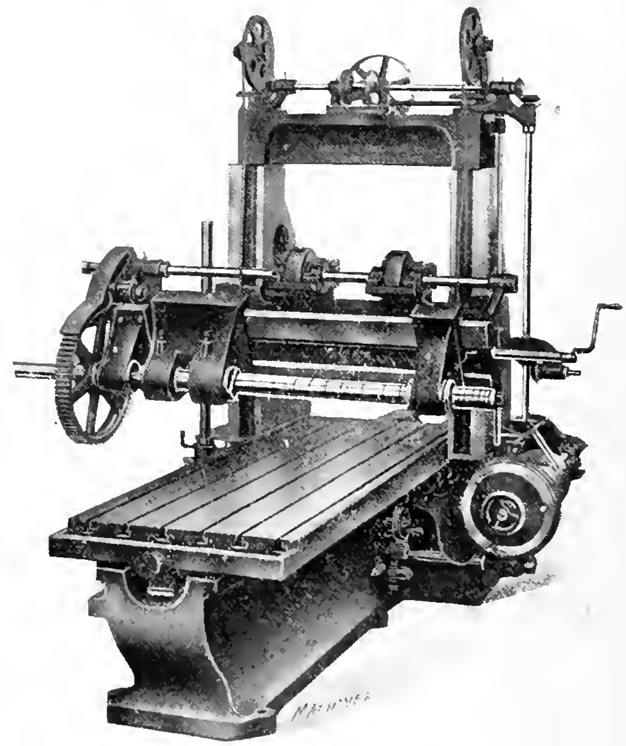


Fig. 1. Ingersoll Horizontal Milling Machine, with Supplementary Vertical Spindles on Back of Cross Rail.

this way, can be done with stock tools. It is also possible to machine surfaces at one cut that would be impossible to do even with gang tools, such as finishing horizontal surfaces and cutting tongues or grooves in the sides of vertical surfaces, at the same operation.

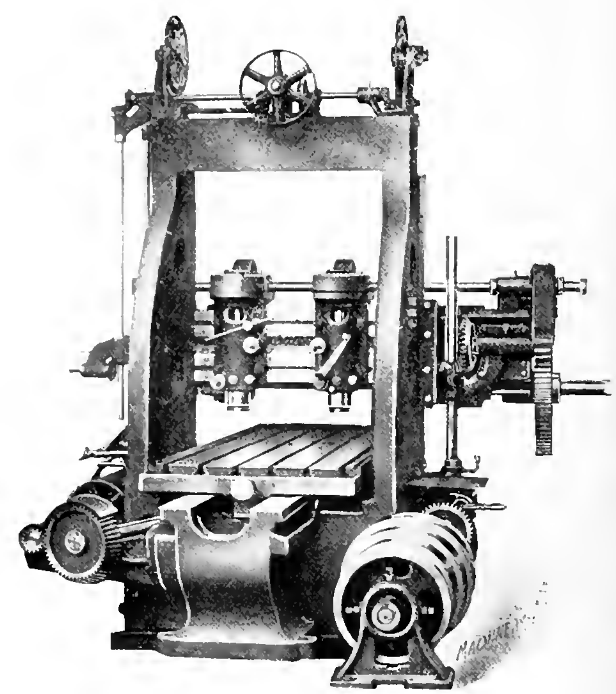
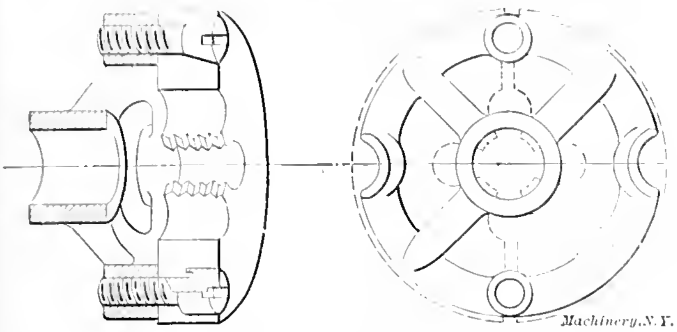


Fig. 2. Rear View showing Arrangement of Vertical Spindles

This method of attaching spindles at the back of a cross rail is not confined entirely to horizontal milling machines, like that shown in Figs. 1 and 2. The arrangement may be used with any other machine which has a cross rail, the builders having furnished vertical machines of this type with four heads on a single rail, two at the front and two at the back. This makes it possible to take cuts closer together than would be the case if all the heads were on a single rail.

GREEN RIVER SCREW PLATE FOR BRAZED BRASS TUBING.

The accompanying line cut shows a Green River die with an improved guide, designed for threading brazed brass tubing. The die used is the standard form furnished with the maker's ordinary sets for threading bolts and nuts. Particular attention is called to the long bearing provided by the style of



Green River Dies with Bushing Attachment for Threading Brazed Brass Tubing.

guide used, thus enabling the operator to always be sure of cutting straight and perfect threads. The dies are so formed as to leave a large space for getting rid of chips, and give also an excellent opportunity for oiling the work.

The device is furnished in all sizes, from 3-16 to 1 inch in diameter, the usual pitch being 27 threads to the inch for all American sizes, and 26 threads to the inch for all English sizes. These screw plates are made by the Wiley & Russell Mfg. Co., Greenfield, Mass.

FRONT CROSS FEED FOR GOULD & EBERHARDT SHAPERS.

The device, whose absence is indicated by the position of the operator in Fig. 1, and which is shown in use in Fig. 3, is not an entirely new idea, as it has been previously described in communications to trade papers. It is new, however, for the first time regularly applied to a manufactured line of shapers, so it is worth while bringing it again to the attention of our readers. This front acting table feed is being applied to the line of shapers built by Gould & Eberhardt, of Newark, N. J.

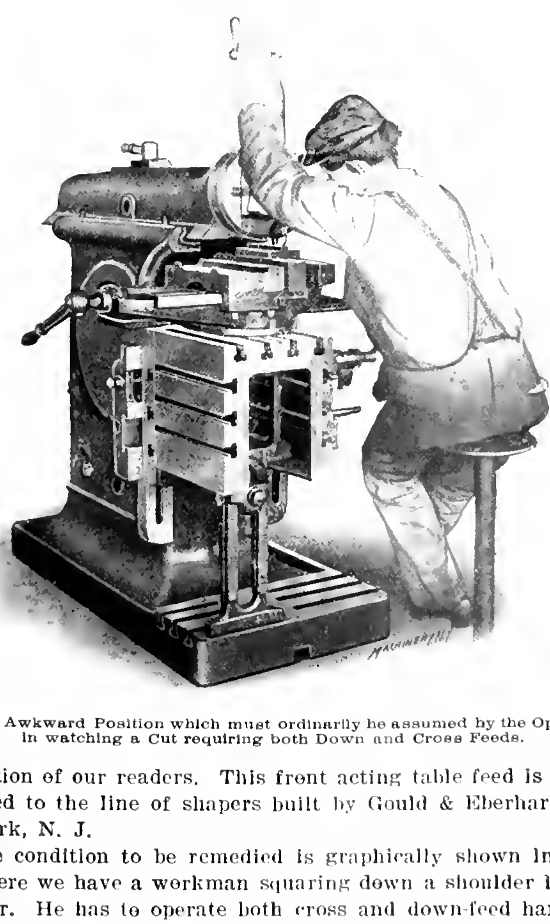


Fig. 1. Awkward Position which must ordinarily be assumed by the Operator in watching a Cut requiring both Down and Cross Feeds.

The condition to be remedied is graphically shown in Fig. 1. Here we have a workman squaring down a shoulder in the shaper. He has to operate both cross and down-feed handles, and, at the same time, has to keep an eye on the lines he is working to, scribed on the front face of the casting. With the handles placed as they are, this necessitates a bodily contortion which is far from agreeable or profitable. To remedy this, an additional connection for the cross feed is made. This is a shaft at right angles to the table and screw, having a crank handle at the front of the work table. With this, as

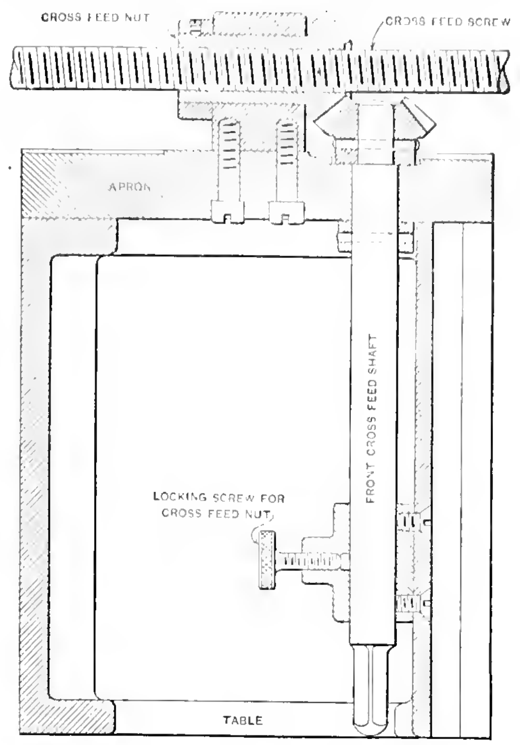


Fig. 2. Arrangement of Device used to work Cross Feed from Front of Table, as shown in Fig. 3.

shown in Fig. 3, the operator can place himself squarely in front of the machine, with both cross and down-feed handles in easy reach, and in a position to see surely what he is doing.

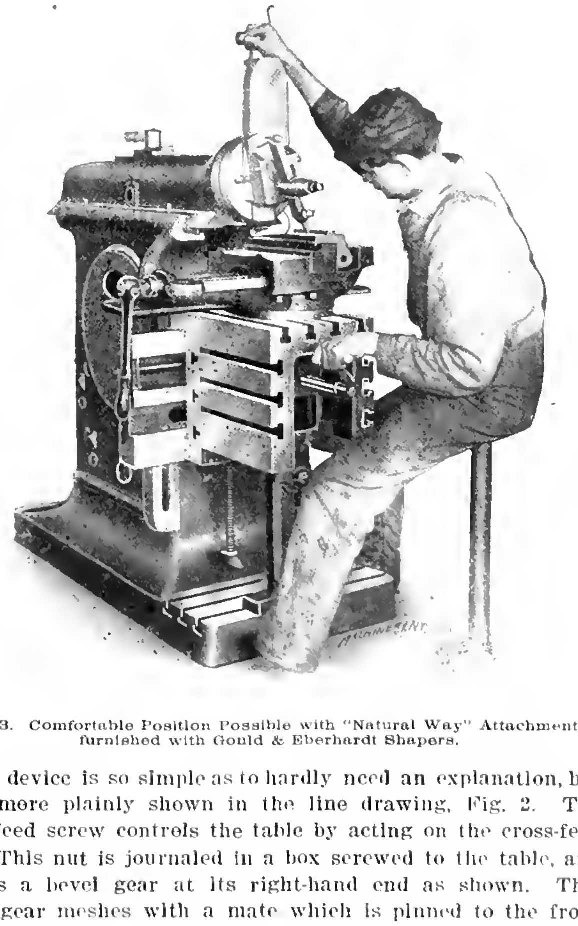


Fig. 3. Comfortable Position Possible with "Natural Way" Attachment, furnished with Gould & Eberhardt Shapers.

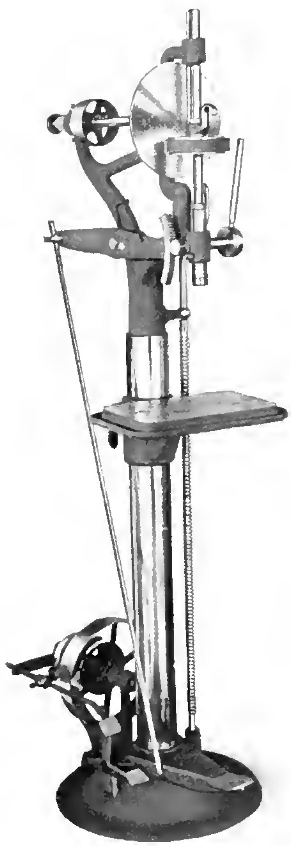
The device is so simple as to hardly need an explanation, but it is more plainly shown in the line drawing, Fig. 2. The cross-feed screw controls the table by acting on the cross-feed nut. This nut is journaled in a box screwed to the table, and carries a bevel gear at its right-hand end as shown. This bevel gear meshes with a mate which is pinned to the front cross-feed shaft, running out to the front of the table. This

shaft is squared, as may be seen, to fit the crank by which it is operated.

The lock screw shown has a cylindrical end, adapted to clamp the front cross-feed shaft and prevent it from turning. When the cross-feed shaft is so engaged, the cross-feed nut is stationary, and the table may be fed back and forth by the cross-feed screw in the usual manner. When, however, it is desired to use the crank on the shaft running out to the front of the table, the lock screw is turned back, so that the nut may revolve freely. The feed-screw then being stationary, the revolving of the crank, as shown in Fig. 3, feeds the table at the will of the operator.

BARNES FRICTION DRILL PRESS WITH COMBINED FOOT AND HAND FEED.

We show herewith an application of a combined foot and hand feed to the 10-inch friction drill made by W. F. & John Barnes Co., 231 Ruby Street, Rockford, Ill. The foot lever for operating this spindle is particularly useful for work requiring light drilling, which is yet so bulky as to need the use of both hands in holding and shifting it. As may be seen, the device is an addition to the regular hand feed, and does not supersede it. A lever having a segment of a gear formed on its outer end meshes with a pinion on the rack and pinion feeding shaft. The rear end of this lever is connected with the treadle by a long reach rod. Three different holes are provided in the treadle for attaching the reach rod, so that provision is thus made for applying varying degrees of power for drills of varying diameter.



Foot-operated Feed, applied to Barnes Friction Drill Press.

SMITH MICROMETER ADJUSTABLE REAMER.

The reamer shown in Figs. 1 and 2, made by the Wm. J. Smith Co., 424 State Street, New Haven, Conn., is called the Smith Micrometer Adjustable Reamer. It gets its name from the graduations provided on the body of the reamer, read by an adjustable sleeve in the same way that the readings for a micrometer caliper are obtained.

Aside from the blades, the tool consists of but three parts, shown disassembled in Fig. 2. These are the body and head of the reamer (formed in one piece), the adjusting sleeve, and the clamping screw. The blades are fitted in tapered slots cut in the head of the reamer. The adjusting sleeve is threaded to the shaft with a thread of fine pitch. It has a

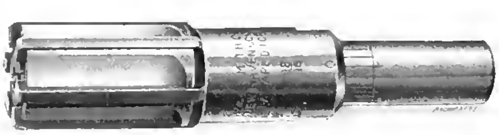


Fig. 1. The Smith Micrometer Adjustable Reamer.

cone-shaped inner surface, which engages the beveled ends of the blades, and holds them down to the bottom of the slot. The outer ends of the blades have under-cut bevel projections, which engage an internal cone-shaped surface under the head of the clamping screw. This clamping screw is threaded into the body, and serves to bring all the blades down to a firm and rigid bearing in the bottom of the slots.

In making adjustments, use is made of the graduations provided on the shank of the reamer. These are read from a zero mark on the sleeve, and give readings to one-quarter of a thousandth. To change the adjustment, the tightening screw is loosened, the adjusting sleeve is rotated to make the reamer larger or smaller by the desired number of thousandths, and the tightening screw is again set down firmly.

No threads are exposed in this reamer, all the adjusting parts being protected, leaving the exterior surface smooth and symmetrical with ample chip room for doing clean, fast work. The reamers are made throughout of high carbon steel, tempered to give the required hardness for resisting strain and wear. All the parts are interchangeable. The ream-

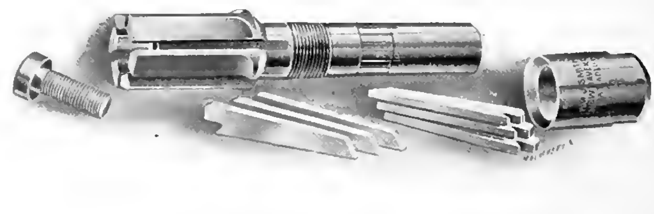


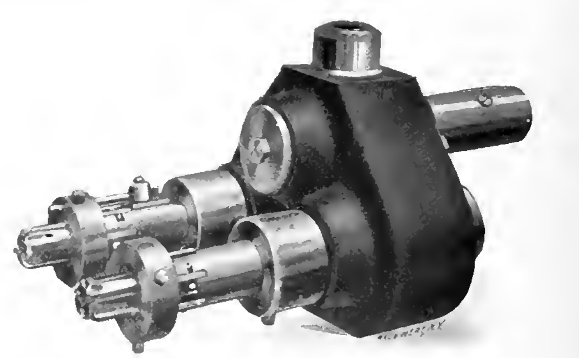
Fig. 2. Component Parts of the Reamer, showing the Simplicity of its Construction.

ers of this type are made and carried in stock in sizes from $\frac{1}{4}$ inch to 1 inch in diameter inclusive, varying by 32nds. Special sizes, of course, can be made to order. Micrometer adjustable reamers for tapered holes are also made on the same plan.

The blades used in these reamers are ground in the same way as described for the maker's "one lock" adjustable reamer in the October, 1907, issue of MACHINERY. As there explained, the blades are ground in a cylindrical grinder in a special arbor or fixture, which gives radial or eccentric relief to the work cutting edge of the blade. This form of relief will cut without chattering in all kinds of metal in which reaming can be done. Twelve jigs are required for covering the entire range of reamer sizes from $\frac{1}{4}$ to 1 inch diameter. These are furnished by the makers, or, if desired, blades may be sent to them for resharpening. This will be done at a nominal cost. A complete stock of interchangeable blades is carried by the builders, fitted and ground ready for use. The reamer bodies do not need to be returned for sharpening the blades or for fitting in new ones. They will be furnished of either carbon or high speed steel. Blades may be reground in the usual way if desired, but the special method devised for these reamers gives more satisfactory results.

MURCHEY DOUBLE COMBINATION TAPPING AND REAMING ATTACHMENT.

The device shown in the accompanying engraving was designed primarily for reaming and tapping two one-inch standard pipe threads at a time, in cast iron heater sections, such



An Attachment for Reaming and Tapping Two Holes at the Same Time without changing Tools or readjusting Work.

as are used in blower heating systems. It is built by the Murchey Machine and Tool Co., Fourth and Porter Streets, Detroit, Mich.

The two spindles of the attachment are connected by gearing with the driving spindle, which is revolved by the machine in which the tool is used. Each spindle carries a combined reaming and tapping head, by the use of which the holes in the headers can be finished without changing the tools. The tap is of the collapsible variety. When the tool is

first run through the holes, the chasers are withdrawn, allowing the reaming blades to do their work. The second time it is forced through, the chasers are in their working position, and the threads are tapped in the holes. When the proper depth has been reached, as determined by the threaded stop rods, the taps automatically collapse, and the tool may be withdrawn without requiring the spindles to be reversed. This saves a great deal of time, as compared with the reversing spindle machines employing solid taps formerly used for this work.

Though intended for the particular work mentioned, this attachment will be furnished by the builder to do work of any size, within a reasonable range. Taps of the kind used in this device, are furnished by the manufacturers in sizes to cut standard pipe threads from 1-inch to 12-inch, and they are used in all kinds of tapping machine and Monitor lathe work.

HOLROYD DRILLING MACHINE AND GRINDING MACHINE.

The machine illustrated in Fig. 1 is more especially intended for drilling the flanges of pipes and fittings. On a strong base is mounted an upright carrying the drill head-stock. At right angles is another base embodying the table slides. On the table is mounted a revolving square table. The head-stock carries a hard steel spindle 2 inches diameter which has an automatic feed of 12 inches by means of drop-out worm and wheel which is released by an adjustable knock-off. The spindle is bored No. 3 Morse taper and is driven through spur and bevel gears by a four-speed cone for 3¼-inch belt, the diameter of the speeds being 10, 11, 12, and 13 inches, giving speeds of 241, 287, 342, and 407 revolutions per minute. Quick hand traverse is by rack sleeve and pinion actuated by hand-wheel. The self-acting feed is 1/100 inch per revolution of spindle. The spindle has a vertical adjustment on the column of 36 inches, with a similar cross traverse, both operated by screws and conveniently placed hand-wheels. The table slides are gibbed to the bed, the longitudinal traverse of the table being 12 inches. The revolving table is 3 feet

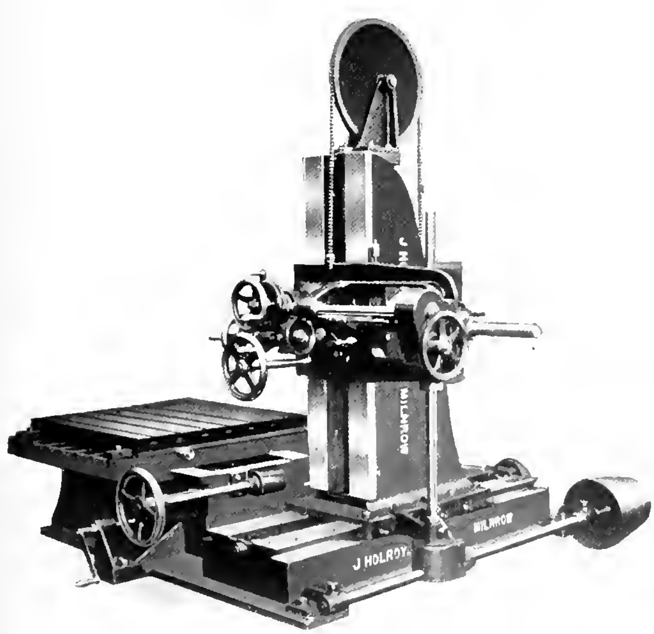


Fig. 1. Holroyd Drilling Machine.

square. The counter-shaft carries 12-inch by 4¼-inch pulleys, and runs at 470 R.P.M. The floor space required is 10 feet by 8 feet, and the total weight of the machine is 3 tons, and, as in the case of the bushing grinding machine illustrated in Fig. 2, the tool is built by John Holroyd & Co., Ltd., Milnrow, Manchester, England.

The second machine mentioned is specially designed for grinding the inside of bushings and cutters from 2 to 6 inches diameter, and up to 12 inches long. It has a strong body with facings provided to receive the spindle and table slides. The emery wheel spindle of hard steel runs in gun-metal bearings carried in the cast iron sleeve. The spindle is driven from a 12-inch diameter pulley for a 1½-inch belt onto a two-speed cone connected to a drum pulley 7½ inches diameter, which in turn drives the spindle pulley. The spindle slide is balanced and provided with self-acting vertical feed of 12 inches, adjustable stops being provided to reverse the feed at any desired point of the traverse. The feed is obtained from the main cone driving shaft through a series of gears onto rack and pinion. Hand cross adjustment of the spindle

Fig. 2. Holroyd Bushing Grinding Machine.

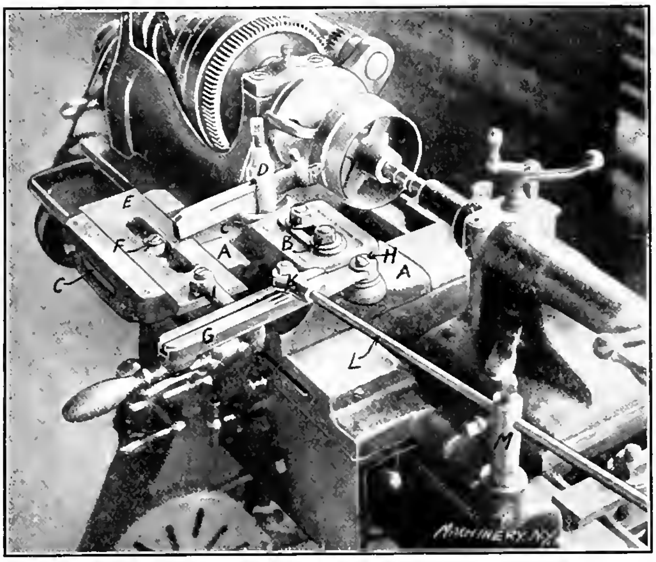
is provided, a micrometer disk being arranged to read to 1/1,000 inch. The work table is 18 inches diameter and has four tee-slots. The table drive is through spur and bevel gearing from a three-speed cone for 2¼-inch belt, the largest speed being 12 inches diameter. The table drive may be brought into or out of action independently of the rest of the machine, by lever and clutch, an advantage when gaging the work being ground. A hinged guard is fitted to prevent the lubricant splashing. The emery wheel speeds range from 6,900 to 10,800 R.P.M., and those of the table are 66, 100, and 150 R.P.M. The feeds per revolution of work are 0.166, 0.25, and 0.375 inch. The counter-shaft pulleys are 12 x 3¼ inches, and the speed 400 R.P.M. The floor space occupied by the machine is 5 feet 6 inches by 3 feet 8 inches, and its weight 2,900 pounds. J. V.

MOSSBERG PULLEY CROWNING ATTACHMENT FOR LATHES.

In the half-tone is shown a pulley crowning attachment, made by the Mossberg Wrench Co., of Central Falls, R. I. The notable features of this attachment are that it is adapted to turning suitable crowns for narrow or wide-faced pulleys, without requiring a change of formers, and that it is also adapted for being attached to a wide range of sizes and designs of lathes, without requiring reconstruction. A number of other advantages will appear in the course of the description.

It consists essentially of a main casting *A*, clamped by bolts *B B*, to the regular tool-post slot of the cross-slide. This main casting carries ways for slide *C*, on which the tool-post *D* is mounted, and also ways at right angles to, and above *C*, for confining former *E*. This former has a curved slot, operating on a roll *F*, whose pivot is fast to the tool-post slide *C*. It will thus be seen that a longitudinal movement given to former *E*, will, through the action of the curved slot on roll *F*, give an in and out movement to the tool-post, thus determining the contour of the surfaces being turned. This longitudinal movement is given by the link work shown. A bar *G*, pivoted at *H* to the main casting *A*, is connected with *E* by the link *J*. It carries a handle at its outer end, and its upper surface has a T-slot on which pivot *K* can be adjusted to any desired position. This pivot constrains the end of rod *L*, whose other end is fastened, at any length desired, to an adjustable bracket *M*.

As the carriage is moved back and forth, it will be seen that rod *L* will swing slotted bar *G*, which, through link *J*, will move the former *E*, thus affecting the turning tool and the contour of the work. If *K* is adjusted to position immediately over the connection point of link *J* in the slotted bar, then the former will stand stationary with relation to the bed of the lathe, while the carriage and the tool-post move back and forth by the feed or by hand. Under these conditions, the contour of the slot in the former will be exactly traced on the face of the pulley. If pivot *K* is clamped in the position shown, the swinging movement of *G* will be much greater for a given movement of the carriage, so that a shorter and more pronounced curve will be turned, suitable for narrow faced pulleys. If the



Attachment for Crowning Pulleys, which gives Curves Suitable for Pulleys of Different Faces with the Same Former.

pivot, on the other hand, is located at the extreme outer end of the slot in *G*, the movement of the former will be very much slower, and the conditions will be suitable for turning pulleys of wide faces which do not require a pronounced crown. This makes unnecessary the provision of a former for each shape of crown desired.

Another advantage of this device is the fact that special arbors with shoulders for locating the work are not required. In operation, when it is desired to start on a new pulley, the carriage is adjusted until the tool point is central with the face of the pulley; the set-screw in pivot *M* is then released, and slotted bar *G* is adjusted by the handle at its outer end until roll *P* is in the center of the slot in *E*, as determined by the center line traced upon it. The set-screw in *M* is then tightened down again, and the tool brought over to commence the operation of turning.

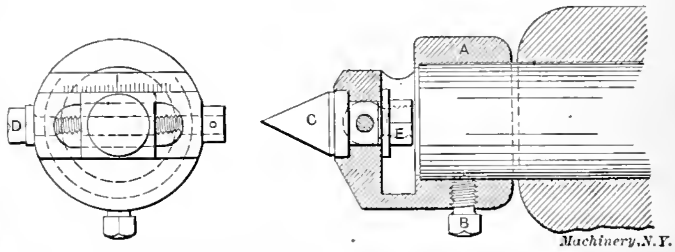
These features, and the self-contained construction of the attachment, should make it convenient for the work it is designed for.

CINCINNATI CENTER FOR TURNING TAPERS.

The device shown herewith has been designed by Max C. Zange, 2827 Sidney Avenue, Cincinnati, Ohio, for doing away with some of the troubles incident to turning tapers in the lathe by the method of setting over the tail-stock. One of the chief difficulties in turning tapers in this way, as is well known, is the fact that the center adjustment of the tail-stock is disturbed, and it requires considerable time and trouble to bring it back, after the taper job is completed, to a position where the lathe will again turn work to the required degree of cylindrical truth. With this device the tail-stock is not set over, the setting over being done on the center itself, provision being made in the attachment for this.

The body *A* of the device, machined out of round stock, is clamped to the tail-stock spindle by set-screw *B*, the regular tail center being removed for the purpose. The tail-stock spindle seats against a shoulder in *A*, to take the thrust of the work between the centers. The front of the body of the device is milled out to form ways in which the center *C* can be laterally adjusted. The lateral movement of this center is effected by the stationary adjusting screw *D*, and the amount of off-set is read by graduations on the body, as shown in the end view. After the required adjustment has been obtained, the center is clamped in position by nut *E*, which is reached by the wrench through the opening in the body left for the purpose.

The center is made of tool steel, hardened, and is made to an angle of 50 degrees instead of the usual 60 degrees of the



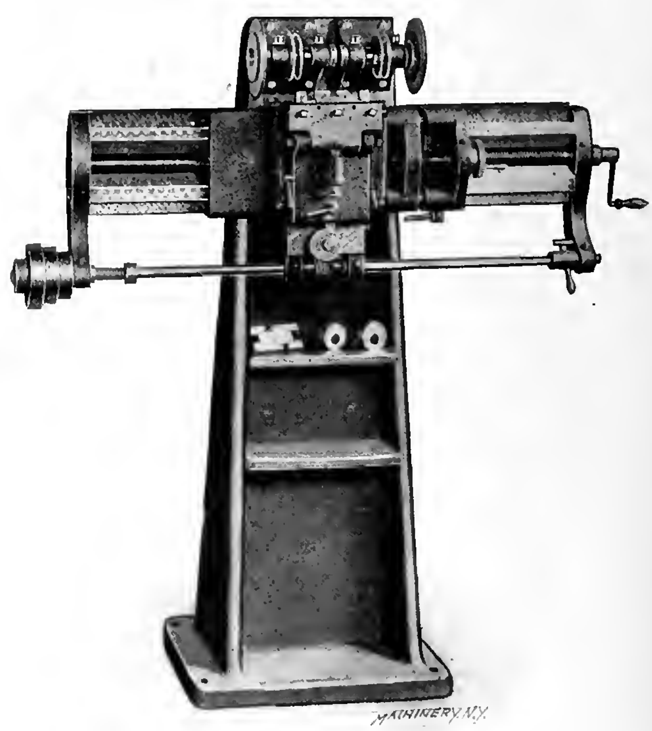
A Device for Setting Over the Tail-center for Taper Turning, without disturbing the Adjustment of the Tail-stock.

common lathe center. The pointed end is also slightly curved, both of these alterations being made to compensate for the angular position of the center in the work. The adjusting screw *D* has 25 threads per inch, and this pitch, in connection with the squared head of the screw, may be used in obtaining adjustments of hundredths of an inch.

Two sizes of this device are made, one of them suitable for bench and precision lathes, and the other adapted for larger machines. In the smaller one, the nut *E* is provided with a permanently fixed handle, so that it is not necessary to insert a wrench in the opening when the center is to be tightened in position. The small size is suitable for tail-stock spindles up to $1\frac{3}{8}$-inch outside diameter; the larger size will cover the range of from $1\frac{3}{8}$ to 1 15-16 inch outside diameter of tail-stock spindle.

GAGE LAPPING MACHINE, BUILT BY THE WALTHAM MACHINE WORKS.

We show herewith a machine for lapping gages, built by the Waltham Machine Works, Newton St., Waltham, Mass. It is intended for doing the work described in the article on machine lapping by Mr. Shailor in our November, 1907, issue.



A Machine for Grinding Snap Gages, and Finishing them by Lapping.

It will be remembered that the use of the milling machine was there spoken of for this work. This specialized tool accomplishes the same results in a somewhat more convenient way. The upright column of the machine supports two heads,

one of them carrying a spindle for a grinding wheel, and the other for a steel disk charged with emery or diamond dust, for the finishing operation of lapping. Since these arbors are run separately, appropriate speeds can be given to them. The gage to be ground is held in a vise, carried by a slide adjustable on the cross-rail, shown at the front of the column. The crank at the right, attached to the traversing screw, affords means for changing the work from the right-hand wheel to the left-hand, or vice versa. The small adjusting wheel is attached to a fine pitch screw, which is used for feeding the gage up to the wheel for the grinding or lapping operations.

In operation, the gage is brought up to the revolving disk with just enough pressure to give a suitable cutting action. The vise in which the work is mounted slides in vertical ways, and a vertical reciprocating motion is given to it by means of the heart-shaped cam shown, driven by worm gearing from a shaft running lengthwise of the cross-rail, below it. This cam does not give a uniform movement throughout the stroke. It accelerates its motion at the ends of the stroke to avoid the "bell-mouth" effect which is ordinarily seen in lapped gages. The holder or vise in which the gages are mounted can be swung outward at an angle of 45 degrees for gaging the work. A clutch is provided for stopping the cam driving shaft, without requiring the counter-shaft to be stopped.

This machine is built only to order by its makers. The one shown is quite elaborate and was so made to meet the requirements of the purchaser. Simpler machines of the same sort for lapping gages could be designed, and the makers will furnish them adapted to suit individual needs.

TOLEDO TOGGLE ACTION DRAWING PRESS OF UNUSUAL SIZE.

The Toledo Machine & Tool Co., of Toledo, Ohio, has recently shipped to one of its customers, what is believed to be the largest toggle action drawing press ever built. The ma-

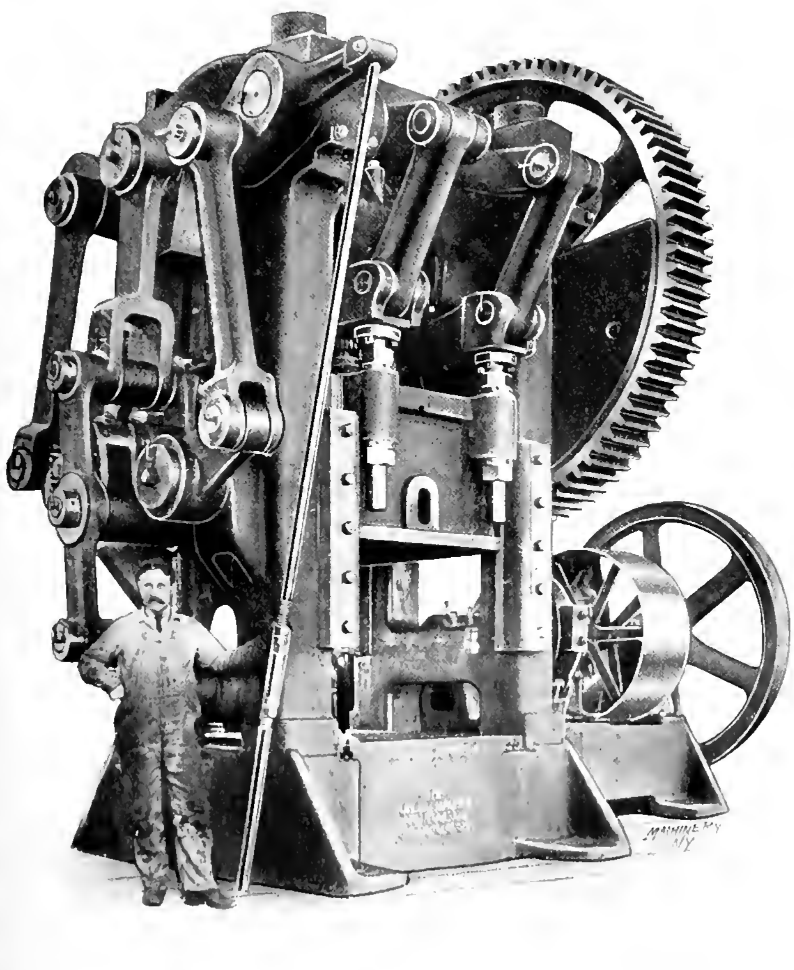


Fig. 1. Heavy Drawing Press with Blank Holder operated by a Toggle Mechanism.

chine is certainly of tremendous size, as will be seen by comparing it with the man who stands in the foreground of Fig. 1. It has interest aside from its unusual size, from the improved construction of the toggle mechanism (described also in the December, 1905, issue of MACHINERY), which gives a long "dwell," and is unusually efficient so far as power consumption is concerned. The press is intended for deep stampings in steel or other materials, particularly for brake drums for automobiles, sinks, bathtubs, and similar work.

The toggle mechanism, which is plainly shown in the half-tone, Fig. 1, and the line drawings, Figs. 2 and 3, is of such

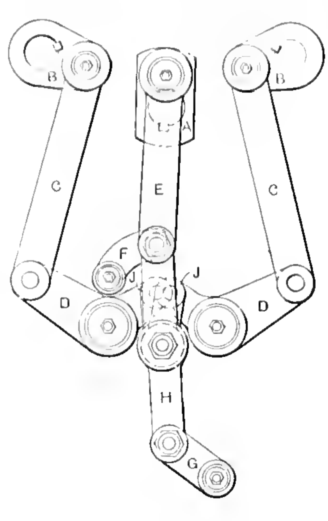


Fig. 2. The Outside Toggle Mechanism in the Position to raise the Blank Holder.

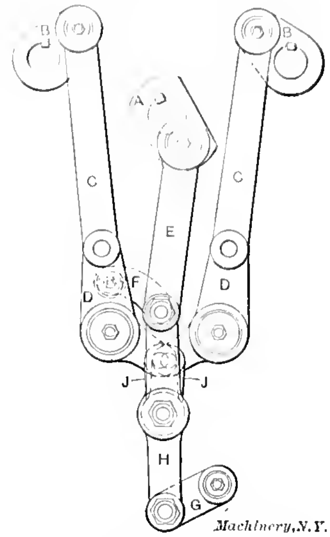


Fig. 3. The Toggle Mechanism while the Blank Holder is Lowered.

design that all sliding surfaces are eliminated, being replaced at all points with pivoted joints, most of which have but a very small angular movement. A (see Figs. 2 and 3) is a crank keyed to the main crank-shaft of the press. Connecting-rod E, attached to this, is pivoted in yoke H, which is suspended on rocker arms F and G, pivoted to the side frames of the machine, on opposite sides of H. Bell crank levers D are operated from the center pivot of H, through short links J. Links C connect the upper arms of bell cranks D with cranks B, which are keyed to rocker arm shafts. The rocker arms between the frames are directly connected with links to the blank holder slide, as shown in Fig. 1.

A comparison of Figs. 2 and 3 will show the action of the mechanism. In Fig. 2, crank A is at its highest position. In Fig. 3 the blank holder is down. It will be seen that in this position bell cranks D and links C are straightened out, so that a powerful toggle action with an appropriate dwell is obtained, lasting through a considerable portion of the revolution of the crank-shaft.

Cranks B, in turn, operate the rocker arms, which, with the links connecting them with the blank holder slide, form a second toggle joint mechanism. It will be seen that these two sets or toggle joints, acting in series as they do, give a powerful pressure to the blank holder, estimated by the builders at 2,000 tons. This gives a very long dwell as well. This extends to over 90 degrees of the crank action, without perceptible movement of the blank holder.

All the parts of the toggle mechanism are made of steel castings, and each bearing is bushed with bronze. The bearings of the outer movement are oiled through the ends of each of the pivots, by means of self-oiling or compression cups. The smoothness and ease of action obtained by this thorough lubrication and by the avoiding of sliding surfaces, allows the machine to be driven with an 8-inch belt, though it was supposed that a 10-inch double belt would be necessary. The press is operated by a powerful friction clutch, and is therefore under complete control of the operator at all points of the stroke of both plunger and the blank holder.

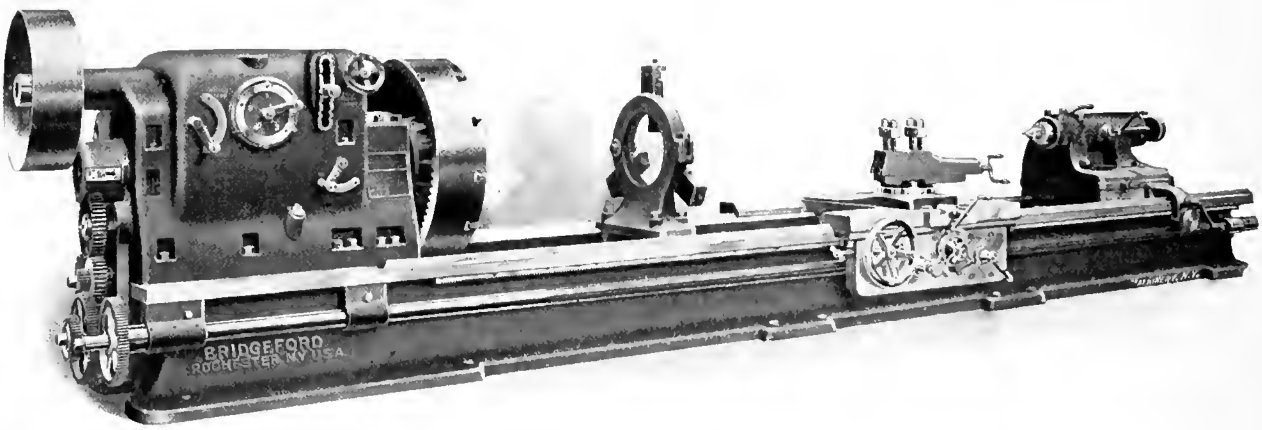
The distance between the uprights is 57 inches, this being also the width of the bed. The distance from the bed to the

blank holder, with the stroke down and the adjustment up, is 24 inches. The distance from the bed to the plunger with the stroke down and the adjustment up is 28 inches. The stroke of the plunger is 26 inches. The belt pulleys are 58 inches in diameter, designed for a 10-inch belt, and are intended to run at 250 revolutions per minute. This, with a gear ratio of 50 to 1, gives 5 strokes per minute for the press. The shaft is 13 inches in diameter at the crank bearing.

The total height of the machine above the floor line is 21 feet. It weighs, complete, 175,000 pounds.

BRIDGEFORD GEARED HEAD LATHE.

The Bridgeford Machine Tool Works, Rochester, N. Y., has recently designed a line of geared head lathes covering the sizes between 26 and 48 inches swing. The engraving shows the 42-inch lathe. The 48-inch swing is, so far as our memory serves us, the largest single speed pulley geared head lathe we have even seen illustrated or described. The lathe has been designed to meet the severest requirements, and is claimed to be limited in capacity only by the efficiency of the best of the modern high speed tool steels.



A Geared Head Lathe of Unusual Size, built by the Bridgeford Machine Tool Works.

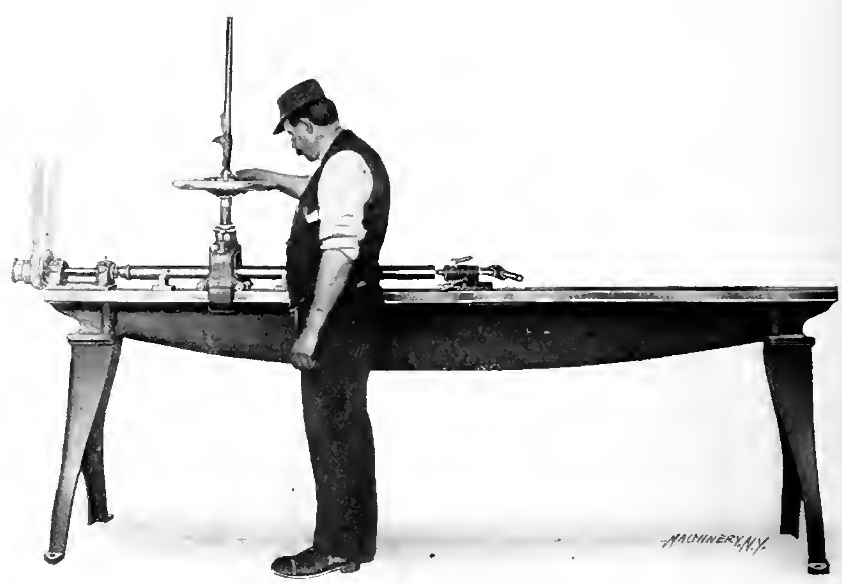
The power is applied to a constant speed pulley from which the 15 cutting speeds are obtained by change gearing. These speeds are arranged in geometrical progression, and the changes are accomplished by shifting the conveniently located levers, shown in the half-tone in front of the head-stock. All the driving gears, with the exception of the face-plate gear, are of steel cut from the solid. All those within the head run in oil, and provision is made for furnishing a constant supply of oil to all the bearings. The proportions of gearing used give from 2.26 to 110.8 revolutions of the driving pulley to 1 revolution of the face-plate. On a diameter of 42 inches the pulling power is about 25,000 pounds, or about four times that of the ordinary cone driving lathe. The spindle is of crucible steel, ground to size, running in heavy bronze bearings scraped to fit. The face-plate is pressed onto the spindle and keyed to it.

The bed is of ample width and depth, and is strongly reinforced with heavy cross ties of box pattern. It is also provided with a longitudinal rib with ratchet teeth cast in its upper face, which engage a pawl at the back of the tail-stock. This provides a positive stop for the tail-stock, which is a great advantage when the lathe is engaged on heavy work. The tail-stock is so shaped as to clear the compound rest when turning angular work. The carriage compound rest and apron are of heavy construction, and in keeping with the balance of the lathe. The direction of the feeds is changed at the apron, and the lateral and cross feeds are driven by independent frictions.

The following dimensions will give some idea of the rigidity of the design. The main spindle bearing is 8¾ inches in diameter and 14 inches long, with a 1 7/16-inch hole through it for removing the center. The centers are of tool steel, 3 3/16 inches in diameter. The 42-inch face-plate is 11 inches wide. The driving pulley is 30 inches in diameter, for an 8-inch belt. The lead-screw is 2 11/16 inches in diameter, two threads to the inch, and the rack is 2 inches wide, 5 diametral pitch. With a 16-foot bed, the distance between centers is 6 feet 7 inches. It can be built with a bed of any length desired. A 42-inch lathe with a 16-foot bed weighs 27,000 pounds; 6,500 pounds should be added for each additional foot of length. The regular attachments are: Compound rest, side-turning rest, 16-inch center rest, thread indicator, change gears, self-oiling counter-shaft, and the necessary wrenches and cranks.

ROCKFORD DRILLING MACHINE COMPANY'S STRAIGHTENING MACHINE.

The machine shown in the accompanying engraving is a combination of lathe and straightening press, for straightening centered work. Straightening presses have been built to use in the lathe, and straightening presses have been built provided with centers on which to spin the work to determine the "high spots," but this is the first device that has come to our attention that is really a combination of the straightening press and lathe. It would seem to be a very efficient ma-



A Combination of Lathe and Screw Press for Straightening Centered Shafts.

chine for use in places where there is considerable of this work to do. It is built by the Rockford Drilling Machine Co., Rockford, Ill.

The machine consists essentially of a heavy, rigid bed, carrying a power driven head-stock and an adjustable foot-stock, and supporting a straightening press with suitable blocks for the straightening operation. The head-stock spindle has a

three-step cone, on which the belt may be shifted to drive the work at a rate of revolution suitable for accurately determining its truth. A center is supported by this spindle in the front end in the usual way. Instead, however, of driving the work from a face-plate by a dog, a friction device is provided which revolves the work as soon as it has been clamped between centers. This consists of a collar fitting over the head-stock center, and provided with a leather face which is pressed against the work by four coiled springs. The support blocks used are provided in sets of two for each diameter of shaft. They are bored to accurately fit the diameter they are made to, but with centers 1/16 inch or thereabout below the center of the spindle. The tail-stock center is operated by a lever, and may be held in position by a clamp screw in the ordinary way. It will be seen that this method of supporting and driving the work is very convenient, since when the centers are released, the work drops into position in the supporting blocks, ready to be straightened. After the straightening is done and the tail-center is again brought up and clamped, it raises the work from the supporting blocks, the centers enter the center holes in the work, and the work is driven by the constantly running spindle, all of this being done in one movement of the tail-stock operating and clamping levers.

The carriage which supports the straightening screw runs on rollers, and can be shifted very quickly and easily on the bed to bring it to the point where the straightening needs to be done. This screw is of fine pitch, so that the hand-wheel provided is generally of sufficient diameter for providing enough pressure to straighten the work. For large work, however, the ratchet lever shown may be swung down into place, giving sufficient leverage to straighten any piece within the capacity of the machine. On this straightening screw is fixed a revolving dial, read from a stationary index point. The operator watches this in straightening a piece of work, and is able to use it for reference in applying pressure a second time to the same point, if the first application of the pressure was not sufficient. The bed is very rigid, and capable of sustaining as severe a straightening pressure as should be applied to any work within the capacity of the machine. It is long enough to give the machine a capacity of 8 feet between centers.

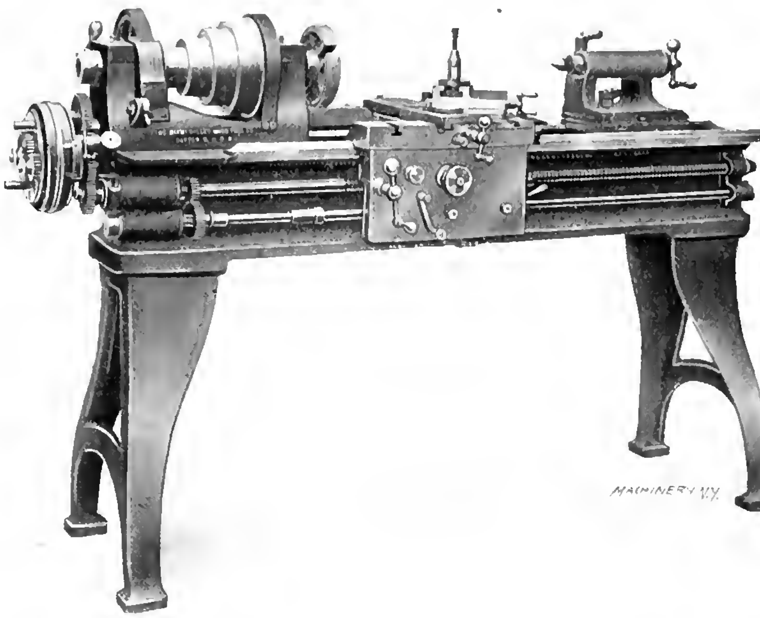
The builders have been using this machine to do all of their straightening with, none of it now being done in the lathe in their shops. They have found that it permits doing the work in a very much shorter time, owing to the convenience of operation which the design of the machine provides for. All of this straightening is best done by one man, who soon becomes skillful at the work, so that it is done in a small fraction of the time previously required.

IMPROVED MIAMI VALLEY 13 1-2 INCH ENGINE LATHE.

The machine shown in the accompanying engraving is an improved design of the lathe built by the Miami Valley Machine Tool Co., 843 W. Germantown St., Dayton, Ohio. Among the improvements made are: the addition of a quick change gear attachment; an automatic stop for the carriage feed; a chasing dial for cutting screw threads; and a taper-turning attachment.

The general design of the lathe is simple, rigid and serviceable. The spindles are of high grade crucible steel, ground accurately to size, running in bronze bearings. The head- and tail-stocks are of heavy design, and are held to the bed with a V-bearing at the rear, and a flat bearing on the front; the carriage has a V-bearing in the front, and a flat bearing in the rear. There being but one V-bearing in front, the carriage may be stiffened materially without decreasing the swing. The chasing dial is located just at the right of the carriage. It is connected to a worm-wheel meshing with the lead-screw, and the graduations on its face are used to determine the proper time for throwing in the lead-screw nut when cutting threads. The use of this dial makes it unnecessary to reverse the counter-shaft for thread-cutting. An interesting point in the construction of the compound rest is the fact that the screw is journaled in the swivel base, while the nut is fast to the tool-post slide. It is thus possible to lubricate the latter.

The quick change gear attachment shown is the well-known one designed by the National Machine Tool Co. It consists of a series of change gears, of various numbers of teeth, arranged in a circular casing and engaging with a central intermediate gear. Changes are made by rotating the casing and engaging the different gears in it with the lead-screw in different positions, and by placing the slip gear on the outside of the casing on the desired one of the various studs provided for it. The number of threads that can be cut varies from 4 to 56 per inch, including the 11½ per inch pitch for pipe threads.



Miami Valley Lathe, as arranged with Quick Change Gear Device.

This machine, which is built in the 13½-inch size, may be had in three lengths of bed—5, 6, or 8 feet. The lathe, with an 8-foot bed, weighs 1,450 pounds. The machine is regularly provided with the compound rest. A taper attachment, carriage turret, and quick change gear device are provided extra when desired.

MILLING MACHINE ATTACHMENT FOR CHAMFERING TRANSMISSION GEAR TEETH.

In the speed change mechanism used in the automobile, the changes are usually obtained by a sliding gear mechanism of some form. To facilitate the sliding of the gears into mesh when they are running at considerable speed, it is usual to chamfer the ends of the teeth, to guide them in entering into mesh with each other. Sliding gear mechanisms are coming into more frequent use in machine tools, so that a machine or attachment like that illustrated (for performing this operation of chamfering the ends of the teeth) is of wider interest than to the automobile industry alone. The device illustrated in Figs. 1 and 2 is built by the "Long Arm" System Co., Cleveland, Ohio. The attachment is fastened to the milling machine table, and its driving pulley is belted to a special counter-shaft. The mechanism is automatic in its action. All it is necessary for the operator to do is to place the work on the work-spindle, adjust the machine and the work properly, and start the counter-shaft. The mechanism revolves the work, feeds it up into the cutter, retracts it—and so on until the work is completed.

The cast iron frame of the device is in the form of a knee, which is bolted to the table. To this frame, on the front side, best seen in Fig. 2, is attached a bracket carrying the driving pulley shaft. A pinion on this bracket drives a gear, which

is connected with a face cam of the enclosed groove type. This cam gives movement to the vertical slide which carries the work spindle. It serves to feed the work upward into the cutter and return it again while it is revolving for the next tooth. This cam gear is connected by an intermediate with the gear driving the indexing worm, the cam and the indexing worm being geared to run together at the same number of revolutions per minute. The gear is its own index wheel. The index worm is adjusted in the T-slot provided for it in

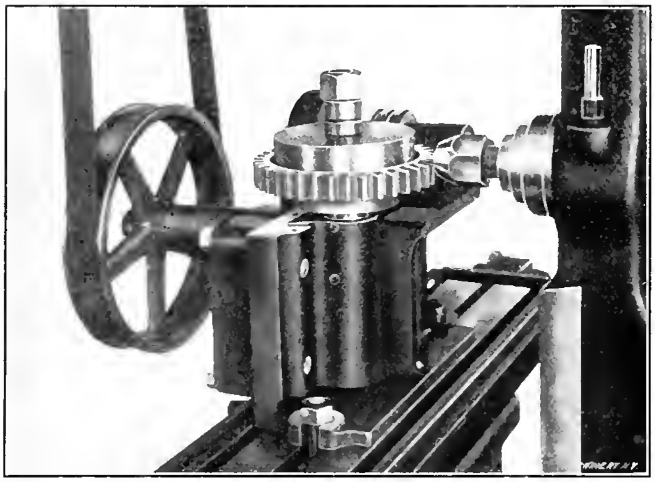


Fig. 1. The "Long Arm" Automatic Gear Tooth Chamfering Attachment at Work.

the body of the fixture until it meshes properly in the teeth of the gear to be cut, and it is clamped in this position, the intermediate gear from the cam shaft being adjusted to drive it without back lash.

When the machine is thus arranged, it may be driven continuously from the counter-shaft. The rotation of the driving pulley will then impart a constant rotary movement to the work through the index worm, the cam, meanwhile, raising and lowering it. With the cutter properly adjusted with relation to the work, it will be seen that this continuous action may be so planned that the cutter will trim off the corner of one side of a gear tooth as it drops into the tooth space, and trim off the corner of the other side as it comes out again, then drop into the next tooth space, beveling the corner as it does so, and continuing the work in the same way until the gear has been finished, and the work removed.

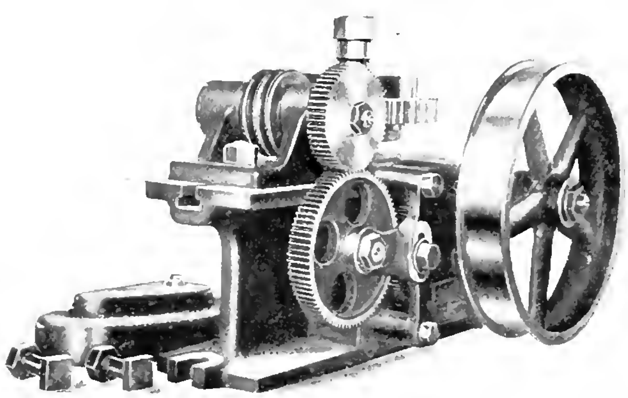


Fig. 2. Front View of the Attachment with the Gear Guard Removed, showing Mechanism.

In practice it is not necessary to stop the machine to put in the work or take it out again. The milling machine saddle is simply run back to withdraw the worm from the cutter, the nut on the end of the work spindle is loosened, and the work is removed. A new gear is then put in, the nut tightened, and the work again brought up to the cutter, when the attachment will continue in operation as before. The under side of the gear can be operated on by changing the position of the cam roll, to engage with the slot below the center of the cam instead of above it, at the same time altering the adjustment of the knee of the milling machine on the column to bring the work to the proper height.

In adjusting the device for gears of the same pitch but of different numbers of teeth, it is only necessary to adjust the indexing worm out or in to mesh properly with the new gear, and to set the machine so that the cutter is in the proper relation to the work. The same index worm will work properly with all gears of the same pitch within the capacity of the machine, a separate index worm being required for each pitch. The cutters used are double ended, of the formed end mill type, the body of the cutter being ½ inch in diameter. They may be held in the milling machine spindle by any collet adapted for holding ½-inch straight-shanked cutters. By using cutters of different shapes, different contours of chamfering may be given to the work.

The machine is well made. The worm is of hardened steel, as is also the work spindle and the cam with its cam roll. Means are provided for taking up any looseness endwise in the worm due to wear, and similar provision is made for taking up wear on the work slide. A gear guard is furnished to cover the intermediate and the worm-driving gears, thus protecting the operator from injury.

The capacity of the attachment is for work from 2 inches to 9½ inches pitch diameter, and from 4 to 10 diametral pitch. When run at the proper speed, about 12 teeth per minute can be chamfered or rounded. The attachment weighs about 80 pounds. A counter-shaft is provided having tight and loose pulleys and an idler pulley with an adjustable counterweight. The counter-shaft weighs about 90 pounds. The price of the machine includes the counter-shaft, clamping bolts, one indexing worm, one cam, two double end cutters, and bushings for locating and holding a gear of one size.

BETHLEHEM STEAM DROP HAMMER.

The Bethlehem Steel Co., South Bethlehem, Pa., has been for some time engaged in the drop forging business, making forgings from all grades of iron and steel to which the process is applicable. In fitting up the plant, it was at first equipped with board drop hammers of the best design and construction the firm was able to find at the time. These failed so seriously

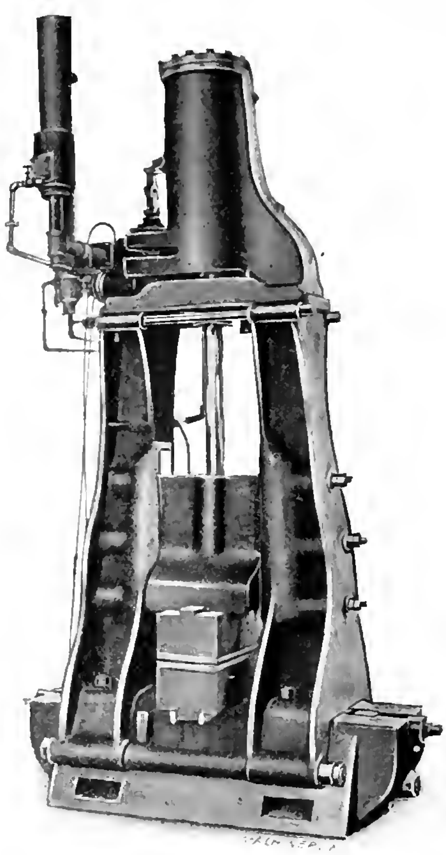


Fig. 1. The Bethlehem Steam Drop Hammer.

and often on ordinary work, involving expensive repairs and delays, that it was finally decided that all future additions to the equipment should be of the type in which the drop is raised by the pressure of steam beneath the piston.

It had been considered in the first place that the steam hammer was more efficient and economical than the board

hammer, but experience with it had shown that it developed serious weak points in service, when of the usual construction. The Bethlehem Steel Co. therefore decided to design a hammer in which the various defects were eliminated, so far as possible, by skillful design and careful construction. The result of this decision is the steam drop hammer we herewith illustrate and describe.

Experience has shown that the steam drop hammer, as ordinarily made, has too small a ratio between the weights of the drop and of the base to permit the most efficient work. This is remedied by increasing the weight of the drop. To prevent the base from cracking under the greater strain thus put upon it, it is made of a steel casting instead of cast iron, as was the previous practice. Another difficulty met with is the rapid wearing of the bearing surface of the housings on the base. This is due largely to the abrasive action of the scale, which makes it impossible to keep the dies properly matched. These difficulties have been overcome by providing ample bearing surfaces, and designing the parts so as to prevent the lodging of scale and the wear consequent thereon.

The severe side thrust arising from forging out of the center of the dies, brings about very serious difficulties, such as the breaking of the guides and uprights, and the consequent bending or breaking of the piston-rod. To overcome these difficulties, the uprights have been tied together to prevent spreading, and to distribute the strains so as to minimize any eccentric action on the part of the drop, thus extending materially the life of the piston-rod. In addition, the substitution of steel castings in place of iron for the uprights has obviated all the danger of the breaking of these parts.

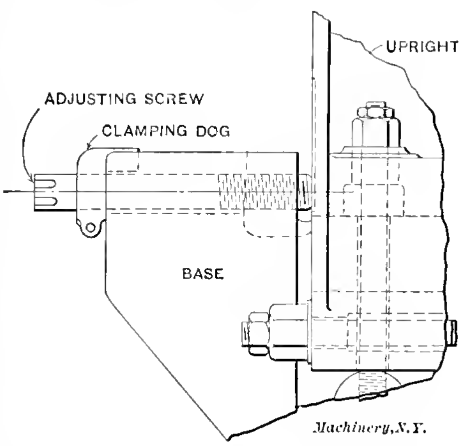


Fig. 2. Adjustment of the Uprights on the Base, for Centering the Dies.

In the ordinary steam drop, no provision is made for adjusting the dies in any other way than by the keys in the lower member. The screw and nut adjustment used in the board drop is short-lived, the screw either breaking or becoming fast in the nut. To replace these broken parts, it has been hitherto necessary to dismantle the hammer, an operation consuming from 1 to 3 days. On the Bethlehem steam hammer, as is shown in detail in Fig. 2, the screw and nut are made exceptionally heavy, and are so placed as to facilitate their renewal and the substitution of new ones in case of necessity—an operation requiring less than half an hour. The aligning of the dies, as may be seen, is effected by moving the whole frame-work of the hammer on the bed one way or the other, by operating the screws at the ends of the bed. These screws are locked by the dogs clamped to them, whose tails enter slots provided for them in the base.

The builders are prepared to furnish these hammers in any size from 500 to 10,000 pounds inclusive.

PEASE AUTOMATIC ELECTRIC BLUE-PRINT MACHINE.

The device illustrated in Figs. 1 and 2 is made by the C. F. Pease Blue-Print Machinery & Supply Co., 22 Fifth Avenue, Chicago, Ill. It consists essentially of a blue-print frame, mounted on pivots between uprights, and provided with mechanism for traversing at a uniform and adjustable speed across its face, an electric light of the Cooper-Hewitt type.

The printing frame is made of carefully selected hard wood, well finished and reinforced. The frame on which it is mounted is of iron, and is provided with a spring stop to hold the frame in the operating position shown in Fig. 1, or the position for removing or inserting the prints or tracings shown in Fig. 2. The lamp used, as is well known, consists of a hermetically-sealed glass tube containing a quantity of

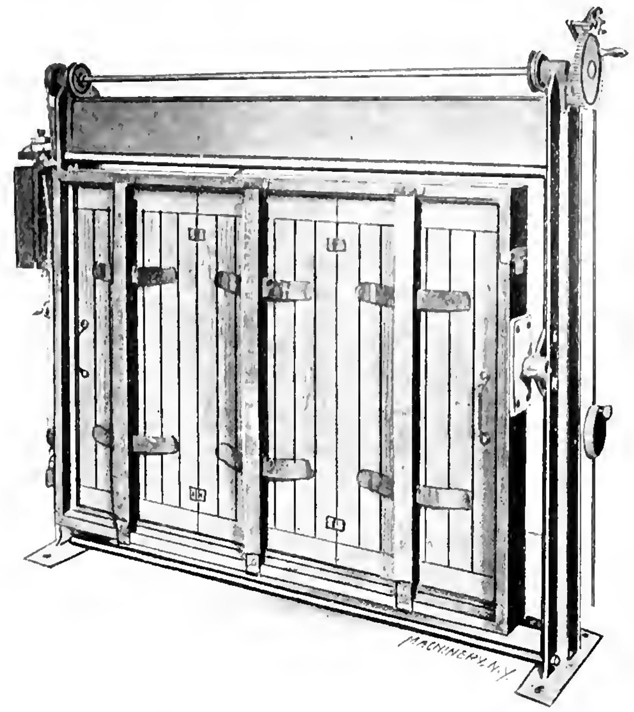


Fig. 1. Blue-printing Machine using Cooper-Hewitt Lamp, whose Descent is regulated by a Pendulum and Escapement.

mercury. As may be seen, the tube is placed in a slightly tilted position, with the mercury at the lower end. As soon as the current is established by throwing on the main switch, the tube is tilted by mechanical means provided for that purpose so that the mercury flows in an unbroken stream to the other end. When this has been done the tube becomes luminous throughout its length, and is then allowed to resume its normal position, as shown in Fig. 2.

The mechanism for traversing the tube across the face of the print comprises an escapement, regulated by a pendulum

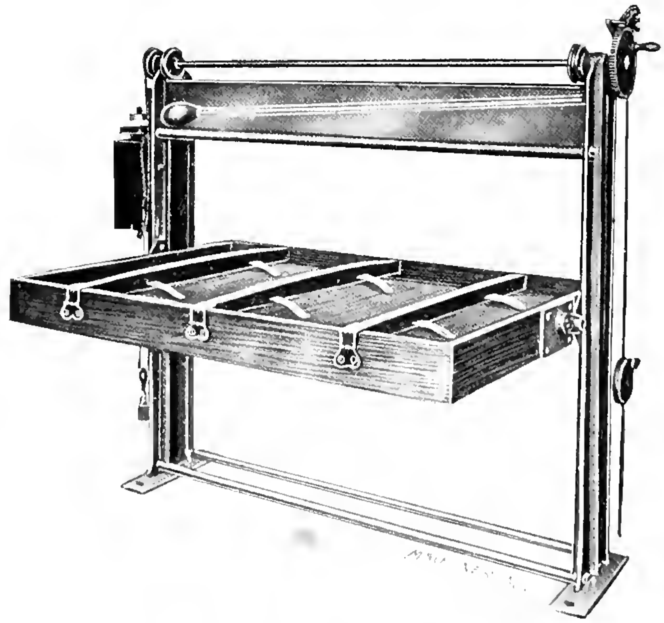


Fig. 2. The Printing Frame swung down to permit Insertion of Tracing and Paper.

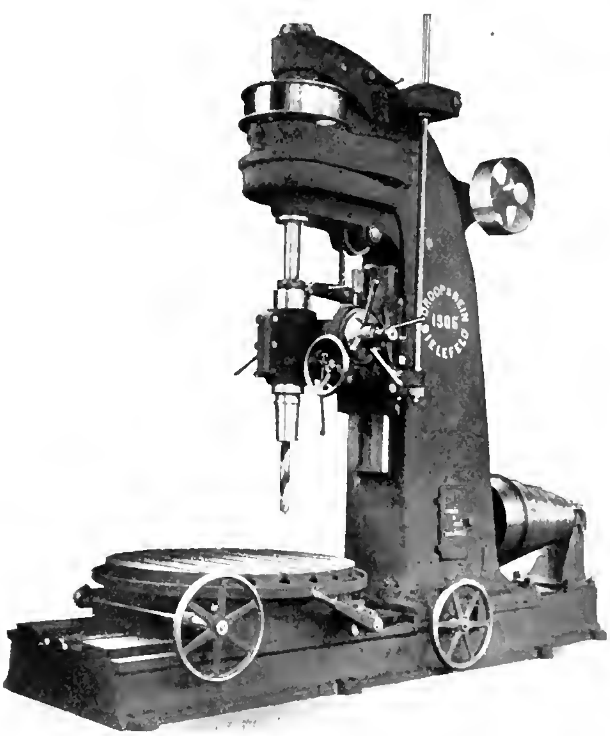
with an adjustable weight, which may be set to give the rapidity of printing required by the quality of the paper used, and the transparency of the tracing. The lamp is mounted in a well-ventilated reflecting box, not shown in the cut, guided between uprights on the main frame of the machine, and supported by cables attached to the speed controlling shaft at the top.

A number of advantages are claimed for this device. The machine is highly efficient as compared with those using arc lights. This is due to the use of the Cooper-Hewitt lamp, which gives about double the amount of light obtained from an arc lamp consuming the same amount of current. The amount of heat thrown off is also so small that the lamp may be placed close to the paper, so that the printing efficiency is much greater than with an arc lamp placed as far from the work as is necessary in a cylinder machine. The Cooper-Hewitt light is also very rich in chemical qualities, making it an ideal one for this use, since practically all the energy is transformed into actinic rays. It requires only 3½ amperes at 110 volts to print at the same speed as an arc lamp in a cylinder printer, consuming 15 amperes at the same voltage. A life of 2,000 hours is guaranteed for the tubes, and single tubes have been known to last twice this length of time. The cost of operating the machine is less than two cents per hour at the rate of five cents per kilowatt hour. The simplicity of construction and operation permits the machine to be handled by inexperienced help, an ordinary office boy being capable of running it to good advantage.

Three sizes of this machine are made for frames 20 x 24, 30 x 42, and 36 x 48 inches, respectively. They occupy floor space 12 inches in width, varying from 30 to 60 inches in length for different sizes. They are considerably less expensive than the cylinder type machines.

DROOP & REIN HIGH SPEED DRILL PRESS.

We show herewith an engraving of a businesslike-looking high speed drill press, made by Droop & Rein, Bielefeld, Germany. The frame of the machine is built in the form of a hollow housing, giving the tool the stiffness and strength necessary for drilling holes of large diameter with high speed drills. To allow easy adjustment of the large work for which the machine is intended, the work table may be adjusted lengthwise or rotated to bring the work into position for drilling.



A German Machine for Heavy Drilling with High Speed Steels.

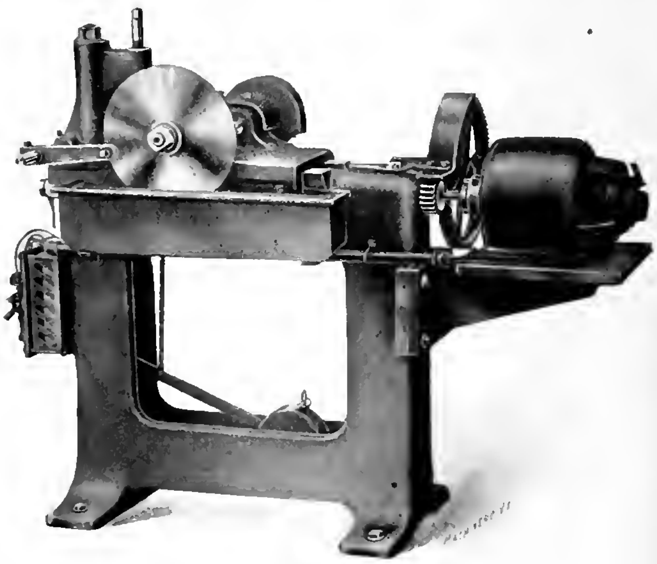
As may be seen, power is conveyed to the spindle by an endless belt, running from the driving cone pulley at the rear end of the machine near the floor, over idlers to the pulley on the spindle. This insures smooth running at the highest speeds. The back gearing is located on the spindle below the driving pulley. It is entirely encased so that it may be run in an oil bath. The maximum spindle speed is 670 revolutions per minute, and ten changes are provided for. All the driving gears are made of steel or phosphor bronze. The diameter of the spindle journal in the sleeve is 4 inches. It is hardened and ground, and is balanced, together with the sleeve, in the usual way. The feed mechanism is driven from one of the guide pulleys. It has eight changes and an automatic stop.

The table may be rotated on the saddle by which it is carried, and may be adjusted in and out on the bed as well. These adjustments may be driven by power, for rapid setting, but can be made by hand as well for minute adjustment. The table is about 4 feet 7 inches in diameter. The distance from the center of the spindle to the column is 2 feet 1⅛ inch. The whole machine weighs about 28,600 pounds.

As an example of its capacity in actual service (not for short trials) a large German manufacturer, who was the first user of this machine, has made the following record in everyday work, day after day, using high speed drills; 12 holes, 1⅞ inch each in diameter, were drilled in wrought iron flanges, 2 15/16 inches thick, in one hour—that is to say, at the rate of 5 minutes per hole, including the time necessary for setting up the work.

BURR MOTOR-DRIVEN COLD SAW FOR SMALL WORK.

The photograph shows a new motor-driven cold saw, built by John T. Burr & Sons, 34 South 6th St., Brooklyn, N. Y. It is adapted to the cutting off of stock, pipe, etc., up to 3½ inches in diameter. The saw-blade is 10 inches in diameter,



Burr Cold Saw arranged for Motor Drive.

and is fed by gravity, the pressure of the feed being adjustable by altering the position of the weight on the lever shown. The driving mechanism consists of a steel worm-gear, hobbed worm and steel pinions.

When arranged as shown, the machine is driven by a ½ horse-power constant speed motor, running at about 2,000 revolutions a minute. It is connected to the worm shaft by a rawhide pinion and a cut iron spur gear. All the gears are covered, and the starting box and switch are conveniently placed at the rear of the machine.

When desired, the makers will arrange the saw to be driven by an alternating motor.

GORTON CUTTING-OFF MACHINE.

Among the carefully designed and ingeniously constructed machines we are continually describing and illustrating in these columns, we once in a while have the opportunity to describe one which shows such striking originality of conception as to at once arrest the attention. This is the case with the cutting-off saw we here illustrate, built by the Geo. Gorton Machine Co. of Racine, Wis. The idea of turning the cutting-off saw "inside out" presents such obvious advantages that it is strange it has not been tried before. Very possibly it has been thought of; it would be strange if it has not been. But Mr. Gorton seems to have been among the first to think of it, and certainly the first to work the idea out in practical shape.

The difficulties met with in the design and operation of metal saws for heavy duty are well known. Fig. 2 shows the

conditions quite graphically. The saw is usually driven from a spur gear mounted on a saw arbor, which is of necessity very much smaller in diameter than the saw, to allow the latter to take a reasonable depth of cut. In the case shown, a not unreasonable one, the radius of the driving gear at the pitch line is only one-third of the radius on which the teeth

Fig. 1. The Gorton Cutting-off Machine, using Saw with Internal Teeth.

of the saw are cutting. This means that the driving power is lamentably weak, so that the consequent excessive vibration and chatter have established a limit in saw efficiency beyond which it has seemed impossible to pass. Various ingenious schemes have been tried for applying the power nearer the periphery of the blade, but in none of these, so far as we know, has it been possible to apply the power on a circle of greater diameter than that in which the saw blades revolve.

The mechanism by which this is made possible, is shown in Fig. 3. The saw, having inserted teeth of high speed steel, is mounted on a revolving ring and supported by a swinging frame, pivoted about the pinion shaft by which the ring and its attached saw are driven. The ring is journaled on its outside diameter in the swinging frame which carries it. The stock is passed through the center hole of the saw, and the saw is fed through the stock by swinging it about the center of the driving pinion, the frame for this purpose being provided with a 90-degree segment of a worm-gear, as shown, which engages the feed-worm below it. The ability to obtain a smooth and powerful drive by this means, and a smooth and powerful feed as well, will be readily appreciated.

Figs. 1, 4 and 5 show how the scheme of Fig. 3 has been applied in a commercial design. The frame of the machine, as may be seen, is of hollow, box-like construction, and exceedingly rigid. The main driving pulley (which is 14 inches in diameter by 10 inches face, and runs at 350 revolutions per minute) is connected by spur gearing with the driving pinion shaft, which is geared to the saw-carrying ring as described, and shown in Fig. 3. The swinging frame in which the ring and saw are mounted is shown raised in Fig. 4, and in working position in Fig. 1. The fact that this frame is hung on trunnions from above, avoids the possibility of having its bearings injured by grit and scale. This is an important detail in the construction of the machine, as is witnessed to by the badly cut ways frequently found on the usual types of sawing machines.

The driving pulley shaft is connected with the feed shaft at the rear of the machine, near the base, by a belt passing over a pair of six-step cones. These give six feeds in geometrical progression, which, on the 6-inch machine shown, will sever a 6-inch bar in from $1\frac{1}{4}$ to $5\frac{1}{2}$ minutes. As may be seen best in Fig. 5, this feed shaft is connected by worm-gearing in the enclosed casing shown, to a hollow shaft to which the feed worm is keyed. This shaft comes through to the front of the machine as may be seen in Figs. 1 and 4, where it may be operated by the large hand-wheel shown. The small hand-wheel controls a push-rod, which passes through the center of the hollow shaft and operates a clutch by which the worm-gear at the back of the machine is connected with the feed worm shaft. An automatic feed release is provided.

A geared lubricating pump is provided, with all the necessary piping, for conveying water or special lubricant to the cutting point. A generous reservoir is furnished by the base of the machine. An opening is provided at the rear (see Fig. 5) for the removal of the chips which settle into the chute shown, which is provided with a screen bottom, through which the lubricant drains off, while the chips slide down to the outside pan provided for them. This view also shows the adjustable gage, which may be used when desired, or swung

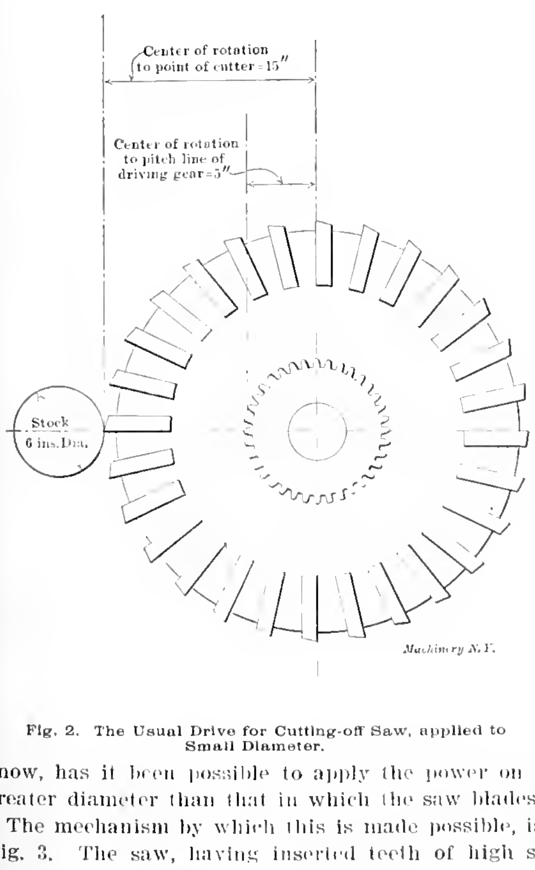


Fig. 2. The Usual Drive for Cutting-off Saw, applied to Small Diameter.

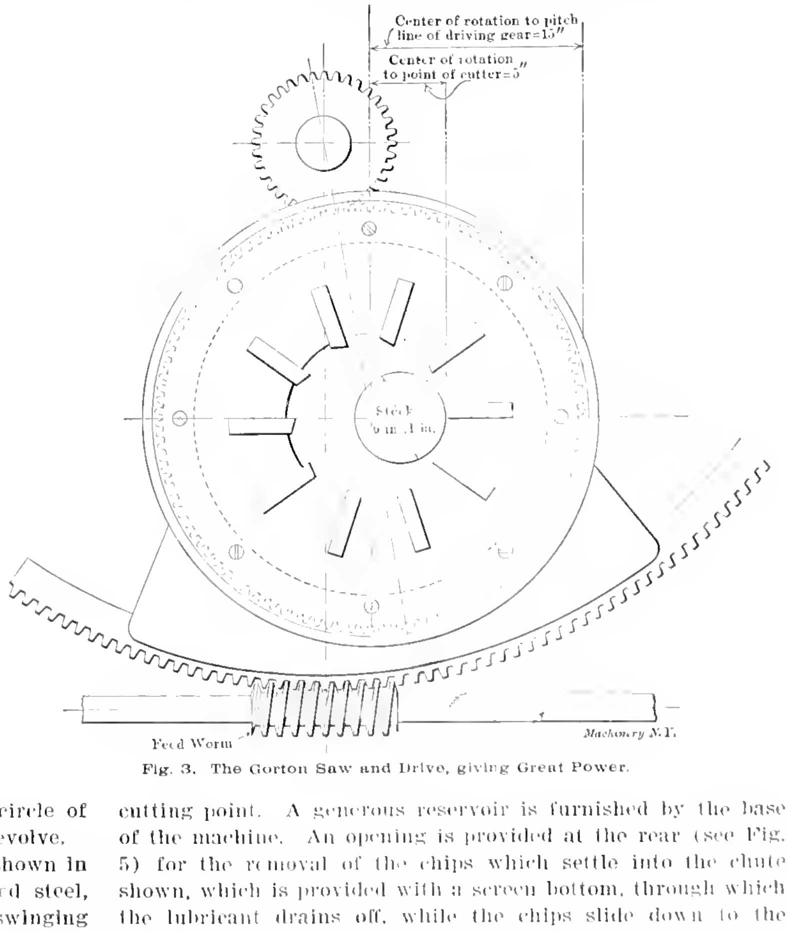


Fig. 3. The Gorton Saw and Drive, giving Great Power.

out of the way when not required. The rear stock support, as shown, enters the saw-driving ring close to the blade. Stock supports are furnished when desired, provided with rollers to enable heavy bar stock to be easily inserted and adjusted.

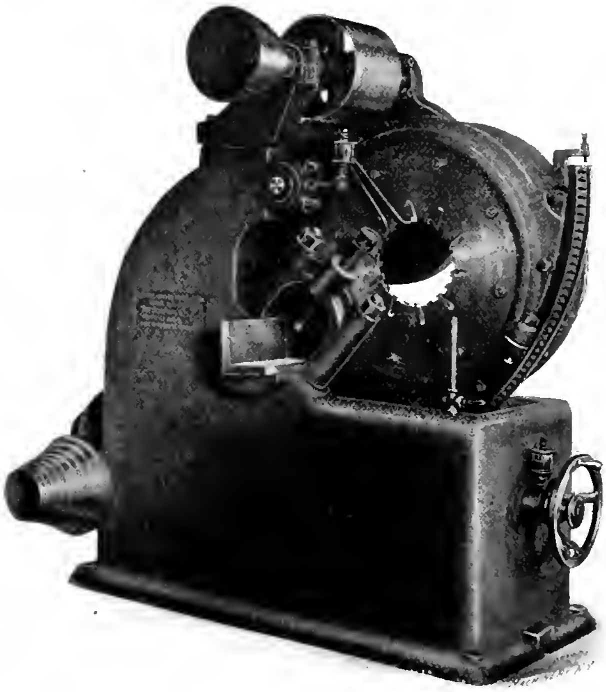


Fig. 4. The Machine with the Saw Frame Raised.

Special effort has been made to produce a machine capable of hard service through a long life, and one that it would be safe to trust to the care of unskilled operators. The gears are of generous proportions, and are all cut from the solid. The main driving pinion is a steel forging, formed integrally with the shaft. All the bearings either run in oil, are ring oiling, or are provided with sight-feed lubricators.

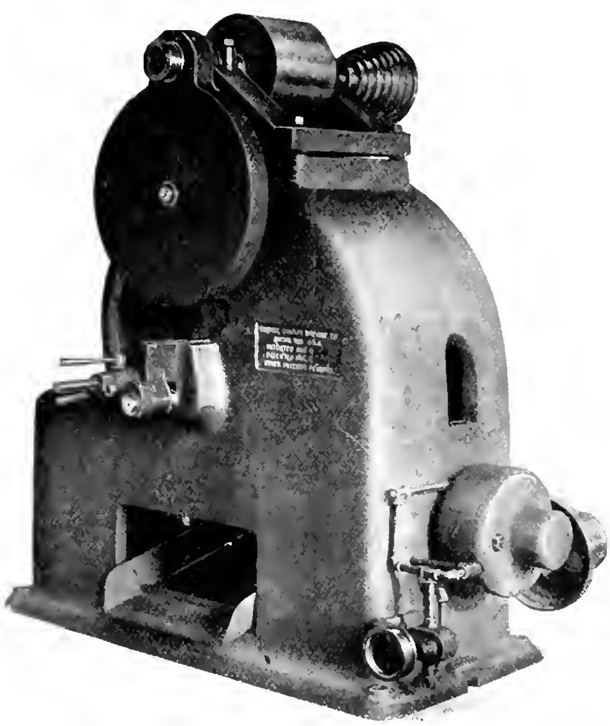


Fig. 5. Rear View of Machine, showing Feed Works, Chip Chute, Etc.

All these bearings are grit proof, and all the gears are fully enclosed. The feed worm is of generous size and runs continuously in oil.

Summarizing the advantages of this construction, we may say that the drive is from four to six times as powerful as on other machines of similar size; the feed is applied in a more effective manner, having as it does a 2 to 1 leverage; the saw blade works to better advantage, being supported around its entire periphery, so that it cannot buckle or "snake"; the machine is dust and grit proof throughout, and designed for operation by unskilled labor; and vibration and chattering is eliminated so that high saw speeds and heavy feeds are obtained.

We show an example of the work of the machine in Fig. 6. This shows a section cut from a 6-inch bar of open-hearth steel, with the saw feeding at the rate of 4 inches per minute, severing the 6-inch bar in a little less than 1½ minute. While doing this, it is said that the machine was entirely free from the slightest vibration. This was done on the machine we illustrate, which weighs about 7,000 pounds. The saw teeth cut at about 75 feet per minute, and were flooded with a compound of water, lard oil, soda, and soap. The power required for this maximum output is about 18 horse-power.

While this machine is a new one so far as being placed on the market is concerned, the idea is not a new one with Mr. Gorton, the designer; the main features of the machine have been a pet hobby with him for over twenty years. It has only been possible, however, to practically apply the principle in the last few years, since the advent of the high-speed steels, because the solid saw blades of the old type could be driven to their full capacity by the driving mechanism formerly in use.

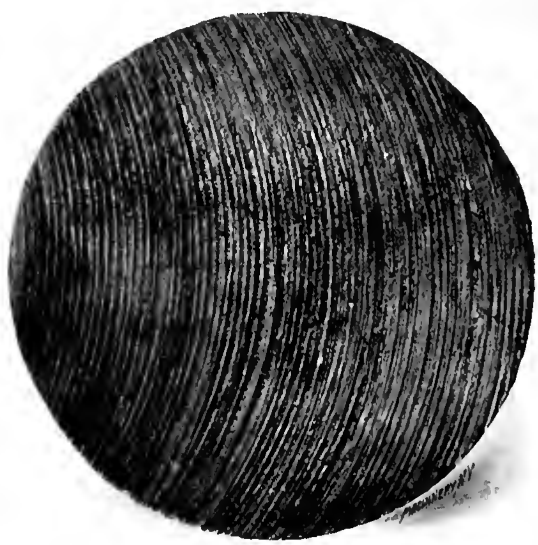


Fig. 6. This Section of 6-inch Open-hearth Steel was cut off in 1 1-2 minute, 75 feet per minute Cutting Speed.

The new steels plainly taxed the old design beyond its strength, and offered an opportunity for the practical application of the idea of an internal cutting-off saw.

In addition to the 6-inch size shown, three other sizes are in process of construction, these being for 4-inch, 9-inch, and 12½-inch stock, respectively. These machines weigh from 5,000 to 25,000 pounds each. They can be furnished either belt driven, or direct connected with an electric motor.

* * *

We have mentioned in the columns of MACHINERY, at various times, the proposed schemes for internal waterways in this country. Great as has been our railway development, we have, to a great extent, neglected the development of canals and inland waterways, which in Europe play so great a part in commerce and industry, supplementing the railways for such classes of freight as can be carried to advantage on the canals. The Inland Waterways Commission has now made a proposal to construct a vast system of canals, and to try to improve certain river channels, so that large craft may be able to use them, and an effort will be made to secure from the present Congress the necessary legislation for beginning the work. The most important of these proposals seems to be the construction of a deep waterway between the Great Lakes and the Gulf, but a number of other projects are also under consideration. It is likely that some of the railroads will oppose this work, but in view of the difficulty of the railroads in handling the traffic of the country in prosperous times, it does not seem reasonable that there should be any objections from these quarters.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

Though in some industries in this country a comparative depression is evident, the trade of the country as a whole would appear in a more healthy state than that of any other. However, in the engineering and machine building industries a great many discharges are taking place. It is not that so many less machines are employed than during last year, but in place of being worked night and day, they are working day shifts or moderate overtime only. From one large machine building firm in Nottingham about 800 men have been discharged during the last three months, but for a year or two previously such continuous pressure on the productive capacity had never before been experienced, the whole plant having been working night and day. Then again, the question of unemployment generally is much more closely looked into than formerly. The unemployed making their plight known in no uncertain fashion, so that a depression or slackness which would have been taken as a matter of course in former periods, now, at once, receives recognition, and pertinent inquiries are made as to the causes leading up to it, and the best remedy to be employed. Of course such a state of things gives plenty of opportunity for divergence of views regarding tariff "reform," free trade, etc. At the moment, in the case of the Amalgamated Society of Engineers—the leading trades union in its line—the number of members receiving out-of-work pay is 4,863, and in the Boiler Makers and Iron Shipbuilders' Society 5,916 are similarly placed, a proportion of the membership giving cause for apprehension. However, the outlook is not altogether depressing. It is the contrast of ordinary, or somewhat restricted, working with what was perhaps a somewhat unhealthy pressure which makes things appear worse than the facts warrant.

Speaking on January 25, after inspecting the Cardiff Docks and the Great Dowlais Ironworks, Mr. Lloyd-George (president of the Board of Trade) addressing the members of the Exchange, said "There are just a few indications that the ebb tide in trade is beginning," but his opinion, based on the investigations of the best intelligence department in the empire—the Board of Trade—was, that they were not going to have a bad ebb tide. They had seen times of great prosperity. British exports last year attained dimensions of which neither this country nor any other had ever before seen the like. They must not forget that the present depression started in America, it was being felt in Germany, "and," he added, "our turn will possibly come, but it is not going to be a bad one from what I hear."

Results of New Patent Act.

Again, the new patent act, though it only came into force on January 1, is already bearing fruit. According to Mr. Ivan Levenstein, a prominent Manchester chemical manufacturer who took an active part in the agitation leading to the new act, a number of foreign patentees have been, and are, negotiating with British manufacturers to carry on, in the United Kingdom, their British patents, whilst others have taken land for the purpose of erecting works in order to work their British monopoly. As an instance may be mentioned the Hœchst Farbwerke, working in conjunction with Cassella & Co. The combined capital is valued at $40,000,000. They have secured land near Chester for a large works to be employed in the manufacture of synthetic indigo. Another concern, the Elberfeld Farbenfabriken, together with the Badische Aniline and Soda Works and the Berlin Co., with a capital of $65,000,000, are about to erect works, probably near Manchester. A well-known American firm holding British patents for the manufacture of safety razors, hitherto made solely in the States, is reported to have secured land in Sheffield, and expect to employ about 500 men. According to Mr. Levenstein, "Scores of the foreign manufacturers holding British patents which they have previously worked solely abroad, are following their example, and there is not the slightest doubt that the new act will find additional employment for our people, the operative classes, highly trained engineers, and chemists, and give a new impetus to British enterprise. This will become more and more apparent as time goes on. Fortunately, the act, unlike preceding ones, is so definitely and clearly worded especially is this the case with Section 27, which deals with the revocation of patents worked outside the United Kingdom that there are no loopholes to afford escape from it. Surely Mr. Lloyd-George must feel proud of having passed such a far-reaching measure, an act that will confer greater benefits on our industrial welfare than any act passed during the last fifty years."

Labor Union Topics.

For some little time Mr. Lloyd-George has appeared all-pervading, in the facilitation of trading operations, and, more recently, in the influence he has exercised in the settlement of industrial disputes of unprecedented magnitude. Following on the railway men's dispute came that of the cotton spinners respecting revisions of piece-work price lists, which involved most complicated details and numerous side issues. A very reasonable solution was arrived at through Mr. Lloyd-George's direct intervention, and replying to the thanks accorded him he congratulated both parties very heartily on the splendid good sense and good feeling they had shown. He thought it was a real victory for British industry, and he felt that as long as British industry was conducted on both sides by men who were capable of settling disputes in that way, they had nothing to fear from rivals in any part of the world. Hardly was this particular dispute settled, when another broke out respecting the wages of female labor in another section of the trade—ring spinning. Though the number of workpeople primarily affected was small, a lock-out of the whole number employed which would, directly and indirectly, throw 250,000 people out of employment, was threatened. Finally, an eleventh-hour dramatic settlement was reached late in the afternoon of January 24, the day previous to the expiration of the lock-out notices.

Ship-building Notes.

Though last year closed unpropitiously as regards ship-building, the aggregate tonnage for the year was phenomenal. On the Clyde 509 ships were launched of a total tonnage of 620,000 tons as against 372 ships of 599,000 tons in 1906. Eleven years ago the highest total was 400,000 tons, and six years ago, 500,000 tons. Yarrows', the well-known torpedo vessel builders, are now practically removed from London to the Clyde. After one or two torpedo boats, now almost completed, are handed over, all business will cease at the old works. Some reduction in the rate of warship building was anticipated last year, but the new German program has necessitated a revision of the British scheme, so that busier times than the present are anticipated during the year in the warship building centers. Refrigerating machinery will, in the future, be much more extensively employed than in the past for cooling ammunition chambers in the navy, recent explosions in the French navy emphasizing its importance.

The manner in which the United States engineering corps is proceeding with the construction of the Panama Canal occasions commendatory notice over here. The fact that the United States government eventually lost patience with the propositions placed before it by commercial interests, and found it necessary to directly proceed with the work, appears rather a "nasty jar" for private enterprise, which is usually understood to be ahead of government managed concerns. The American consul at Sheffield reports a big decrease in the exports of special steel, for mining purposes, to the United States. For the last quarter in 1907, only $109,344 worth of this steel was exported to that market as against $736,970 the previous quarter, $810,895 six months before, and $783,075 a year previously.

Condition of Textile Machinery Trade.

The textile machinists still make a very good show in the matter of exports, the returns showing continued increases. For November the figures are $3,572,890 as against $3,057,105 for the same period in 1906. For the first eleven months of 1907 the figures were $36,723,665, against $30,396,505 in the corresponding months of the previous year. The increases have been mainly in spinning, as distinct from weaving machinery. It does not pass unnoticed that the export of machinery increases the competition to be faced by British

textile manufacturers, but the machinists, of course, cannot help that, and it is significant that the present year has been a record one for Lancashire spinners of American cotton, the profits being nearly double those of 1906. Taking the returns of one hundred mills, a share capital of $18,613,900 has earned no less than 35½ per cent net profit, an increase of 18 per cent. The total capital employed includes $11,887,330 loaned capital in mortgages, debentures, and short date loans, and taking it that 4 per cent has been paid on these loans, the total profit on the combined share and loan capital works out at about 23 per cent. These returns do not apply solely to new mills, but include some which have been in existence over thirty years. With increasing production and uncertainties in the supply of raw material and labor disputes, such unusually good returns are not anticipated during the coming year. While touching on these cotton trade matters—which have a more intimate connection with engineering and machine building prospects than is generally recognized—an important inquiry is being made by the British government as to the pros and cons of the practice of "steaming" or introduction of artificial humidity in weaving sheds, as regards its effects on the health of workpeople. The commission is very representative, and inclndes Sir Hamilton Freer-Smith, superintendent inspector of factories; Mr. J. D. Shackleton, M. P., and Mr. Joseph Cross, on behalf of the workpeople; Mr. Henry Higson and Mr. J. Roberts, for the employers, and Prof. Lorraine Smith, M.D., professor of pathology at Victoria University.

Machine Tools.

The use of disk grinding machines, mostly of British make, is spreading in this country, though the tendency seems in the direction of an increase in the range of quality, capacity, and adaptability. Many of the more expensive machines are fitted with accurate attachments, but the requirements of users who appreciate the advantages of this method of working, but have no need for continuous working of a machine or the acme of refinement, are now also receiving attention, and a number of reasonably well-made and durable machines are now obtainable at a very moderate cost. Tool grinding emery wheel machines are also developing on much the same lines. Arrangements for supplying the necessary water spray in a convenient manner, and also the provision of cheap and easily handled wheel truers, being well attended to. Richard Cremer, Aire Road, Leeds, is now supplying a handy range of clamps and divided machine vices, etc., of varying designs from those for holding constructional steel work whilst being drilled, etc., and those with one jaw of the clamp having a semi-globular grip enabling it to clamp work of varying tapers, to cheap, quick acting clamps for carpenters and cabinetmakers' work. Very satisfactory sales are reported.

In Germany, the Union of Iron and Steel Industries, in conference, mentions the possibility of the smaller industries syndicating in defense, in consequence of the action of large industrial syndicates. It was therefore necessary to bring about an agreement in time. Also, "perhaps the financial power and the intellectual training of Germany had been overestimated." In conclusion, the extent to which the British industrial classes, notwithstanding occasional accusations of improvidence, assure against sickness, and death, may be mentioned. In a recent government report, one society alone, the Manchester Unity of Odd Fellows, is shown to have an available capital of $66,851,345, and a number of others are proportionately well placed, and in the case of other societies which, through lack of actual data at the time of their inception, have been rather severely tested for some years, are now making very good progress in the right direction.

Importance of Machine Tool Business being More Recognized by European Engineering Journals.

A tendency recently more noticeable over here is the increasing attention given in the engineering journals to machine tool matters. It is evidently being grasped that improvements in design and manipulation are now made so rapidly that special effort is needed to chronicle them in such a form and with such promptitude as will make them of value to readers. JAMES VOSE.

Manchester, England, February 10, 1908.

MISCELLANEOUS FOREIGN NOTES.

EXHIBITION OF APPLICATIONS OF ELECTRICITY IN MARSEILLES.—An exhibition devoted to the application of electricity in the arts and industries will take place next summer in Marseilles, France, commencing on April 19, and closing on October 31. The exhibition is intended to be of international scope. Applications for sites should be sent to, and further information may be had from, the Commissariat-General, Boulevard Louis Salvator, 52, Marseilles, France.

AUTOMOBILE INDUSTRY IN GERMANY.—We have previously referred to the fact that the present reaction in the automobile industry has not affected German manufacturers as badly as those of the other three great industrial nations. One reason for this appears to be that a large proportion of the motor car builders in Germany are also engaged in some other line of manufacture, such as that of bicycles, sewing machines, typewriters, or even machine tools, and thus are able to concentrate their activities on their other industries when one declines.

AUSTRIAN TRADE CONDITIONS.—While it is stated that the condition of the iron and steel and allied industries in Austria is not on as favorable a basis as a year ago, there does not seem, from present reports, to be any serious cause for complaints. There are delays in deliveries, charged partly to scarcity of labor, but that is rather a sign of continued prosperity than the reverse. The true state of affairs may be that the financial flurry in the United States reacted throughout the world, causing a temporary depression, but not in any way unsettling business conditions.

DEPRESSION IN THE BRITISH SHIPBUILDING TRADE.—Continued depression in the shipbuilding trade in the northern portion of Great Britain is reported. Employers have been forced to issue the usual three months' notice that demands a reduction in wages of 5 per cent on piece work, and 2 shillings a week on time rates, this latter also being equivalent to a reduction of about 5 per cent, or perhaps a somewhat greater amount, of the wages paid. It is stated that the ship yards at present have plenty of work on hand, but that the orders for new work are not coming in to such an extent as to make the future prospects as bright as would be desirable.

THE JAPANESE EXHIBITION OF 1912.—The Exhibition Committee of what is termed the Grand Exhibition of Japan, which will be opened in Tokio, on April 1, 1912, has given out a statement in regard to the general rules governing the exposition. Foreign exhibits belonging to the five departments of education, science, machinery, electricity, and manufactured goods, will be allotted space in the exhibition buildings, specially erected for these departments. For exhibits other than those above mentioned, any nation may have a separate building, erected at its own expense, but no charge will be made for the space allotted for such buildings. Machines and articles imported from foreign countries for the sole purpose of exhibition will be admitted free of duty. It is also intended to afford special protection to all inventions, designs and models of foreign exhibits, and a bill to that effect will be introduced at the next session of the Japanese Diet. The site of the exhibition covers about 292 acres.

MACHINE TOOL TRADE IN GERMANY AND ENGLAND.—As time progresses it appears that the same reaction as has taken place in the steel industry in this country has also made itself apparent in Germany. There is a stringency of money, which is rather unusual, tending to prohibit the entering into new enterprises, and preventing the ordinary commerce from being carried on as usual. The conditions in the machine tool trade, itself, however, seem promising. In England, also, the latest information indicates steady conditions, and the outlook for new business does not seem unsatisfactory. Extensions of works are still carried on to a great extent, and the modernizing of shop equipment creates a great demand for machine tools. As the home market in this country is not placing as heavy demands on our manufacturers as usual, it is likely that they will be able to secure for themselves a share of this trade in Great Britain.

THE AUTOMOBILE INDUSTRY ABROAD.—Recent reports indicate that the automobile industry in Great Britain and Germany is placed on firm ground, while the manufacture of motor cars

in France is not in the same flourishing state as in the years past. The explanation of this condition, partly at least, is doubtless to be found in the fact that many French firms have devoted themselves exclusively to expensive pleasure vehicles, the demand for which is rapidly waning, while the German, and, particularly, the English makers have devoted themselves also to the development of cars for industrial purposes, and cheaper cars for everyday use in business, for which latter classes of motor cars the demand is increasing. The exports of British cars is steadily increasing. During the first eight months of this year these exports amounted to a value of $2,380,000 as compared with $1,200,000 for the same period the preceding year. At the same time imports of foreign cars to Great Britain have been decidedly smaller than last year. In France, while an increase of production is reported, several failures of automobile building firms are also on record. Thus, the Société Automoto in Saint Etienne, Loire, with a capital stock of 1,700,000 francs, has ceased payments, and a receiver has been appointed for the Pilain firm in Lyons, which has a capital of 1,500,000 francs. The figures stating the extent of Germany's motor trade for the six months ending June 30, 1907, indicate that Germany is still importing a greater number of cars than it exports, the imports being valued at about $2,900,000, while the exports were valued only at about $1,800,000, or less than two-thirds of the imports. It is a significant fact, however, that one-third of the exports were industrial vehicles, which rather confirms one of our previously made assertions that Germany is placed on a firmer basis in the automobile trade on account of having devoted more energy to industrial vehicle than to pleasure cars.

* * *

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.

The National Society for the Promotion of Industrial Education held a three days' meeting at the Art Institute, Chicago, Ill., January 23-25. A public dinner was given at the Auditorium Hotel, January 23, of which Mr. Theodore W. Robinson, first vice-president of the Illinois Steel Co., was toastmaster. Papers on industrial education as an essential factor in our national prosperity, were presented by Dr. Chas. W. Elliott, president of Harvard University, and Mr. James W. Van Cleave, president of the National Association of Manufacturers, St. Louis, Mo. Dr. Pritchett spoke on the aims of the National Society for the Promotion of Industrial Education. At the public meetings of January 24 and 25 a number of notable papers were presented on various phases of industrial education, apprenticeship, etc. Among these were "The Apprenticeship System as the means of Promoting Industrial Efficiency," by Carroll D. Wright, Worcester, Mass. The list of speakers included men and women prominent in industrial education, among whom were Mr. W. R. Warner, Cleveland, Ohio, of the Warner & Swasey Co.; Mr. James O'Connell, Washington, D. C., president of the International Association of Machinists; Mr. J. F. Deems, general superintendent motive power, New York Central lines; Mr. Leslie W. Miller, Philadelphia, Pa., principal Pennsylvania School of Industrial Art; Miss Jane Addams, of Hull House, Chicago, and many others whose names are prominently connected with industrial betterment.

* * *

THE VALUE OF A TREATISE AS AN ADVERTISING MEDIUM.

About eight years ago a series of articles on mechanical draft by Walter B. Snow was published in MACHINERY, which attracted wide attention. These articles were afterward published in book form by the B. F. Sturtevant Co. with the title "Mechanical Draft," for which a nominal price of $1.50 was charged. The price, however, was a device to prevent needless distribution to a class that could make no good use of such a work. It was distributed free to concerns, engineers and others legitimately interested in the subject of mechanical draft.

Mr. Snow, the author of the work, published an article in the November issue of *Selling Magazine*, in which he referred to the extraordinary advertising value of such a work. The work on mechanical draft treated the subject in a comprehensive manner, giving rules, tables, and formulas of much value to the engineering profession. The fact that the book is essentially an argument for mechanical draft does not necessarily detract from its value as a contribution to engineering literature. Engineers who received a copy were only too glad to make it a part of their engineering library, where it became a source of information and an educational influence in favor of the use of the fan as a substitute for the high brick chimney.

The hint is one that is worth taking to heart by manufacturing concerns who spend large sums on their advertising literature. It is not enough that the best cuts, finest paper and elegant press-work be used in advertising literature. If the literature does not contain something of permanent value it will not be retained by the recipient, unless it is made part of a catalogue file. There are catalogues, however, of very ordinary appearance, but containing valuable tables and data pertaining to the subject matter in general which are treasured and frequently referred to. There is undoubtedly a wide field for the expansion of this idea. Many lines of work could be represented by catalogues which would be in effect, condensed treatises of great value on the subjects represented. Such advertising matter is not ephemeral but becomes more and more valuable with the years.

* * *

A remarkable test of endurance of automobiles was begun February 12 when six automobiles left Times Square, New York, for Paris, France. The route is across the United States to San Francisco, thence by water to Valdez, Alaska, thence by land to Cape Prince of Wales *via* Nome, thence across Behring Strait to Siberia, thence by land to Paris. The total distance is about 22,000 miles. The cars entering the race were Thomas (American), De Dion (French), Moto-Bloc (French), Sizaire-Naudin (French), Zust (Italian), Protos (German). The Sizaire-Naudin car broke down twice in traveling the first 100 miles and withdrew from the race.

* * *

PERSONAL.

W. P. F. Ayer, who has represented the Walworth Mfg. Co., Boston, Mass., for many years in the South, has been appointed assistant secretary of the company.

H. H. Vreeland, president of the New York Railroad Club, and a well-known street railway man, was the guest of honor at a dinner given by the club at the Hoffman House, February 7.

Arthur W. Graham, of the Builders' Iron Foundry, Providence, R. I., sailed January 25 for an extended trip to Mediterranean ports and other places of interest in Southern and Western Europe.

Robert McF. Dolde, consulting engineer making a specialty of hydro-electric power equipment and transmission, formerly of San Francisco, California, has removed his office from Colorado Springs to No. 528 Majestic Bldg., Denver, Colorado.

L. R. Pomeroy, a well-known railway shop equipment engineer, has resigned his position with the General Electric Co., to become assistant to the president of the Safety Car Heating and Lighting Co. He will have charge of the sales department.

Lester G. French, formerly editor of MACHINERY, and later manager of the Technical Press, Brattleboro, Vt., has been made editor of the Proceedings of the American Society of Mechanical Engineers, New York. Mr. French assumed his new duties March 1.

Charles A. Baemeister has been appointed western representative of the Monarch Emery & Corundum Wheel Co., Camden, N. J., with headquarters in Chicago. Mr. Baemeister has had extensive experience in the grinding wheel business, and is well prepared to fill his new position.

C. F. Harding has been appointed head of the school of electrical engineering, Purdue University. Prof. Harding is a graduate of the Worcester Polytechnic Institute. He has a broad practical training as an engineering teacher, and special training along the line of high tension railway work. He was electrical engineer for the first electric railway built in New England. He was engineer for the D. & W. Fuse Co.,

Providence, R. I., publication manager for the Fort Wayne Electric Co., Fort Wayne, Ind., and engineering expert for Stone & Webster, Boston, Mass. He was also associate professor of electrical engineering of Cornell University. Prof. Harding will assume his new duties about March 1.

* * *

OBITUARY.

Daniel Shafer, for the past three years salesman and engineer with the Allis-Chalmers Co., died of pneumonia January 24 at Nashville, Tenn., aged 47. His home was in Wheeling, W. Va. Mr. Shafer was well known and had a wide circle of friends. Prior to taking his present position he was associated with Hooven-Owens-Rentschler Co., Hamilton, Ohio.

Orrin S. Werntz, treasurer of the National-Acme Mfg. Co., Cleveland, Ohio, since its organization, died February 6, 1908, after an illness of about one month. He was born in Canal Fulton, Ohio, and was thirty-two years old. His first position was with the National Screw & Tap Co., which he retained until the organization of the National-Acme Mfg. Co. He is survived by his wife, mother and young son.

* * *

NEW BOOKS AND PAMPHLETS.

ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF STEAM ENGINEERING TO THE SECRETARY OF THE NAVY FOR 1907. 56 pages, 6 x 9 inches. Published by the Navy Department, Washington, D. C.

A COMPARISON OF THE EFFECTS OF FREQUENCY ON THE LIGHT OF INCANDESCENT AND NERNST LAMPS. By Frederick W. Huels. 45 pages, 6 x 9 inches. Published by the University of Wisconsin as Bulletin 157. Price 25 cents.

TESTS OF PLAIN AND REINFORCED CONCRETE. Series of 1906. By Morton Owen Withey. 66 pages, 6 x 9 inches. Illustrated. Published by the University of Wisconsin, Madison, Wis., as Bulletin No. 175. Price 25 cents.

EXPERIMENTAL WORK CONDUCTED IN THE CHEMICAL LABORATORY OF THE UNITED STATES FUEL TESTING PLANT, St. Louis, Mo., January 1, 1905, to July 31, 1906. By N. W. Lord. 52 pages, 6 x 9 inches. Published by the U. S. Government, Washington, D. C., Department of Interior, U. S. Geological Survey.

This is Bulletin 323 and is devoted to an account of experimental work conducted on coals.

INVESTIGATION OF CENTRIFUGAL PUMPS. By Clinton Brown. 140 pages, 6 x 9 inches. Published by the University of Wisconsin as Bulletin 173. Price 50 cents.

This bulletin is devoted to a discussion of the theory of the centrifugal pump, and a record of tests of a 6-inch vertical centrifugal pump. It includes a description of the pump and impellers, general method of making observations, calibration of electrical instruments, effect of the number of vanes and variation of speed on discharge and efficiency, effect of curving the vanes of the impeller at entrance, power required to hold up the head of impending delivery.

HOW TO READ PLANS. By Charles G. Peker. 46 pages, 4¾ x 7¼ inches. Illustrated with 43 cuts and 8 folding plates. Published by the Industrial Publication Co., New York. Price 50 cents.

Many carpenters are handicapped by ignorance of ordinary working drawings, and this little work is intended to instruct such mechanics in the principles of working drawings so that any intelligent mechanic will be able to work from drawings intelligently. Incidentally the book will be found useful by carpenters who desire to make drawings or sketches of building details for themselves. The folding plates are of a six-room frame house and this set of plans alone is worth many times the cost of the book to the ambitous carpenter who would launch out in independent work.

A STUDY OF FOUR HUNDRED STEAMING TESTS MADE AT THE FUEL TESTING PLANT, St. Louis, Mo., in 1904-1905-1906. By L. G. Breckenridge. 200 pages, 6 x 9 inches. Illustrated. Published by the U. S. Government, Washington, D. C., Department of Interior, U. S. Geological Survey.

The fuel tests discussed in this publication were made under two Heine water-tube boilers by the U. S. Geological Survey Fuel Testing Plant at St. Louis, Mo. These boiler tests were begun during the Louisiana Purchase Exposition during 1903, and have been continued. The general information and results yielded by these boiler tests are of great value. The voluminous nature of the published reports makes the present study of much greater value to those who have not the time or ability to make an analysis of the previous publications.

TABLES OF THE PROPERTIES OF STEAM AND TEMPERATURE-ENTROPY TABLE. By Cecil H. Peabody. 131 pages, 6 x 9 inches. Published by John Wiley & Sons, New York. Price $1.00.

These valuable tables are too well-known by engineers to require an extended review. They were calculated about twenty years ago to accompany Prof. Peabody's work, "Thermodynamics of the Steam Engine." Since then they have been re-computed, and the results of important experimental investigations have been incorporated. The present edition is the seventh. The tables given are for steam, English units, degrees; steam, English units, pounds; steam, French and English units; ether; alcohol; chloroform; carbon-bisulphide; carbon-tetrachloride; aceton; ammonia; sulphur-dioxide; specific volumes of liquids; volumes of hot water; inches of mercury and pounds; connective factors, superheated steam, etc. The tables are presented in attractive typographical form and are indispensable to the testing engineer and others having to do with the calculations in thermodynamics.

STEAM TURBINES. By Carl C. Thomas. 334 pages, 6 x 9 inches. 145 illustrations and 20 large folding plates. Published by John Wiley & Sons, New York. Price $4.00.

This work has passed into the third edition. The development of steam turbines during the past few years has been very rapid, and the revised edition gives attention to the problems in design of the Curtis and Parsons types of turbines and to suggestions regarding turbine analysis. The book is written with a view of setting forth the principles essential for intelligent grasp of steam turbine work. It is to be recommended to designers, engineers and others having to do with the theory of steam turbine operation and construction. It discusses the general principles relating to the action of steam upon turbine buckets; thermodynamic principles involved in the flow of steam; calculation of velocity; the effect of frictional resistance on velocity; experimental work on the flow of steam through orifices, nozzles and turbine buckets; the impulse, and impulse and reaction turbines; the operation of various shapes of turbines. One chapter is devoted to marine steam turbines.

A STUDY OF ROOF TRUSSES. By N. Clifford Ricker. 28 pages, 6 x 9 inches. Illustrated. Published by the University of Illinois, Urbana, Ill.

This publication is Bulletin No. 16 of the series issued by the engineering experiment station of the university for free distribution, and is fully up to the high mark set by the previous bulletins. It records the results of several years' study and tests. About fifty trusses of a selected type and of different proportions and arrangement were designed in long-leaf pine and steel and changed until the assumed and actual weights of the trusses agreed. Other trusses were likewise designed in white pine and steel and a few entirely constructed of steel. To perform this work as conveniently and as rapidly and accurately as possible, it became necessary to devise simplified formulas and tables, with a systematic method of treatment, all of which are fully explained in the pamphlet. The results illustrated are mostly shown in graphic tables for ready appreciation. The most important features are a new formula for the weights of trusses; per cent of weight to be added for connections; most economical ratio of depth to span of truss; distance between trusses; number of purlins per panel; and dimensions of panels. It was found that white pine and steel trusses are about 10 per cent lighter than those of long-leaf pine and steel; also, that if carefully designed, steel trusses from 100 to 200-foot span have about the same weight as those of white pine and steel. It is believed that this bulletin will be valuable and suggestive to all persons interested in the design and construction of trussed roofs.

MEN WHO SELL THINGS. By Walter D. Moody. 295 pages, 6 x 9 inches. Published by A. C. McClurg & Co., Chicago, Ill. Price $1.00; by mail, $1.10.

Selling goods is an art that few master in the full sense of the term, but it is one which many may become proficient in, if we can accept the sentiments of the author. The masters of the art, if there be any, will not need to read this book to learn anything new, of course, but they will find it interesting, nevertheless, and perhaps helpful and uplifting in a moral sense. It was written by a veteran who worked his way from stock-boy to salesman, from salesman to buyer, from buyer to sales manager, and from sales manager to employer. It records the observations of over twenty years' experience in America and in Europe. The author denies that the trite expression "salesmen are born, not made" is unqualifiedly true. Failures or "near salesmen," as he calls them, are often such because of small faults or vices that could be and would be corrected if once they were recognized. The "near salesman" ordinarily does not recognize that he just misses being the "real thing," or if he does dimly see it he cannot see the cause for it. For such unfortunates this book, read in the right spirit, should be helpful, indeed. It is good for any one to read, being optimistic and moral in tone. It leaves no escape from the conclusion that strict integrity and uprightness of character are positively necessary to any salesman's success, in the long run. In fact the qualities requisite for success in a salesman are exactly those that are required in a merchant, banker, manufacturer or business man of any kind, salesmanship being not so very much different from any other business in the last analysis.

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS. Written and compiled by a staff of specialists. 1,283 pages, 4 x 6¾ inches (standard handbook size). Numerous illustrations, diagrams and tables. Published by McGraw Publishing Co., 239 West 39th St., New York. Price, bound in flexible red morocco, $4.00

No doubt one of the best forms of technical literature for everyday use is the engineer's handbook as it exists in numerous examples. These convenient compilations bring together into one comparatively small volume the equivalent of many books in their essentials, and when, as in this case, a copious index with cross references is provided, the comparative value of such aids to rapid work is beyond computation. This work is unique in that it is, in effect, twenty handbooks in one, there being twenty chapters or units on various subjects, each prepared by an expert in the subject treated. It contains about one million words, 1,300 illustrations, and the index has over 6,000 references. The mechanical and typographical features are exceptionally good. It is printed on India bible paper, 1,300-odd pages of which are only about 1¼ inch thick. The binding permits the book to lie flat open at any page without breaking down the back. Following are the headings of the sections: Units; Electric and Magnetic Circuits; Measurements and Measuring Apparatus; Properties of Materials; Magnets; Transformers; Electric Generators; Electric Motors; Batteries; Central Stations; Transmission and Distribution; Illumination; Electric Traction; Electrochemistry; Telephony; Telegraphy; Miscellaneous Applications; Wiring; Standardization Rules; Tables and Statistics. The handbook is one that can be heartily recommended to the electrical engineer and his brother the mechanical engineer, who, more and more every day, has to undertake work involving knowledge of things electrical.

CATALOGUES AND CIRCULARS.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Record No. 64, "Locomotives Built for the Central Railway of Brazil."

CULLMAN WHEEL CO., 1019 Dunning St., Chicago, Ill. Catalogue No. 6 of driving chain, sprockets, automobile differential gears, etc.

GREEN FUEL ECONOMIZER CO., Matteawan, N. Y. Bulletin No. 108 on mechanical draft illustrating, and describing the Green apparatus and applications.

BROWN & SHARPE MFG. CO., Providence, R. I. Booklet entitled: "Why the Constant Speed Drive Milling Machine," giving reasons why constant speed drive is preferable to the cone drive.

GISHOLT MACHINE CO., Madison, Wis. Loose leaf illustrating boring automobile cylinders on the Gisholt turret lathe, and a view in the Warren, Pa., shops.

WHITMAN & BARNES MFG. CO., Chicago, Ill. Catalogue No. 66 listing "Diamond" twist drills, reamers, screw wrenches, drop-forged wrenches, spring cotters, etc.

JENKINS BROS., 71 John St., New York. Supplement to 1907 catalogue superseding pages 70-71, and giving description and list prices of Jenkins Bros. extra heavy and medium pressure gate valves.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Twelve-page booklet descriptive of graphite brushes for motors and generators. Useful information of those having electrical apparatus in care is given.

WHITMAN & BARNES MFG. CO., Chicago, Ill. Circular descriptive of the "Norka" high-speed twist drills, "Economy" high-speed flat drills, "Economy" chucks for flat drills and "Norka" chucks for Norka twist drills.

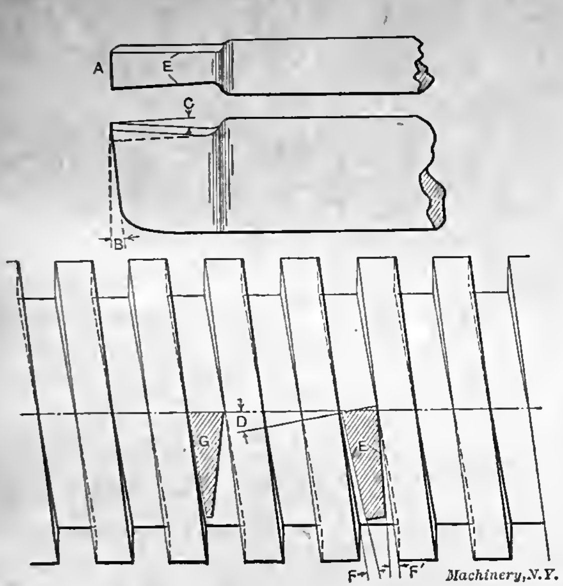
DE LAVAL STEAM TURBINE CO., Trenton, N. J. Bulletin 501, being a catalogue of turbine steam engines for driving dynamos, blowers and centrifugal pumps, and of electric motor pumps, multi-stage pumps, steel plate and cast-iron foundry blowers, etc.

BOSTON GEAR WORKS, Norfolk Downs (near Boston), Mass. Catalogue 131 of gears, chains, sprockets, bearings, automobile steering devices, etc. It will be found of general interest to mechanics, model-makers and others having use for gearing.

LUCAS MACHINE TOOL CO., Cleveland, Ohio. Flyer entitled "Matthew Mears and His Eight-day Clock," *but* advertising the Lucas power

SHOP OPERATION SHEET NO. 58.

E. H. Fish. MACHINERY, April, 1908.



To Grind a Thread Tool for Cutting a Square Thread.

1. Grind the nose *A* of the tool square across the end, and wide enough to be a tight fit between the teeth of the tap which the thread is to follow. If a tap is not used, make the width of the nose equal to one-half the pitch of the thread to be cut. If a close fit is required, the width of the nose may be made 0.002 or 0.003 inch less, and the thread finished to size by taking light cuts from the side of the thread.

2. Grind the front face of the tool until the angle *B*, of front rake, equals 5 to 8 degrees.

3. If the thread is to be cut in soft steel, grind the top of the tool until the angle *C*, of top front rake, equals from 5 to 10 degrees; if cast iron is to be cut, there should be very little top front rake, and when cutting brass the top front rake is often negative, as shown by the dotted line, varying from 0 to 5 degrees. The top of a thread tool should also be ground to an angle *D*, sufficient to make the top at right angles to the sides of the thread.

4. Grind the sides *E* so that they have a backward taper of from 1 to 3 degrees on each side, and a downward taper of from 3 to 5 degrees on each side. This downward taper is indicated by the angles *F* and *F′*. Note that the angle *F* is the angle between the side of the tool and the side of the thread at the bottom, while the angle *F′* is the angle between the side of the tool and the side of the thread at the top.

NOTE.—If the tool is ground as shown at *G*, it will rub on the left-hand side as the cutting of the thread progresses, and be gradually crowded to the right, impairing the accuracy of the thread.

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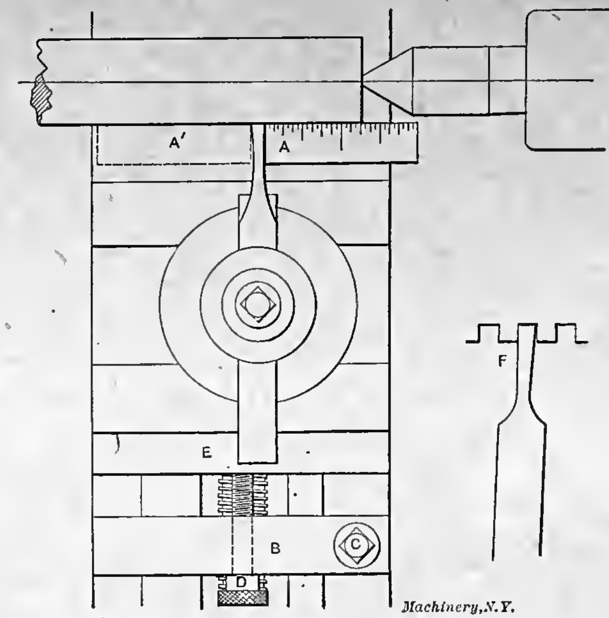
SHOP OPERATION SHEET NO. 59.

E. H. Fish. MACHINERY, April, 1908.



To Cut a Short Right-hand Square Thread.

1. Center and turn the blank, making its diameter from 0.002 to 0.005 inch less than the diameter of the tap.

2. Gear the lathe so that it will cut a thread of the required pitch. See Shop Operation Sheets Nos. 13, 14, 15, in September, 1907, issue of MACHINERY.

3. Set the tool so that its cutting edge is the same height as the lathe centers, and set it square with the work by using a scale as shown at *A* and *A′*.

4. Place the tool against the work, and fasten the depth gage *B* to the carriage by a bolt *C*. Screw the screw *D* into the tool-slide *E* until its shoulder is against *B*.

5. Loosen the screw *D* sufficiently to give the tool the proper depth of cut, move the tool to the right-hand end of the work, and start the lathe. Feed the tool inward until the shoulder on *D* is against *B*, and then engage the split nut with the lead-screw of the lathe, and take the first cut. When the tool has cut as far as desired, reverse the lathe and withdraw the tool at the same time. Again unscrew the screw *D* slightly, and when the tool has reached the right-hand end of the work, again reverse the lathe and feed the tool inward as before. Continue in this manner until the diameter at the root of the thread is from 0.002 to 0.005 inch less than the same dimension on the tap.

NOTE.—If the thread, when cut, is too tight a fit, it may be due to the tool having been ground too narrow, or to the pitch of the tap having changed in hardening. In such a case, the tool may be set as shown at *F*, and light cuts taken from the sides of the thread until the required fit is obtained.

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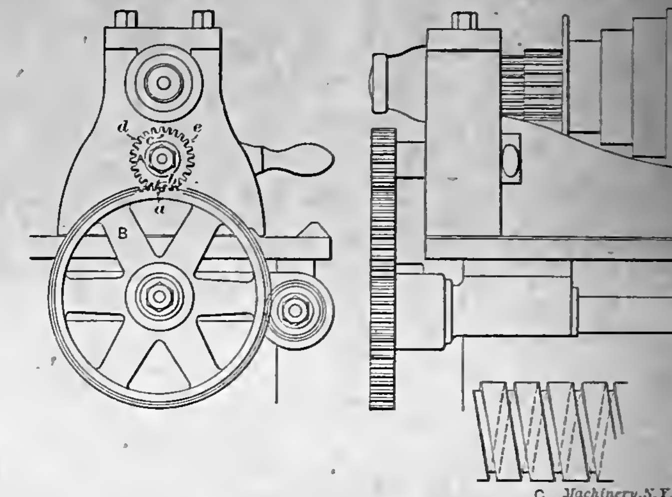
SHOP OPERATION SHEET NO. 60.

E. H. Fish. MACHINERY, April, 1908



To Cut Double and Triple Threads.

1. To cut a double thread, gear the lathe so that it will cut a thread of the required lead, (the lead of a double thread equals twice the pitch) selecting a change gear *A* which has an even number of teeth. Mark a tooth *a* on the intermediate gear *B*, and a space *b* on the gear *A*. Half-way around gear *A* mark a space *c*.

2. Cut a thread on the blank, proceeding the same as if a single thread were being cut. After this first part of the thread is finished, the blank will appear as shown at *C*.

3. To finish the double thread, a second cut must be taken midway between the turns of the first cut. Turn the lathe until the tooth *a* is in mesh with the space *b*, and then disengage the gear *B* from *A*. Again turn the lathe until the tooth *a* will mesh with the space *c*, and then clamp the gear *B* in place. Cut the second part of the thread to the required depth. The tool should not be disturbed during this operation, and it is especially important that the tool be carefully ground so that it will not crowd sideways.

1. To cut a triple thread, gear the lathe so that it will cut a thread of the required lead, (the lead of a triple thread equals three times the pitch) selecting a change gear *A* with a number of teeth which is divisible by three. Mark the spaces *b*, *d*, and *e*, dividing the gear into thirds.

2. Cut the first thread to the required depth.

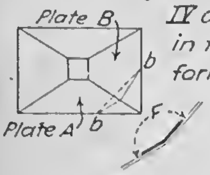
3. Disengage the gear *B* from *A*, and turn the spindle until tooth *a* meshes with space *e*, then cut the second thread.

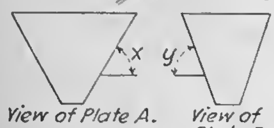
4. Again disengage the gear *B* from *A*, and bring the space *d* into mesh with tooth *a*, then cut the last thread.

NOTE.—This method of cutting multiple threads applies only when the stud on which the gear *A* is mounted and the lathe spindle have the same speeds. On some lathes the spindle makes two revolutions to one of the stud. In such a case the divisions on the gear *A* can be made on one-half of the gear.

I.—ANGLES OF HOPPER SIDE INTERSECTIONS.

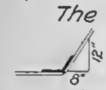
Usually there may be passed through an ordinary hopper or chute, a plane which will cut out a section having four straight sides and four right angles, and to these cases only do the curves on sheets I, III and IV apply. Let plates A and B in the accompanying sketch form the angles x and y with the horizontal plane. If a plane b-b be passed through perpendicular to their line of intersection, and the angle of flare be called F, then cos F = − cos x cos y. The curves were calculated from this formula.



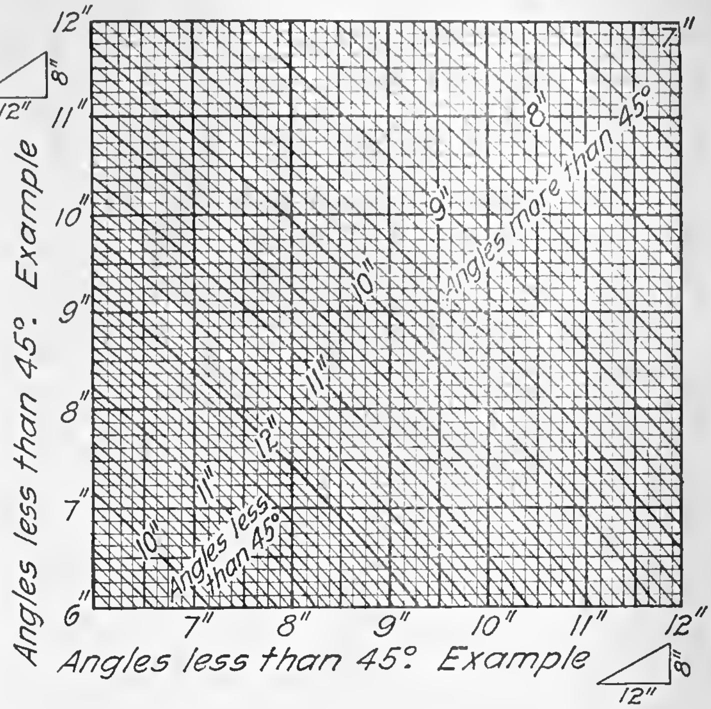


View of Plate A. View of Plate B.

The values of the angle of flare and the angles formed by the hopper sides are expressed in the slope of inches per foot.

The angle of flare is expressed thus  if the angle is more than 45 degrees.

The angle of flare is expressed thus  if the angle is less than 45 degrees.

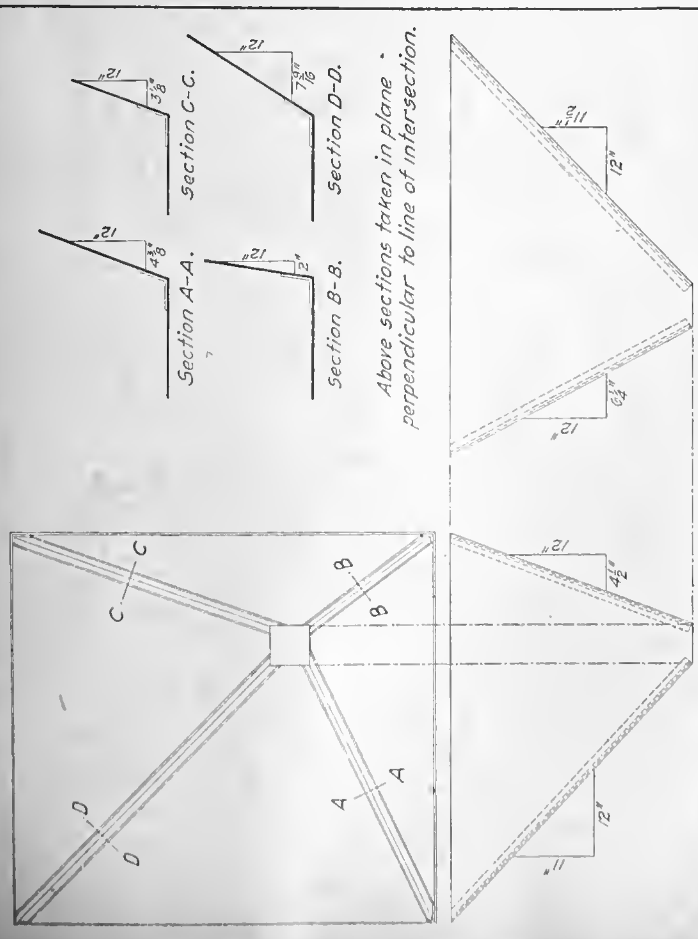


Three sets of curves are given for the three cases found in actual practise:

1. Two angles, x and y, both more than 45 degrees.
2. Two angles, x and y, both less than 45 degrees.
3. Two angles, x and y, one angle less, and one angle more than 45 degrees.

Contributed by Charles T. Lewis and Horace R. Thayer.

II.—ANGLES OF HOPPER SIDE INTERSECTIONS.



Above sections taken in plane perpendicular to line of intersection.

Directions for the use of the diagrams.

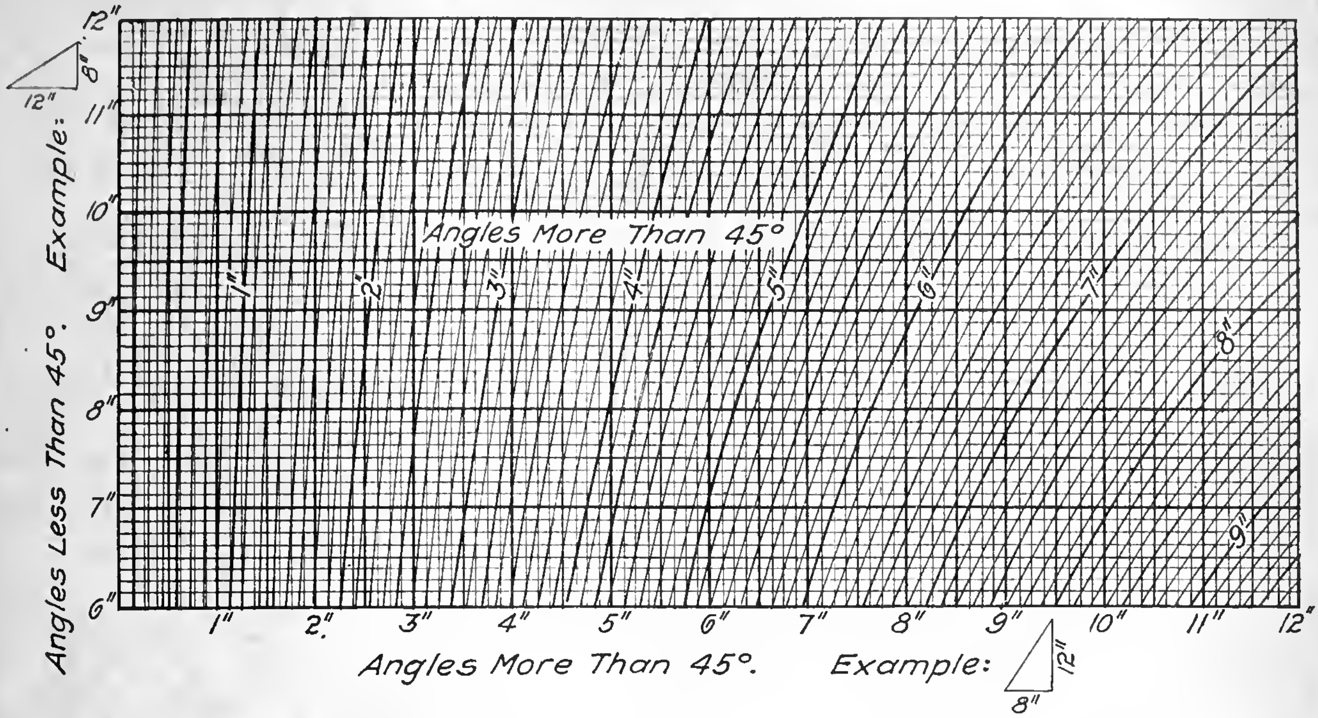
In the accompanying illustration of hopper, let the slopes of the four sides be known, as indicated by the slope in inches per foot. For the intersection angle of the side sloping 11 inches in 12 inches with the side sloping 12 inches in 6¼ inches, use diagram for one angle more than 45 degrees and one angle less than 45 degrees. (See upper diagram, sheets III and IV.) At the left of the diagram are values ranging from 6 inches to 12 inches for angles less than 45 degrees. Follow the horizontal line at 11 inches until it meets the vertical line projected up from 6¼ inches. The intersection of these two lines gives, on the curves across the diagrams, the nearest value for the intersection angle, which in this case is 4⅜ inches in 12 inches. (See section A-A of hopper on this sheet.) In a similar manner, use the diagram for two angles both more than 45 degrees (lower diagram sheets III and IV) for section B-B, and for section D-D use diagram for two angles less than 45 degrees, sheet I.

Contributed by Charles T. Lewis and Horace R. Thayer.

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

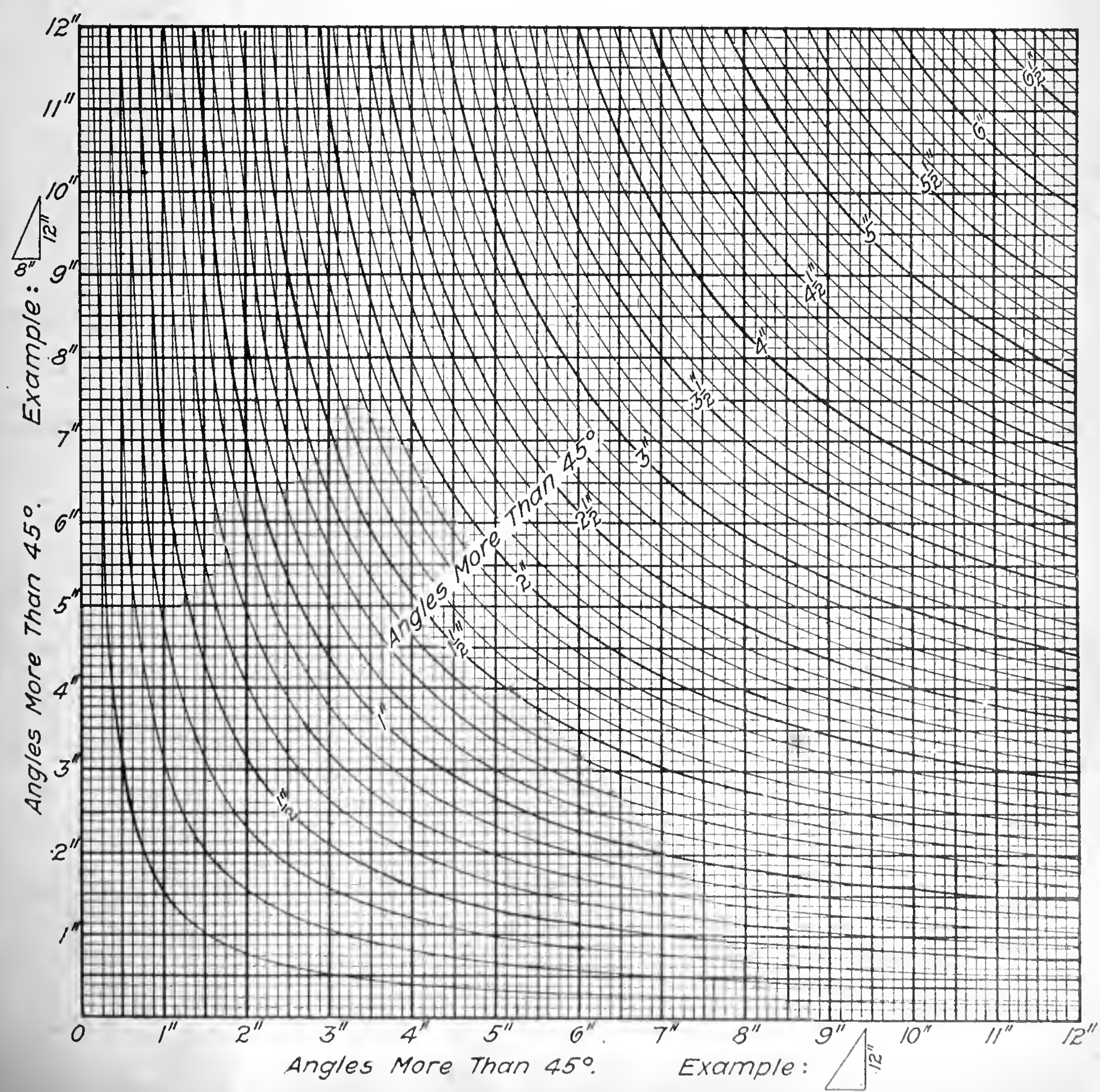
CUT ON THIS DOTTED LINE AND FOLD ON A—B

III. and IV.—ANGLES OF HOPPER SIDE INTERSECTIONS.



4

B



Contributed by Charles T. Lewis and Horace R. Thayer.

MACHINERY.

April, 1908.

ARMOR-PLATE FORGING AND MACHINING AT THE BETHLEHEM STEEL WORKS.

WHILE collecting material for the article published in the November, 1907, issue of MACHINERY, describing the armor-plate vault built by the Bethlehem Steel Co., the writer had the opportunity to see something of the forging and machining operations on armor-plate as carried on at this plant. These operations are so impressive that it has seemed worth while to speak of them briefly here. This description, especially so far as it relates to the forging, is necessarily non-technical, since this work is somewhat outside the range of the writer's practical experience.

So far as the spectacular features of the forging shop are concerned, the interest centers about the 16,000-ton hydraulic forging press, shown in Figs. 1 and 2. Beneath this press the ingots, as they are received from the casting pit, are worked to the proper dimensions for the finished plate into which they are to be formed and machined. With its attendant furnaces, hydraulic pumping engine, cranes and other handling apparatus, this machine forms a large share of the equipment of the department.

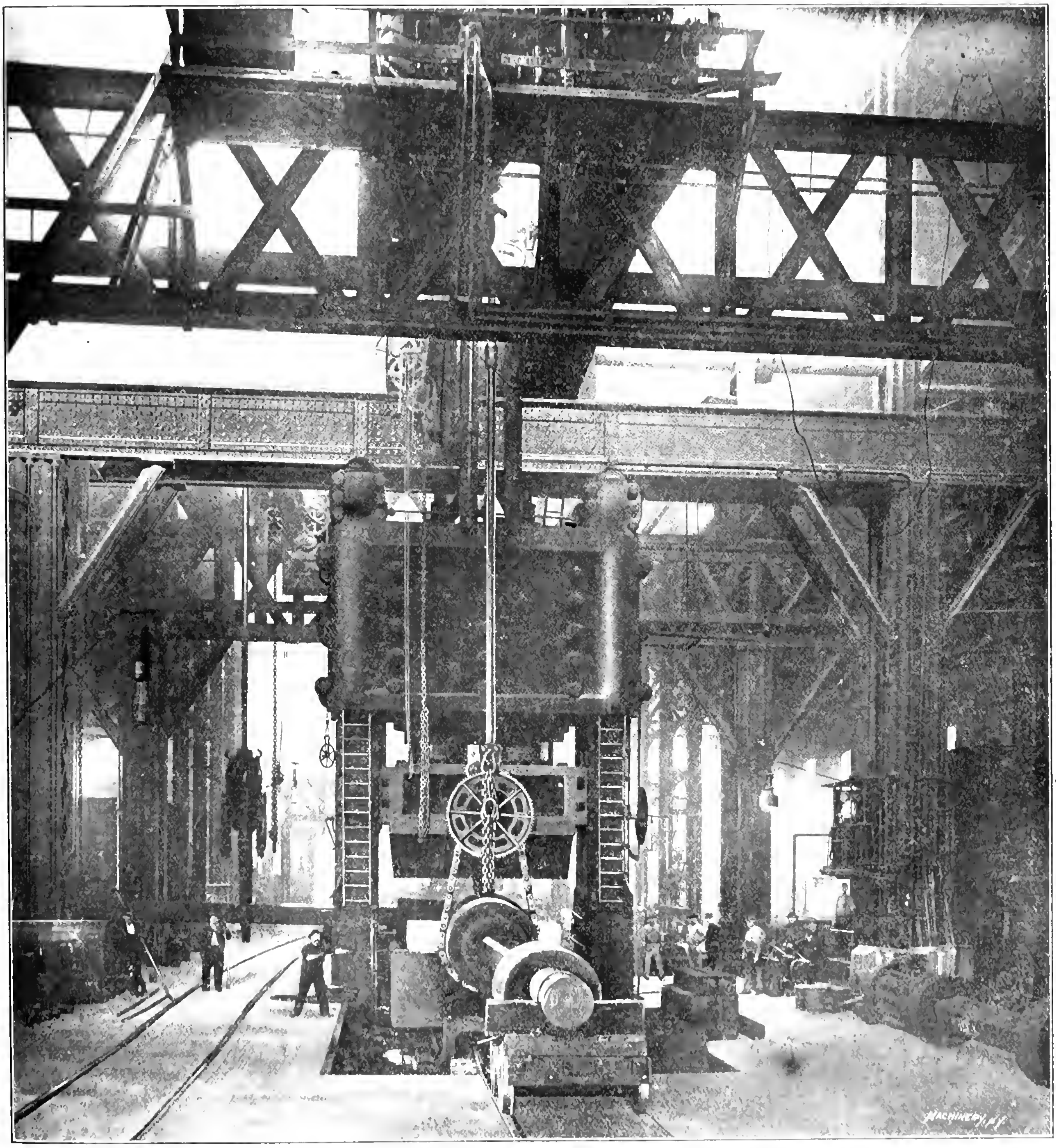


Fig. 1. An Ingot being worked to Shape beneath the 16,000-ton Press of the Bethlehem Steel Co.

The impressive thing in the forging is the handling of the great slabs of hot metal, entirely by mechanical means. It might, in fact, obviously be said of an armor-plate forging, as of a shredded wheat biscuit, that it arrives at its completed form "without the touch of human hands." As the observer

stands on the floor of the shop, gazing curiously at the huge machine and its numerous human attendants standing idly by it, a blast of heat strikes him in the face and he starts back, noting for the first time that the front of the furnace on his left is being slowly raised, revealing the glowing interior. Next, seemingly of its own volition, a car whose body forms the floor of the furnace, deliberately advances, bringing with it, on a pile of incandescent fire-brick, the ingot which has been soaking in the furnace, preparing for the forging operation.

As the ingot advances, we now have an opportunity to admire the dexterity of the crane operator. The geared reel seen depending from the crane trolley in Fig. 1, is provided for this operation with a pair of hooks, attached to opposite ends of a flat link chain arranged somewhat as shown in Fig. 3, one of the hooks being lower than the other. The ingot is so mounted on the fire-brick that its ends project. The crane operator catches one of the hooks centrally under the end of the mass of metal as shown, and then brings the reel over end of the beam which rests on the truck. The crane man, by the mechanism at his command, now has complete control of the mass of hot metal. He may raise it and lower it, turn it over (by revolving the reel), advance it toward the press or away from it (by operating the crane trolley, which is followed by the truck) or swing the whole from side to side about the centers of the truck as a pivot.

On the other side of the press this apparatus is duplicated, so that if the riser has been sheared off beneath the press, the ingot may be worked from end to end, being passed through by the front holder until it is half-way done, when the one in the rear grasps it and draws it through, returning it again, and passing and repassing it until the work is completed. After the riser has been removed, the plate is held by simple solid jaws at the end of the beams, in place of the sockets shown. These movements are all hydraulically controlled, the pressure for the crane movements being delivered to the bridge and the traveler by "scissors pipes"—jointed pipes which open and close to accommodate the movements

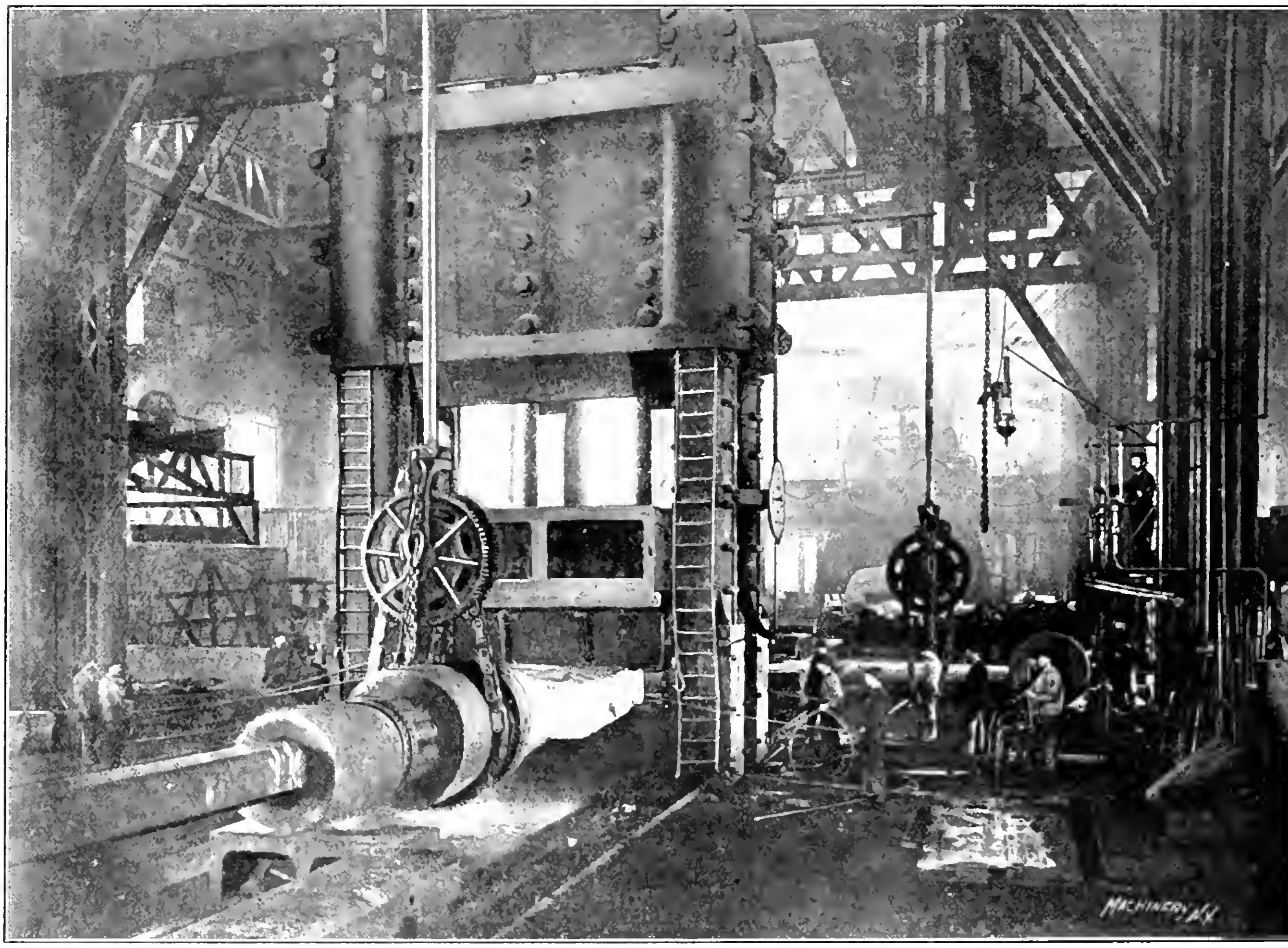


Fig. 2. The Forging Press with the Ram Lowered on the Work. Note the Discarded Steam Hammer in the Background.

until the other hook is engaged. He now raises it clear from the car (which retreats to the furnace, closing the door behind it), swings it about at right angles, and deposits it on one of the die-blocks in front of the press, with its squared stem or riser pointing toward us.

The crane operator has now to attach to the hot ingot what, in default of a better name, we may describe as the "handle" by which it is manipulated. This consists of a great beam whose rear end rests on the truck seen in the foreground of Fig. 1, and whose front end carries a socket with an aperture fitting the stem of the ingot. An endless chain is passed around the reel which hangs from the crane, and the socket is hung in this. Having been adjusted to the proper height by the crane operator, it is advanced toward the ingot and pushed into place over the riser. The crane operator now raises the reel, and with it the socket and ingot, and the bed on which it rested is moved back out of the way. The outer end of the "handle" is weighted (in Fig. 1 a heavy ring is used, as shown) so that the work may not over-balance the of the members to which they are connected. The die-blocks beneath the bed are also hydraulically operated, being brought into place or moved to one side and changed one to another as occasion may require. The men who operate the valves controlling these various movements as well as those of the press itself and of the furnace, are stationed at the right of Fig. 1.

As is well known, the operation of forging by pressure is quite different from forging under the hammer. Instead of pounding the ingot into the shape desired, the end of it is placed between the comparatively narrow dies and given what is apparently a gentle squeeze. The plungers are raised again, the ingot advances another step, and a second squeeze is given. This action is continued progressively until the entire area it is desired to flatten out has been passed over. This successive squeezing is then repeated until the metal has been worked into a plate of the required dimensions. The edges of the plate, when worked by this process, show the characteristic bulging edges resulting from pressure forg-

ing. This shows very plainly that the working of the metal extends clear through to its center, forcing it outward. As most of our readers are aware, it is the ability of the hydraulic press to thus thoroughly work the metal that has caused it to supersede the old-fashioned steam hammer treatment, which, on large work, does little more than deform the surface of the metal, the suddenness of the impact preventing

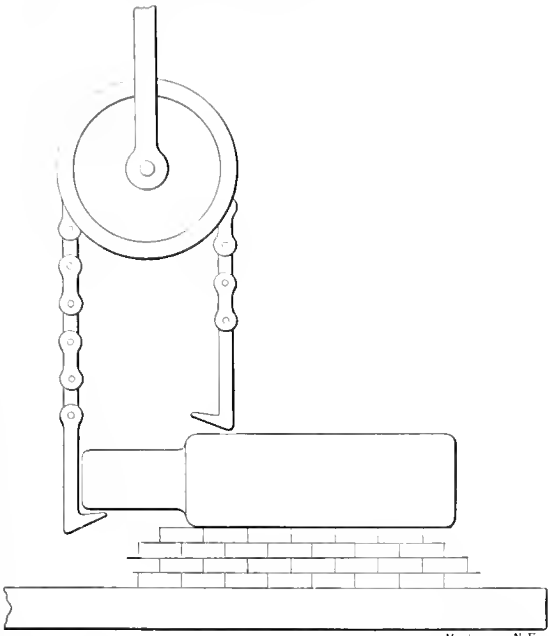


Fig. 3. Method of picking up Heated Ingot from the Furnace Car.

the transmission of the action throughout the whole body. The 125-ton steam hammer, of which a model was shown at the Columbian Exposition in 1893 and which was superseded by this press, may be seen dimly in the background of Fig. 2.

During the forging operation, the work performed on the mass serves to some extent to replenish the heat lost through radiation, so that it is nearly as hot at the conclusion of the working as at the beginning. A noticeable feature of the forging is the shelling off of huge scales of oxidized steel from the surface of the metal, as the operation proceeds.

After the forging, if the plate has to be curved to fit the lines of the ship it is to be applied to, or has to be bent to cylindrical shape for forming a gun turret, it is again heated and shaped under a forming press, similar in design to the forging press shown in Figs. 1 and 2, but of somewhat smaller capacity. In this machine, however, the two plungers are connected with the upper die block by ball and socket joints, and they may be operated independently, so that by using suitable upper and lower dies the plate may be pressed to any desired form.

The metal used for armor-plating, particularly that which is to be hardened by the Krupp process, being of a material which is very tough, even in its softest condition, requires tools and machines for finishing which have unusually strong construction. An idea of their massiveness may be obtained by referring to Fig. 4, which shows a double head milling machine, driven by direct-connected steam engines. This tool is at work finishing the edges of a pair of armor-plate forgings, one on either side. These heads are about 8½ feet in diameter, the cutting circle being 88 inches in diameter, with 12 cutters in each head. A pile of the massive cutters used is shown on the floor in the foreground, at the back and at the left of the small electric motor and controller shown on the floor. The stock used for them is 6 inches by 3½ inches in section. Each table is 8 feet wide by about 23 feet long and has a transverse feed of 21 feet. The double engines have cylinders each 10 inches diameter by 14 inches stroke. The heads revolve very slowly, apparently not giving a surface speed much over 20 feet per minute, or thereabouts. The chips taken are so heavy, however, that it is possible to advance a cut 2 inches deep on an armor-plate 12 inches thick, at the rate of 40 inches per hour.

After machining, the plates are given their heat treatment, being either Harveyized or hardened by the Krupp process. The former is a case-hardening operation pure and simple, though carried to a great depth, and involving weeks of time. The Krupp process is the Harvey process, plus a treatment of which the details are secret. This gives to the metal a peculiar tough fibrous structure which forms an almost unbreakable support for the hardened face of the plate. This hardened face may be chipped and cracked by the impact of the projectile, but the tough backing will hold the plate together without fracture.

In operation, the Krupp process is said to be a very delicate and uncertain one. Two pieces of identical shape may be treated together and laid aside to cool after the treatment is finished. So far as can then be determined, they are in the same condition and have had the same care in every respect. But one of them will have the metal of which it is composed hardened to a very high degree on the face, this merging into a tough fibrous structure with fibers running from front to back as though the plate were sawed across the grain from the end of a huge wooden beam. The other, capriciously and without warning, will crack in two when it

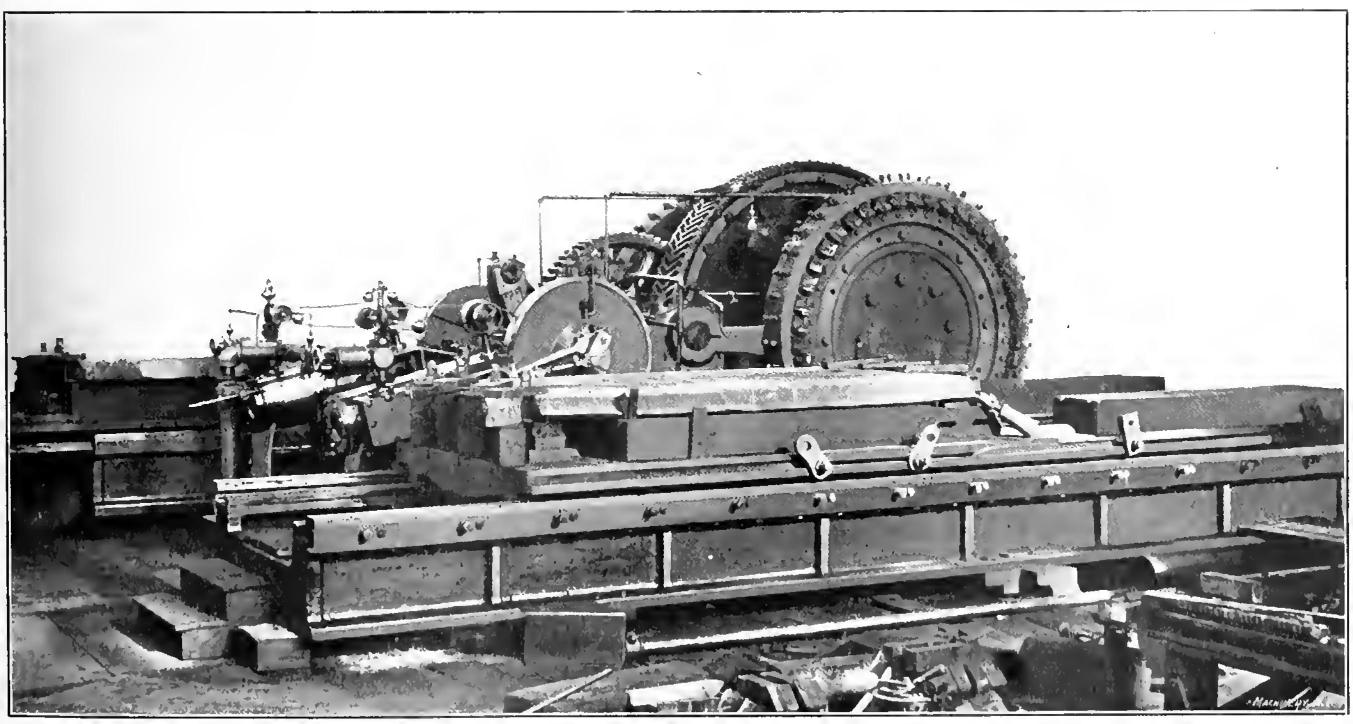


Fig. 4. Double, Steam-driven Rotary Planer, for Finishing the Edges of Armor-plate Sections.

has almost cooled to a point where it can be touched by hand, and the fracture will show a coarse crystalline structure absolutely useless for resisting the impact it may be called upon to stand. Something like 30 per cent of all the finished pieces of armor-plate treated by the Krupp process are spoiled in this way—apparently unavoidably. It is this large percentage of scrap, so the writer was told, which acounts for the high cost of making Krupp armor-plate.

After the heat treatment, the perfect plates again go to a forming press to be straightened, so that their finished surfaces are again squared and in line with each other. This is done by heating them gently, and bending them under the forming press previously described.

Though of huge size, the hydraulic forging press is of such simple construction that its tremendous power is not at first realizable. A walk to the upper end of the shop, however, where is located the 15,000-horse-power hydraulic pump which serves the press, gives the imagination data to work on in appreciating the tremendous amount of work expended in forming the hot ingot into a plate of the desired dimensions. This pump, which was built at the plant, was designed by the well-known engineer, E. D. Leavitt, of Cambridge, Mass. This engine and the press, as well, have been previously described in MACHINERY (see the issue of October, 1899).

* * *

DEFECTS IN THREADS FOR STEAM-TIGHT JOINTS.

In a recent issue of the *Valve World* attention is called to the fact that defects in the tapered thread of the joints of wrought iron and steel pipe are not of so great consequence in obtaining a tight joint as is ordinarily assumed. The Crane Co., of Chicago, has endeavored to show that the ideas held regarding the placing of too much importance on defects in the threads of pipe and fittings, are erroneous, and this company has made some conclusive tests on this subject. The results of these tests seem to give evidence that the many small defects for which pipe and fittings are often rejected, are entirely unimportant in regard to the efficiency of the threaded joints for making a tight connection. One of the common causes assigned for the rejection of pipe is that threads are a trifle broken. To prove of how little consequence this is, a piece of 8-inch pipe was threaded for a distance of 2¼ inches. This pipe was then put in a lathe and the thread was mutilated by turning three circular grooves, each 3/16 of an inch wide, on the surface of the pipe, thereby cutting away some of the threads entirely, and leaving only fragments of some of the other threads. The tops of the remaining threads were then turned off, so that they had a flat surface on the top 1/32 inch wide. At three places on the circumference of the tapered thread flat spots were then filed, one inch wide and two inches long. Twenty-five grooves were then filed in the thread of the pipe, and the same number in the coupling, all perpendicular to the direction of the thread, and two-thirds of the depth of the thread. When this deliberate mutilation was finished, the threads were cleaned, and were thoroughly coated with a cement for making a tight joint, in this case, "Crane" cement. The joint was then screwed up so that the lengthwise grooves did not come opposite each other. The outer ends of the pipe and the coupling were then plugged and the joint was tested to 425 pounds air pressure. The joint was found to be tight, and the same result followed a hydraulic pressure test of 1,000 pounds per square inch. This test also indicates of how little importance it really is in taper-threaded fits if the taper of the two components making the joint should not be exactly the same. In fact, in many cases, pipes are not threaded with the same taper on the outside as the taper of the tap used for threading the corresponding fitting on the inside, but nevertheless, a steam or water-tight joint is effected, by screwing the component parts tightly into one another, and using some suitable compound to make a tight joint.

* * *

A lathe shear is a poor anvil.
The squeak of the dry bearing goes round the world.
A crack in the floor is a poor straightedge.

THE PROBLEM OF THE SPIRAL CONVEYOR.

LAYING OUT THE FLIGHTS.

F. WEBSTER.

In making steel spiral conveyors of small sizes, the pattern for the flights is laid out and the disks are punched from sheet metal. Some makers use the following method for laying out the pattern:

Suppose the conveyor is to be 12 inches outside diameter, and is to have a pitch of 12 inches, as shown in Fig. 1, and that 2-, 2½-, and 3-inch pipes are to be used for the shafts of three sizes. The length of the helix on the outside of the shaft in each case is found by the triangle method: that is, the length equals that of the hypotenuse $a\,d$ of a triangle,

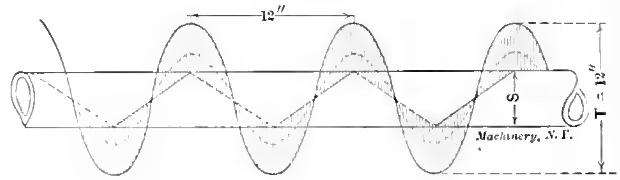


Fig. 1. Typical Spiral Conveyor, showing Pitch, Diameter, etc.

Fig. 2, having an altitude $a\,c$ equal to the pitch, and the base $c\,d$ equal to the circumference of the shaft. Thus, in the case of a 2-inch pipe which has an outside diameter of 2.375 inches, the length of the helix on the pipe equals $\sqrt{12^2 + (2.375 \times \pi)^2} = 14.13$ inches, and this divided by π (3.1416) gives 4½ inches as the diameter d, Fig. 3, for the circumference of the hole in the disk for the flight. For the 2½-inch shaft, the diameter for the hole in the disk is found to be 4 25/32 inches, and for the 3-inch shaft, it is 5 3/16 inches. The outside diameter D of the disk is found by adding the diameter d of the hole to the difference between the diameter T, Fig. 1, of the conveyor, and the outside diameter S of the pipe. For the 2-inch pipe, the outside diameter D of the disk equals 14⅛ inches; for the 2½-inch pipe, 13 29/32 inches; and for the 3-inch pipe, 13 11/16 inches. When the disks are punched, they are also cut along a radial line E, so that one end of the flight can be raised above the other. From a comparison of the values found for the outside diameter of the disk, it will be seen that the outside diameter becomes less as the size of the shaft increases, notwithstanding the fact that the diameter of the finished conveyor remains fixed at 12 inches. Hence, the inquiry arises, is this correct, and also is the method described above the correct one for laying out the pattern?

It is true that the outside diameter of the disks for the flights will be less for the large shaft than for the smaller ones, but this method of laying out the patterns will not

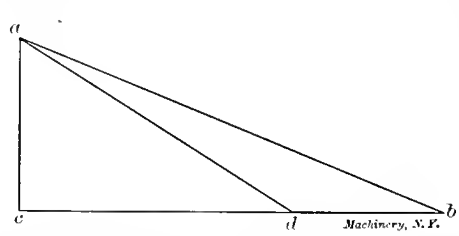


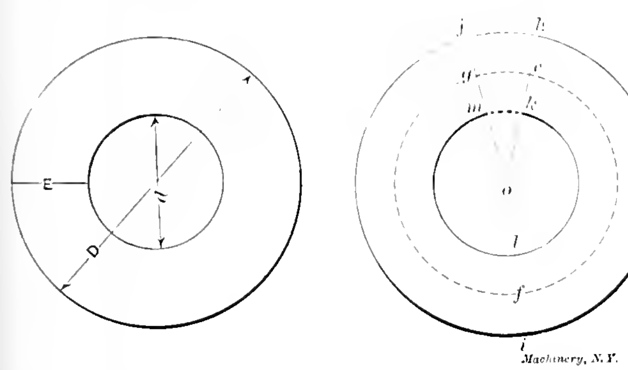
Fig. 2. The Triangle Method of finding the Length of the Spiral.

give the correct dimensions for either the inside or the outside diameters, as will be shown by the following discussion.

In the first place, it must be understood that the flight of a conveyor forms a warped surface, and this cannot be made directly from a flat surface without the material being bent and stretched, or *raised*, as it is called, in order to get the flight set square with the shaft and prevent buckling. The following method will give dimensions more nearly correct for the disk so that after the disk has been raised it will approximately fit both the helix on the pipe and the outside helix of the conveyor. The method consists in constructing a helix, shown by the dotted curve in Figs. 1 and 4, on the flight midway between the outside of the shaft and the edge of the conveyor. The length, $a\,b$, Fig. 2, of this helix is then determined by means of a right-angled triangle in the usual way. The length $a\,b$ of the hypotenuse of the triangle is not

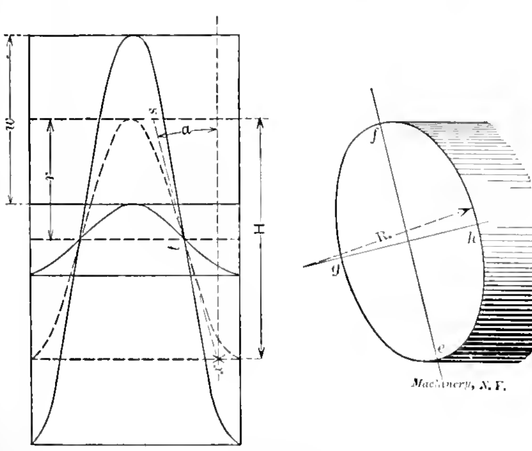
used, however, for the circumference of a circle, as was done in the first method explained, but an entirely different principle must be used for the remainder of the construction. This principle will be most easily understood by considering a more simple example than that of a conveyor flight, namely: the pattern for the surface of the frustum of a cone, shown in Fig. 5. The method requires the use of a slant height OC of the cone as a radius, drawing an arc A from the base, and an arc B from the top, and on these arcs laying off lengths equal to the circumference of the base and the top, respectively. The developed surface $KLMN$ is then the required pattern.

Applying the principle just explained to the construction of the flight of a conveyor, the layout may be made to approach the theoretical requirements as follows: Pass a plane through the tangent xs, Fig. 4, to the middle helix and perpendicular to the axis of the cylinder. The section formed will be an ellipse, as shown in Fig. 6, having its long axis ef equal to the tangent xs, Fig. 4, and its short axis gh equal to the diameter H of the cylinder. The radius of curva-



Figs. 3 and 7.

ture of the helix at the point t, Fig. 4, of tangency is practically the same as that of the flat side of the ellipse at the same point h, Fig. 6. To develop the curve on a plane surface requires the use of the radius of curvature of the helix for drawing the arc (in the case of the frustum of a cone given above, the slant height of the cone was used for the radius). The length of the radius of curvature R, Fig. 6, of a helix or ellipse equals $\dfrac{r}{\cos^2 a}$, where r equals the radius of the cylinder, and a is the angle of the helix as shown in Fig. 4.



Figs. 4 and 6.

This formula is derived by the use of analytical geometry, and will not be explained here. The length of the radius of curvature can also be found graphically.

When the radius of curvature of the middle helix is found by using the formula, draw with it a circle f, as shown dotted in Fig. 7. On this circle lay off the length of the middle helix, as taken from the hypotenuse ab of the triangle Fig. 2, and draw lines from the center of the circle through the extremities e and g of the arc efg representing the length of the helix. Lay off on each side of the central circle distances ek and eh equal to one-half the width w, Fig. 4, of the flight, and draw arcs l and i through them, thus completing the pattern $hklmjih$ for the flight. An inspection of the figure shows that neither the diameter of the hole, nor that of the outside of the disk is the same as the values derived by calculation, according to the method first used. It will also be seen that the punching, Fig. 7, does not form a closed ring as

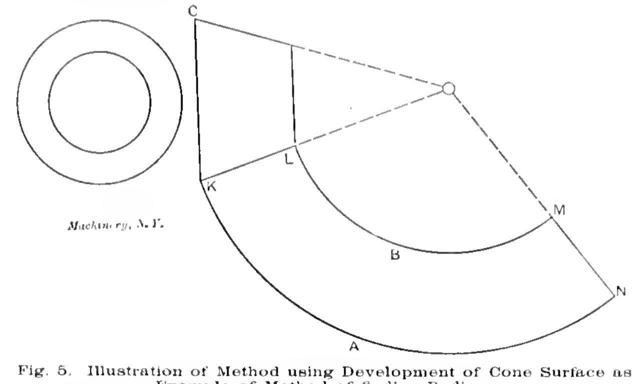


Fig. 5. Illustration of Method using Development of Cone Surface as Example of Method of finding Radius.

in Fig. 3, and hence, there will be more waste material in this case than where a closed ring is used for the pattern, but the work will be more accurate.

The reason for the outside diameter of the blank being smaller when a larger shaft is used, will be seen from a study of Figs. 4 and 6. If the diameter of the shaft be increased, the helix through the middle of the blade will be larger in diameter, and this will cause its tangent, xs, to have less slope. The plane through the tangent will then pass more nearly horizontal, and thus the ellipse cut from the cylinder will more nearly approximate a circle equal to the base of the cylinder. The radius of curvature of the helix then becomes shorter, or more nearly the length of the radius of the cylinder, and hence, the central circle in the layout will be less in diameter. This, in turn, decreases the outside diameter of the pattern.

* * *

CAN A BOY LEARN A TRADE IN A SCHOOL?

E. R. MARKHAM.*

The writer has read so many articles of late on this important subject that he concluded that a few ideas from him would not be amiss. The writer acknowledges that he is engaged in school work, and consequently would not be considered as competent to write from a practical man's point of view, but before he engaged in school work he had over 25 years practical machine shop experience, learned his trade, and worked as machinist and tool-maker for a number of years before taking charge of work himself, and while in charge of shops, the writer was instrumental in teaching the machinist's trade to more than one hundred young men. Having then been engaged in school work for seven years, he therefore feels himself in a position to speak with some understanding of the subject, and having also been connected with two manual training schools, in both of which evening classes for machinists and machine operators in machine shop work are carried on, he has become, in a measure at least, acquainted with the shortcomings of the present so-called apprenticeship system.

In the ordinary manual training school, as conducted at the present time, it is not possible to teach a boy a trade, neither is this attempted. What the school accomplishes, however, must be considered rather a surprise to a fair-minded man. For instance, a boy comes into the machine shop an hour and a half every other day, for a period of 80 weeks, five school days a week, this making a total of 300 hours, and from this should be deducted the time given to lectures and instructions along general lines. If the boy spent the whole 300 hours in the shop, the time for getting ready and cleaning his machine would have to be deducted, and, as he comes into a shop 200 times, this would aggregate a considerable amount to be deducted from the 300 hours. In a shop running 10 hours per day, six days a week, 300 hours would only make five weeks. Now, if the observer examines the range, quantity, and quality of the work done by the average

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pupil in the time mentioned, he must acknowledge that considerable progress has been made, and he will be convinced that a young man, under systematic training, will get along many times faster in a school than if placed in a shop under the conditions which now ordinarily prevail.

As previously stated, we do not attempt to teach trades to our pupils in the trade schools of to-day. However, we occasionally run across a boy who, although intelligent, shows no special fondness for academic work, or, in other words, book study; and such a boy may be given extra time in the shop and permitted to specialize in the shop. Such boys, when they enter into manufacturing work, and find employment in shops, generally give the best of satisfaction, and the schools many times receive word from manufacturers to send them all the young men of this type they can. It is apparent that many young men of this class cannot be furnished, and it is rarely the case that more than one or two at a time take this extra amount of shop work.

Instructors.

Any man, in order to be able to successfully teach any of the mechanical trades, must be a journeyman. He must have had a large all-around experience, and be able to explain to his pupils the various classes of work, as they present themselves. He must have a general knowledge of mechanics, and be able to give short lectures on the manufacture of iron and steel, shop methods, and explain desirability of certain metals for certain purposes. He must understand and also be able to impart to others, the most approved methods of doing work, and when having entered school work, must still try to keep in touch with the advancing achievements of machine shop work.

Outline Plan of an Efficient Trade School.

If trades are to be taught in schools, the mechanical departments must not be "the tail of the dog," as they sometimes are, and "bob-tails" at that. If a trade is to be taught, everything should be so arranged as to accomplish that end. The boy must be given sufficient time in the shop, so that it will be possible to give him the instruction necessary, and his studies must be selected so that he studies in particular those subjects which will help him in his shop work. Such subjects as are included under the head of mathematics, especially arithmetic, should be given special emphasis. The work in arithmetic should be made up of ordinary shop problems, and the use of various formulas entering into shop work. The problems in mechanics should be of a character that will help him in the shop, and apply to his every-day work. The drafting work should be of a kind that will render it easy for him to read working drawings, and he should be required to make drawings of the various details which he afterwards will be required to make in the shop. In this way, his drawing will not be a matter of copying, and the result aimed at will not be simply to get a neat drawing for the sake of getting a good, or passing, mark. The drawing becomes something more than a mere task to be performed. The pupil finds himself placing on paper something that he is to duplicate in wood or iron, and the matter of accuracy is more apparent to him, because if he makes a mistake in the figures, it may mean a great deal to him when he gets to working on the piece in the shop.

Objection to Trade Schools.

The main objection to the establishment of such courses, as have been outlined, in present schools is that it would entirely disarrange the established customs and programs of the school. This, however, would probably not be a bad thing. If a school is supposed to teach trades, everything ought to be shaped so as to give proper emphasis to the shop work. If the teaching of trades is attempted in the manual training high school, there will, of necessity, be a very sharp dividing line between the college course and the trade course. The training which will fit a boy to attend a college or some technical school must of necessity meet the requirements of such an institution, and very little time is left for shop work. Under the conditions existing in many schools, however, the amount of shop work given boys in the college and general courses is the same, and the boy who enters directly into practical work, when graduating, is no better equipped for his work than the boy who is to receive the education which will fit him for a more advanced engineering position. Therefore, if the time now spent in the study of subjects which will not be of direct benefit to the boy who intends to enter practical work directly from the school, were spent in acquiring specific trade education, the boy would be more directly benefited.

Commercial Basis of Trade Schools.

The argument is sometimes advanced that a school cannot be run on a commercial basis, and for this reason a trade cannot be taught along commercial lines. The writer does not know of any reason why a trade school could not be run on a basis at least *parallel* to that of a manufacturing establishment. The fact that such is not the case at present is no proof that it cannot be done. The difference might be that the boy familiar with arithmetic, as it should be taught to a boy learning a trade, would be given the proper speeds and feeds as a part of his trade, rather than to be told to "jack up the speed another cone," or "give her a little more feed," without being told what speed or feed is right for that particular job. In the shop, of course, a boy receives a large share of his instructions from the older men working with him, but whether it is wise or not depends altogether on the man instructing the boy, and on how much he knows, and how much he is willing to impart to the "kid."

If a real trade school is established, efficient journeymen should be employed about the shop. These men should be selected for their ability, character, etc., and being directly under the instructor, who should be a thoroughly practical man, would work according to his directions, so that the instruction which the pupils receive from observation of these men at work, will emphasize the instructions given directly by the instructor.

Then the question comes, what would one make in such a school? One could make some simple line of machinery, make all the jigs, fixtures and other tools necessary to use in the building of the machines, and also some articles of a "jobbing" character, in order that the pupil might get an extended experience. Some things made should be of a character that the shop was not equipped to handle, so that methods had to be improvised for carrying out such work, making the pupils resourceful.

It is no advantage for a young man to learn his trade in a shop where there is a machine specially made and equipped for each piece of work done. If he ever gets into a shop where the equipment is limited, and it is necessary to "invent" ways and means for doing certain work, he is apt to fail, as compared with one who has been taught his trade in a smaller and less pretentious shop. The shop should also have a regular cost keeping system. Each boy should be given charge for a given time, and should be expected to get out certain work in a given time, and try to devise means of getting it out quicker and better. The trade school should, in a word, try to teach the young man how to *think* as well as how to *work*.

Can a Boy Learn a Trade in a School?

In answer to the question suggested by the title of this article, the writer would answer: Yes, trades can be successfully taught in schools, provided conditions are made to suit the requirements, and the instructors are equipped by nature and experience with the qualities necessary, and love their work.

* * *

It is stated in the *Mechanical World* that Mr. Muller, a Bavarian inventor, has obtained a patent for a new insulating material which has a high specific resistance approaching that of gutta-percha and porcelain, and at the same time is almost incombustible in that it will even stand exposure for a short time to electric arc without burning. The composition of the insulating material, according to the patent specifications, consists of 100 parts of mineral pitch dissolved in 20 parts of volatile solvent, such for instance as benzine. From 25 to 75 parts of this solution are added to 100 parts of finely ground asbestos. This mixture is then submitted to high pressure, and dried at a low temperature in order that the solvent may be expelled.

FILLING AND PAINTING MACHINE TOOLS.

H. J. HUDDLESTON.*

Almost every plant has its own system for doing machine painting. There are, perhaps, not a half-dozen firms in the city of Cincinnati which do this part of their work alike. I have been in the employ of the R. K. Le Blond Machine Tool Co. during the past eight years, and as this company received the medal for "finish" at the Paris Exposition, its system, which will be explained, is doubtless worthy of consideration.

First, let all the planing and drilling be done on the casting before it is turned over to the painters, for if, after the work has been filled, rubbed down and painted, it is again handled in connection with machining, it will doubtless be necessary to again refill the work, and this cannot be done and the work made to look as it did originally. The casting should first be thoroughly cleaned, and all lumps and rough edges chipped off. All corners and angles should be filed smooth with a bastard file, and then the casting should be gone over thoroughly with a wire brush, which will loosen all sand and dirt. Next take an emery stone and stone it all over. After this has been done, wash the casting with gasoline or naphtha, using a piece of waste. This will take any oil out of the iron which may have accumulated from drilling and handling. After the casting has been washed in this way, it should be dusted, using an ordinary duster.

Now, in every foundry they make good and bad castings; quite often a casting has a blow-hole in it, and it is almost always in a conspicuous place. The S. Obermayer Co., of Cincinnati, Ohio, manufactures what it calls "National iron filler." This ingredient can be used for filling in blow-holes which may be found in castings. It should be mixed with just enough water to give it the consistency of putty. It can then be placed in the blow-hole, and in one-half hour it will be as hard as iron. After all the rough places have been made smooth, and any bad spots filled as described, the work is given a coat of heavy iron filler. Now, there are many kinds of iron filler on the market, but the one which I have found to give the best satisfaction, is the filler manufactured

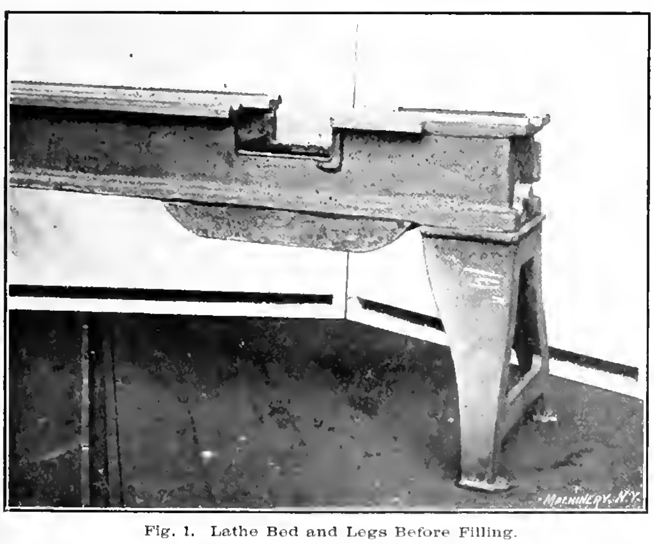

Fig. 1. Lathe Bed and Legs Before Filling.

by the Sherwin-Williams Co. This filler comes in a paste form, and is thinned with turpentine only. After the work has been given a priming coat, it should have about one hour in which to dry. After the filler is dried, the work is plastered. The plastering is done altogether with knives. The knives are of two kinds; one is known as a carrying knife, and the other as a plastering knife. The plastering knives range from 1 to 4 inches in width, while the carrying knives are from 5 to 7 inches in width. The iron filler which is to be applied, is held in a pan, say 12 inches square by 6 inches deep. The filler is thinned with turpentine until it is about like soft putty, then holding the carrying knife in the left hand, and the plastering knife in the right, the filler is applied to the work by cutting some it from the carrying knife with the plastering knife. Hold the plastering knife so as not to pull all the filler off, as it is possible to leave too much filler on the work or to take too much off. It is not well to attempt to handle too much filler on the knives at one time. After going over every part of the work, brush it thoroughly, in this way loosening all the particles of loose or dry filler. The work should now be given three coats of brush-filler, each coat being given about one-half hour in which to dry. The work should now be allowed to set for about five hours; then it can be rubbed.

In putting on the brush-filler, a bristle brush, about 3 inches wide, is the best to use. Care should be taken not to bear too hard on the brush, as brush marks are very hard to sand out. When the work is thoroughly dry and ready to sand, go all over it with No. $1\frac{1}{2}$ emery cloth; then dust it off, and

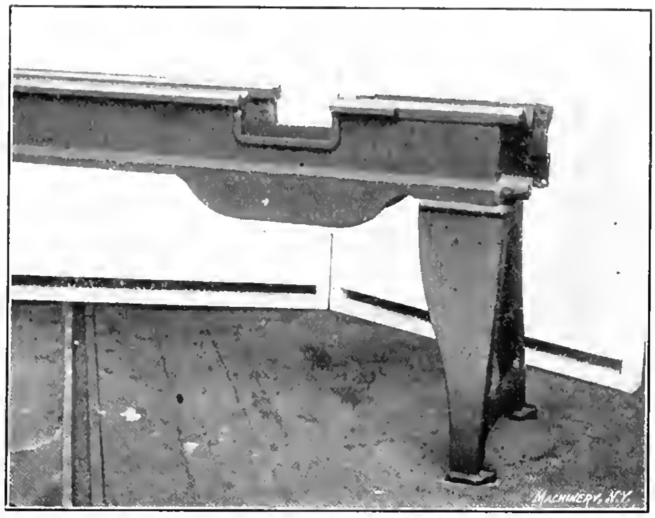

Fig. 2. Lathe Bed and Legs After Filling

go over it again with No. $\frac{1}{2}$ emery cloth, which will remove all scratches. Again dust the work, and it will be ready for painting.

There is, on the market, what is called an "intermediate surfacer," manufactured by the Sherwin-Williams Co. A coat of this paint will give an elegant body for whatever finish you care to give to the work. A paint suitable for finishing can also be bought from this same company, in any shade desired. If the foregoing directions are followed when painting machine tools, I am sure that the results will be satisfactory.

* Address: R. K. LeBlond Machine Tool Co., Cincinnati, O.

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NOVEL PIPE NIPPLE MACHINE.

The Crane Co., Chicago, Ill., has developed an automatic pipe nipple machine embodying a new principle in pipe threading, we believe. The new principle lies in the action of the cutting dies. These consist of four revolving die heads, set 90 degrees apart around the pipe, which carry chasers on their peripheries and which revolve with the plane of the chaser heads parallel to the axis of the pipe being cut. As the pipe rotates, the rotation of the die heads is kept in step with the lead of the thread being cut, the action being essentially the reverse of the common hobbing process employed in making worm-wheels. The chasers thread the ends of two nipples at the same time. The cutting-off and chamfering tools come into operation after the thread is cut, there being two threaded portions of the pipe between the threading dies and the cutting-off tools. It is obvious that the dies working in this way do not cut a truly tapered thread. The threaded part instead of being a true taper of $\frac{3}{4}$-inch per foot included angle, is an approximation only, the outlines of the threaded parts being arcs of a circle having the radius of the cutter heads. This deviation from the true shape, however, is so little that it causes no trouble in practice. The productive capacity of this machine is high; when working on $\frac{3}{4}$-inch nipples it cuts 10 a minute, the cutters being made of high-speed steel and working at a speed of 70 feet per minute.

* * *

The output of the Baldwin Locomotive Works for the past year was 2,750 locomotives, being an average of $7\frac{1}{2}$ locomotives daily, representing approximately $15,000,000 worth of business.

STANDARD NOTATION FOR ENGINEERING FORMULAS.

At a meeting of the Civil and Mechanical Engineers' Society, in Great Britain, January 2, 1908, the question of standard notation for engineering formulas was discussed by several men well equipped for speaking authoritatively ou this subject. One of the most interesting additions to the discussion was offered by Mr. E. Fiander Etchells, who presented the suggestions for a uniform system of notations abstracted in the following. Mr. Etchells called attention to the fact that the real problem was deeper than that simply of notation; the real problem was one of nomenclature. One of the reasous for the condition that, at the present time, there are so many ways of writing the same formula, is principally due to the diversity of names for the same thing. As an example, some writers use S to represent the section modulus of a beam, S being the initial letter of "section," while others, referring to the same quantity, would call it moment of resistance, and would represent it by M or R or even by MR. The first problem, therefore, would be to agree on the nomenclature for the most general engineering and scientific expressions. Having agreed upon this, the following principles might be accepted as a guide for the selection of symbols.

The Initial Letter.

The best symbol to be used, would, evidently, be the initial letter of the word which the symbol was supposed to represent, but this can not, of course, be rigidly adhered to, as in some cases it would lead to confusion, although being adopted for avoiding confusion. In particular, established custom should not be disturbed unnecessarily, for accepted custom, as a rule, represents a natural evolution of unconscious or sub-conscious standardization. Attention was called to the fact that it was not without reason that π represented the ratio of the circumference or periphery of a circle to its diameter, for π is the initial letter of the Greek word περιφερος (periphery), now common on three continents. It would therefore be entirely out of place to try to alter such forms or notations as are already standardized.

Abolition of all Double Symbols.

It would be very inadvisable in any standard system of notation to use any double symbols, for instance, such as BM, representing bending movement, or MR, moment of resistance. Notations of this kind give the impression that M is multiplied by B or by R. Where two letters appear to be necessary, the second letter should be used as a subscript; thus, one would write M_R and M_B, which would be excellent notations for the moment of resistance and the moment of bending.

Self-explanatory Subscript Letters.

Subscript letters should, also, wherever possible, be made self-explanatory. It, for instance, is not at all advisable to say:

A_1 = area of concrete in pillar,
A_2 = area of steel reinforcement,
A_3 = equivalent area.

On the other hand, these three quantities would be very well represented by the notations A_C, A_S and A_E, respectively. Then there would be no need of constantly referring to the explanations of the notations, and the mind would be left free and unhampered to concentrate itself on the real work under consideration. Other things being equal, the less the memory is taxed in grappling with engineering problems, the more it would be possible to arrive at a thorough comprehension of the problems under investigation.

Superscript Letters or Numbers.

Superscript letters or numbers, used at the right-hand top corner of a letter, should be exclusively reserved to represent powers of that letter; thus, whenever the expressions B^2, B^n, etc., are used, it should always indicate the square of B, B in the nth power, etc. Whenever secondary notations are required, and they are not intended to express powers of the principals before them, they should be used as subscript letters, and one should write B_2, B_n, etc.

The Use of Capital and Small Letters.

Capital and small letters may be used to represent related matters; thus, for instance, W may be used to represent the total load, while w would represent the load per inch or per foot of span; P may be the pressure in tons, while p would be the pressure in pounds; L may be the span in feet, l, the span in inches; D may be the external diameter, and d, the internal diameter.

The Use of Greek Letters.

Greek letters should be used very sparingly, and one very important reason for this, which, on consideration, cannot be easily refuted, is because that important factor of civilization, the typewriter, has no such symbols on the ordinary key-board. Greek letters, in general, can easily be dropped, with the exception of the following:

θ = inclination to any horizontal plane; or, in another connection, the angle of torsion; or temperature in the $\theta\phi$, or temperature entropy diagram.

ϕ = inclination to any vertical plane; or the entropy of Clausius definition—*i. e.*, the heat weight of Zeuner—*i. e.*, the thermo-dynamic function of Rankine.

π = 3.141592.

Σ = "The sum of all such terms as."

τ frequently used for absolute temperature, could easily be replaced by T_A—*i. e.*, temperature absolute; most of the other letters could be treated in the same way.

Use of Initial and Second Letter where Necessary to Avoid Confusion.

The initial and the second letter of a word may be used to avoid confusion, the same as is done in chemistry, or in some cases the initial and the last letter may be used. Thus, just as in chemistry, C represents one atom of carbon, and Ca one atom of calcium, so could d represent the depth of a beam, and d_n or d_e represent the deflection of the same beam. This would save any use of letters not to be found on the ordinary typewriter key-board, such as $\triangle$ or δ. The only alternative is the use of the easily confusible d_1, d_2, d_3, etc., which have already been referred to as undesirable when not absolutely necessary.

In cases of notations for such expressions as "absolute temperature," for instance, one would use T_A, and not A_T. In looking in the index of a book for the expression "absolute temperature" one would look under "temperature" and not under the vague heading "absolute," and in the same way, in engineering notations the principal letter should be the one which expresses the principal meaning. For the same reason S_F is preferable to F_S as an expression of factor of safety, safety being the principal term in the expression. The illustrations given have been used only as examples. Perhaps these examples were not the best ones, but the principles laid down would insure clearness and certainty. While it may not be possible to get a complete standardization of engineering terms, it would be comparatively easy and very desirable that a much greater degree of standardization than existed at the present moment, would be accomplished.

* * *

A MACHINERY data sheet index is now ready for distribution, and copies will be sent to all subscribers upon receipt of request. The index is cumulative and supersedes the one issued December, 1905, as it covers all the data sheets, both regular and extra, issued from September, 1898, to December, 1907, inclusive. The twenty-four extra data sheets issued October, 1907, are included under numbers 74 to 79, inclusive. The total number, including the extra sheets, is 82, or 328 leaves, 6 x 9 inches. These fill the binder supplied by the Industrial Press, and the group will be designated as Volume 1. The next index will date from January, 1908.

* * *

Although so hard, the diamond is very brittle, so that a sharp blow will often fracture it. But Sir William Crookes, who has devoted much time during many years to the scientific study of the diamond, has shown that if a good one is placed between the steel jaws of a hydraulic press, and the pressure is applied without jerk so as to avoid fracture due to brittleness, the jaws may be made to meet without the slightest injury to even the edges of the diamond, the hard steel closing round it and taking an impression of the much harder diamond just like so much wax.—*Times Engineering Supplement.*

GEAR-CUTTING MACHINERY.—4.

RALPH E. FLANDERS *

As the rack-cutting machines we have just described (see the preceding installment in the March issue of MACHINERY) are derived in form from the milling machine with rack cutting attachment, so a machine may be made resembling in its movements the arrangement shown in Fig. 65, in which the cutter spindle is mounted on a shaper ram, which is fed forward bodily to pass the cutter through the work. One machine in very common use built on this plan is the Pratt & Whitney rack-cutter. This firm is no longer building this machine, so we do not show a cut of it here, though it is of common occurrence and familiar to every one engaged in the business. Another machine of the same type, built by the R. K. Le Blond Machine Tool Co., is described elsewhere in this issue of MACHINERY.

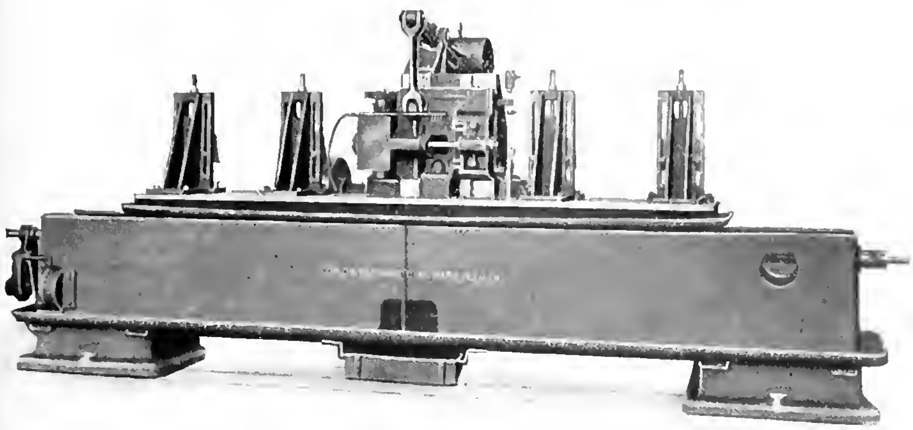

Fig. 69. The Gould & Eberhardt Automatic Rack-cutter.

A third form in which the rack-cutting machine is built, resembles in its construction the heavy type automatic gear-cutter, such as that built by Craven Bros., and shown in Fig. 37. The only difference is in the substitution of a longitudinal work-carrying slide and indexing mechanism, for the rotary work spindle and indexing wheel of the spur-gear machine. This likeness may easily be traced in the case of the Gould & Eberhardt rack-cutter, shown in Fig. 69. As in the spur gear machine, the spindle is mounted on a head sliding on vertical ways on the face of a column. This column may be adjusted in and out on the bed to suit the thickness of the work being operated on. The table, which takes the place of the spindle and face-plate of the spur-gear machine, slides on ways on the main body of the bed. It will be noted that these ways are of unusual length, supporting the table well, even when it is moved out to the extreme of its travel in either direction. The change gears regularly furnished permit the cutting of either diametral or circular pitches. The table can be geared to index in either direction. The work may be fastened either directly to the table by T-slots provided, or may be clamped in the angle vises shown. The cutter spindle is of chrome nickel steel, strongly gear-driven by worm and worm-wheel and splined shafts. The holding of the blank in a vertical position, and the vertical travel of the cutter slide, permit a rigid support for the work against the thrust of the cut, besides causing the lubricant and chips to drop freely out of the way. This type of machine is convenient for setting, inspecting and testing the work. An improved machine of this type is described in the "New Machinery and Tools" department of this issue of MACHINERY.

The machine built by J. E. Reinecker, of Chemnitz-Gablenz, Germany, shown in Fig. 70, like the preceding one, is entirely automatic in all its movements, though it is furnished, if desired, in semi-automatic form in which the spindle head after finishing the cut returns automatically to its starting position, where it stops; the dividing is then done by hand power by the dividing apparatus, after which the feed has to be started again. After the rack is cut through, a special arrangement returns the table to its starting position. This is of great advantage when stocking and finishing cuts are made, as the dividing follows the same direction and from the same starting point.

The driving difficulty previously mentioned as being met with in the rack-cutter, is overcome in this machine in a novel manner—see the line drawing, Fig. 71. As there shown, the cutter spindle is set on an angle with the work, and the forms of the cutters used are made to suit; that is to say, the formed tools used in shaping them are set at the same angle as that given to the axis of the cutter spindle. This arrangement obviously allows the use of a driving gear C considerably larger in diameter than the cutters. The drive is from a vertical shaft D, through a bevel pinion to bevel gear A, driving pinion B, meshing with gear C on spindle E. As here shown, there are two roughing cutters F, and two finishing cutters G. Of course the angularity of the spindle necessitates an increase in diameter for each succeeding cutter on the arbor.

This scheme is especially interesting to the writer because a similar suggestion occurred to him at one time in conversation with a designer who was planning the construction of a rack-cutting machine. In talking the matter over, however, the arrangement seemed inadvisable, owing to the necessity for special cutters and the added complexities of using them in gangs as here shown. Besides this, it would probably be impossible to cut cycloidal teeth of absolutely accurate form by this method, because it would be impossible to obtain clearance for the sides of the cutters at the pitch line where, when absolutely correct, the sides of the teeth are parallel for an infinitesimally small distance. For involute cutters, also, it is obvious that the angle made by the axis of the spindle with the face of the rack must not exceed the number of degrees in the pressure angle (or angle of the sides of the teeth) of the rack being cut. Mr. Reinecker appears to have found this method commercially successful, however, and an actual trial of it is the only true test in a case of this kind.

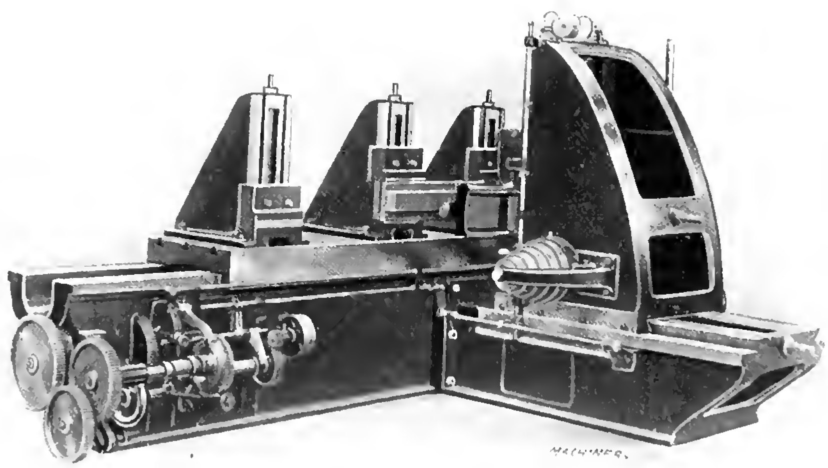

Fig. 70 The Reinecker Automatic Rack-cutter.

Miscellaneous Types of Rack Milling Machines.

The rack-cutter shown in Fig. 72, built by G. Wilkinson & Son, Keighley, England, is built after the planer pattern.

* Associate Editor of MACHINERY.

The cutter head is mounted on a slide on the cross rail on which it travels as it is fed through the work. The work is clamped to the platen of the machine, which is indexed longitudinally for the spacing of the teeth. The indexing is done by hand, though it is not released until the slide has been returned to cut a new tooth, this being done automatically, so that there is no possibility of the indexing being done by mistake at the wrong time. The slow forward feed and quick return of the cutter slide are automatic.

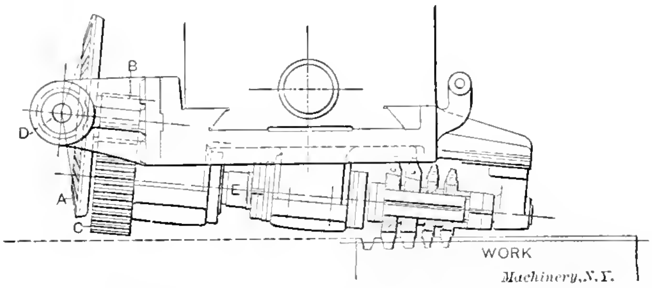

Fig. 71. Diagram showing Angular Position given the Spindle of the Reinecker Rack-cutter to obtain Large Driving Gear at C.

Another rack-cutter with the structural features of the planer is shown in Fig. 73. In the case of this machine it will be seen that its ancestors belonged to the "openside," instead of to the standard double-housing family of planers. The movements are about the same as in the previous case, though the machine has an entirely different appearance, and is built for much larger work. It will cut racks up to 1 diametral pitch, 10 inches width of face, 96 inches long, at one setting. For 1 diametral pitch racks, the machine will take one roughing and one finishing cutter. For finer pitches, cutters are used in gangs, as shown in the engraving, up to the full width of space on the cutter arbor. The table is provided with a quick return, operated by power. The machine is regularly made full automatic, but may be furnished in the half automatic style, if desired. It is built by the Walcott & Wood Machine Tool Co., Jackson, Mich.

The rack-cutter shown in Fig. 74 is built by Armstrong, Whitworth & Co., of Manchester, England. The arrangement of the movements is somewhat different from any of the others we have considered. The cutter spindle, as may be seen, is driven by a worm and worm-wheel. The feed is effected by the forward movement of the cutter slide on the ways provided for it on the rearward extension of the bed. The spindle itself is mounted on a bracket, which may be adjusted vertically to give the proper depth of cut. One interesting feature of this machine is the provision made for cutting very long racks by shifting the position of the work in the vise when the full range of indexing movement has been exhausted. The central vise indexes step by step, being under the control of the indexing mechanism. The short end vises are screwed to the bed and do not move, the clamp screws with which they are provided being loosened while the work is being indexed. These end vises are used, in shifting the work, to hold it, while the central vise is loosened and returned to the starting point for a fresh grip. The particular machine shown is a somewhat specialized form, built for cutting racks used in wire fence knitting machinery.

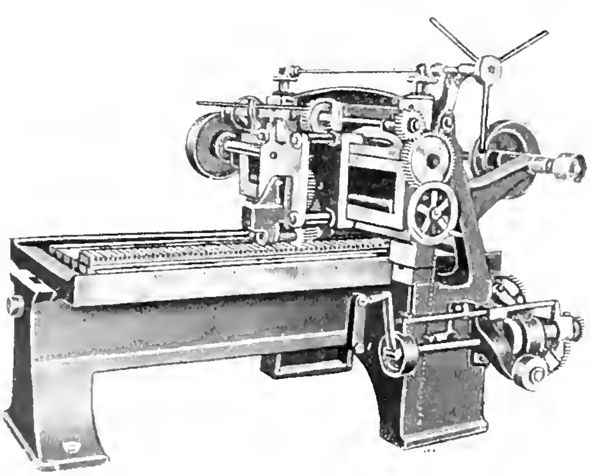

Fig 72. Planer Type Automatic Rack-cutter, built by G. Wilkinson & Son.

The Molding-Generating Method applied to Rack-cutting.

Besides the formed tool method, the only other one commercially applied to rack-cutting is the molding-generating method. The only example of this is in the Fellows system of gear shaping, which is applicable to the cutting of racks as well as to making spur and internal gears. The Fellows gear shaper as arranged for rack-cutting is shown in Fig. 75. This is a smaller size machine than the one shown in Fig. 63, cutting internal gearing, and the arrangement of its parts is somewhat different. In principle, however, it is identical, the same cutter being used and the cutter and work being connected together in the same way. The face-plate or other

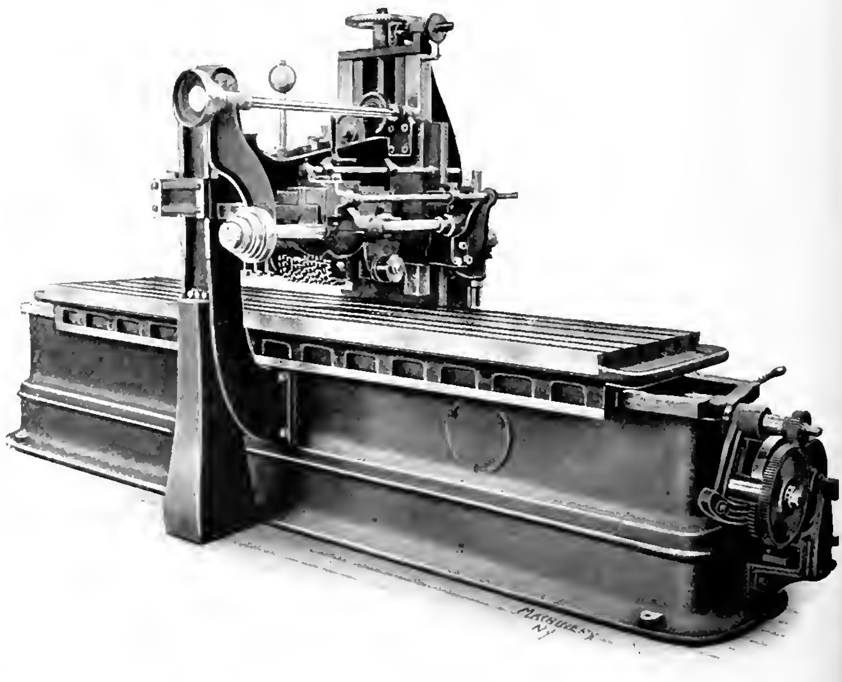

Fig. 73. Heavy Automatic Rack-cutting Machine of the Open-side Planer Type, built by Walcott & Wood.

work-holding device for spur gearing is removed from the spindle, and in its stead is placed a pinion, firmly fixed in the tapered hole of the spindle. A rack-cutting attachment is clamped to the machine, consisting of a guide provided with horizontal ways on which travels a work-holding carriage, having a rack in position to engage the teeth of the pinion clamped in the spindle. The vertical face of this slide forms a lengthened vise in which the work is held.

The method of operation is easily understood. If the spindle (and the pinion connected to it, which moves the work longitudinally) is geared in the proper ratio with the cutter, the machine may be started up with the cutter at the starting point, when the cutter will roll on the work, exactly as if it were a pinion, and the work were a rack with which it engaged. Under these circumstances the shaping action of the cutter will form rack teeth in the work, of suitable shape to mesh with all the gears in the series to which the cutter belongs. The operation is the same as shown in Fig. 8, except that it is reversed. Instead of having the rack the cutting tool and the gear the work, the gear is the cutting tool engaged in forming teeth in the rack. In addition to using an attachment to the regular machine, as in this case, the Fellows Gear Shaper Co., Springfield, Vt., have made special rack-cutters involving this principle, in which the work table slides on a long bed, as in Figs. 69 and 70.*

* Described in article entitled "Fellows Rack Shaper," in the December, 1901, issue of MACHINERY.

This completes the consideration of machines for cutting spur gears, internal gears and racks.

MACHINES FOR FORMING THE TEETH OF WORMS, AND OF SPIRAL AND HERRING-BONE GEARS.

Spiral gearing, twisted and herring-bone gearing, and worm gearing, are all radically different in their action. The first two forms, however, and the worm member of the third, are identical so far as the principles governing the forming of their teeth are concerned; so we will consider them together in this section of this series of articles. It might be mentioned in connection with the name "spiral" gearing, that gears of this kind are not spiral at all, but helical. A spiral is a figure contained in a plane. It has the same shape as the ordinary watch or clock spring, starting from a central point, about which it circles in widening curves. A helix has the shape of a string wound around a cylinder. The name "helical" has come into common use in describing springs of helical shape, and it ought to be used for gears as well. The writer would suggest that the reader practice using the term "helical gear." Criticism might also be directed toward the term "spiral staircase," but since carpentry is out of our field, we will not spend any time here in inaugurating that reform.

Almost as great a variety of methods of cutting teeth are possible for helical as for spur gears. Commercially, however, the two important principles are the formed tool and the molding-generating methods. The templet, odontographic and describing-generating methods of cutting gear teeth (in each of which the outline is worked out by the *point* of a tool, suitably constrained) are most useful for cutting gears of large size, in which tools acting on the formed tool or molding-generating principle would be subject to too heavy cuts. Since helical gearing is generally confined to small and medium sized work, these processes are unnecessary, being by nature rather slow in action, and dependent for their accuracy on the preservation of the shape of easily injured points of comparatively small cutting tools. As in the case of spur gears, the molding-generating method is of comparatively recent introduction, and is confined almost wholly to the production of teeth of involute form.

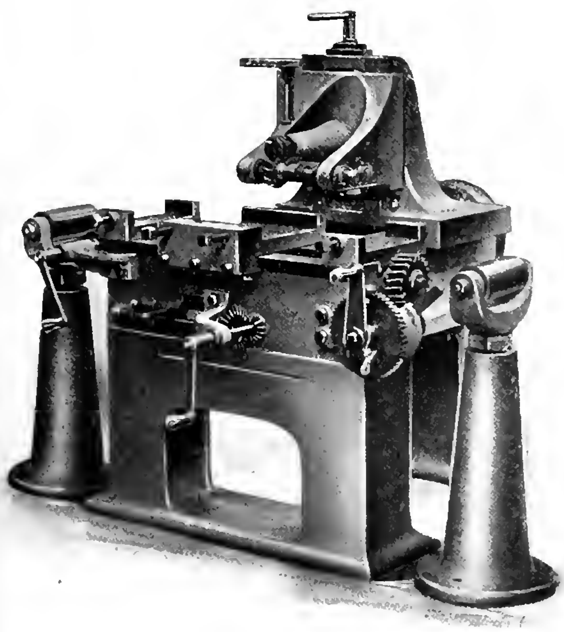

Fig. 74. Armstrong-Whitworth Automatic Rack-cutter.

Machines using Formed Tools in a Shaping or Planing Operation.

With the twisted teeth which we have in gears of the class we are discussing, it is evidently necessary, in employing shaping or planing operations, to give a rotary movement to the blank being operated on, at the same time as, and in the proper ratio with, the cutting stroke of the tool. This is necessary to compel the tool to follow the helix on which the teeth of the gear or the worm are to be formed. In Figs. 76 and 77 are shown two attachments for the shaper, working on different principles, giving the work the proper motion for cutting helical teeth. Both of these attachments were built by Gould & Eberhardt, of Newark, N. J.

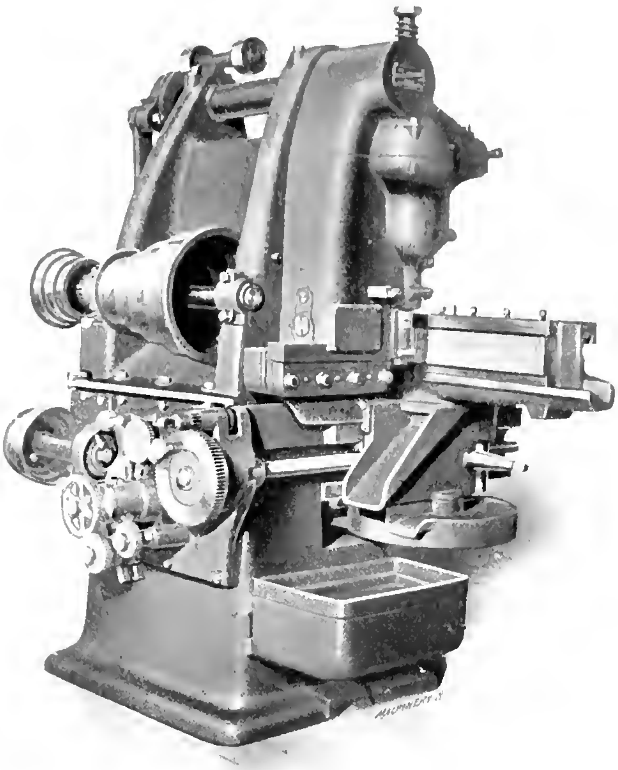

Fig. 75. The Fellows Gear Shaper, with Rack-cutting Attachment.

In the first of these, Fig. 76, the work is mounted between centers on a supplementary bed, fastened to the work table of the shaper. The face-plate by which the work is driven from the head-stock spindle is connected to that spindle by an indexing mechanism, consisting of a notched plate, with a locking bolt for holding the work in the different positions for the different numbers of teeth required. The head-stock spindle is connected, by spiral gearing and a set of change gears, with a pinion operated by a rack, which rack is fastened to the shaper ram. It will be seen that this connection with the shaper ram will give a rocking movement to the head-stock

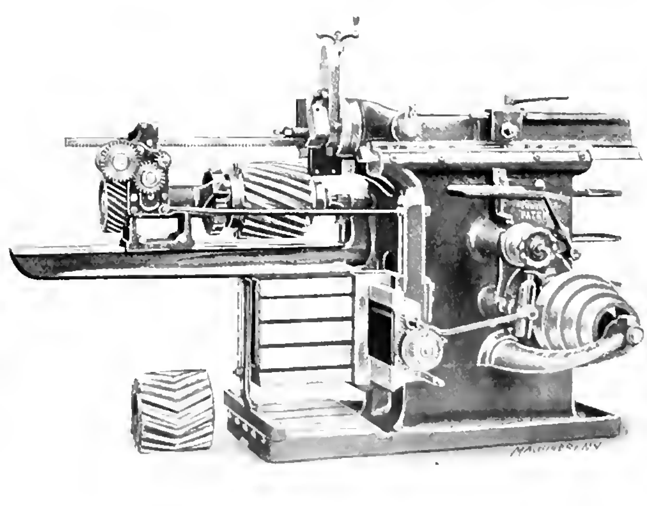

Fig. 76. Helical Planing Attachment for Gould & Eberhardt Shaper, in which the Lead of the Helix is obtained by Change Gears.

spindle and the work, in unison with the stroke of the tool. By selecting suitable change gears, this rocking movement may be made of any desired amplitude for a given length of stroke, so that any lead of helix or spiral desired may be obtained. Provision is made, in the means by which the rack is attached to the ram, for raising or lowering the work

table to the position required for different diameters of work. The tool is, of course, fed downward by hand, and the indexing is done manually also. On the floor at the base of the machine will be seen a pair of right- and left-handed helical gears, similar to the one being operated on; the two form a herring-bone gear.

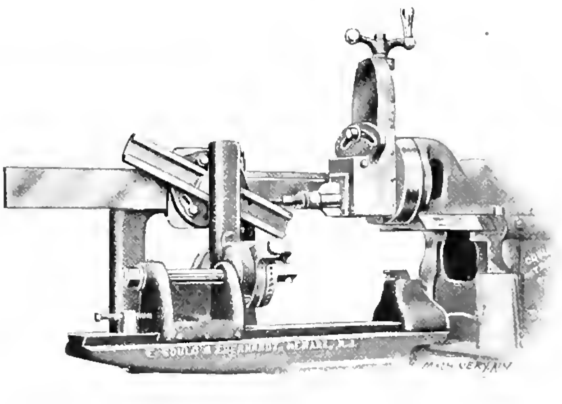

Fig. 77. Helical Attachment for Gould & Eberhardt Shaper, in which the Lead of the Helix is obtained by the Adjustment of a Swiveling Guide Bar.

The second attachment, shown in Fig. 77, employs a radically different principle for varying the amplitude of the rocking movement of the head-stock spindle for a given stroke of the ram, to obtain different leads of helix. The reader, of course, understands that the lead of the helix is the length of the cylinder required to allow a complete revolution of the helix. In this case, a spur gear keyed to the head-stock spindle meshes with a vertical rack, sliding in a guide which is cast integrally with the head-stock. This vertical rack is pivoted to a block which slides in a guide attached to a swiveling head, so that the guide may be adjusted to any angle. This swiveling head, in turn, is attached to a bar, which is fastened to the ram, and is guided on ways supported by a framework at the back of the head-stock. It will thus be seen that the forward and backward movement of the ram will impart an up and down movement to the rack, which will, in turn, give a rocking movement to the spindle of the head-stock, and the work which it drives. The amplitude of this rocking can be increased or diminished by setting the swiveling guide at a greater or less angle, so that the helices of various leads can be obtained. This makes the use of change gears unnecessary. The indexing device is similar in principle in the two arrangements.

It will seem strange at first thought, perhaps, to describe the cutting of worms in a lathe as an example of the use of formed tools in shaping or planing operations, but the operation is essentially the same as that shown in Fig. 76. Compare this with Fig. 78, imagining that the lead-screw shown

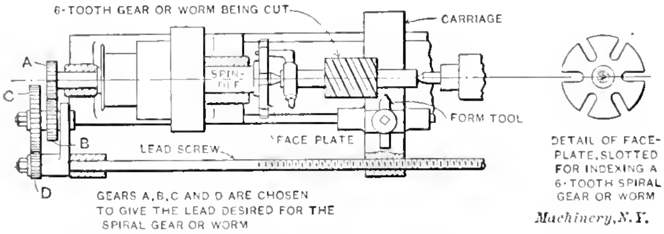

Fig. 78. The Lathe Method of Planing Helical Teeth in Gears or Worms.

in the latter is of such steep pitch that it can be rotated by pushing the carriage backward and forward. Under these circumstances, if provision is made for reciprocating the carriage (corresponding to the ram for the shaper), the lead-screw will be rotated in unison with it, and this movement will be transmitted through change gears A, B, C, and D to the head-stock spindle, giving a rocking movement to the work. The only difference in the two cases is that in the lathe a screw of very steep pitch would be used to change the reciprocating motion of the tool to the rocking motion required by the work, while in the case of the shaper the more natural rack and pinion movement is employed. In the case of the lathe, of course, the power is not applied to the carriage but to the spindle. For that reason it is best adapted for cutting spiral gears of comparatively small lead, or "worms" as we ordinarily call them. If it were attempted to cut 45-degree spirals, for instance, the lead-screw would have to be speeded up so fast, as compared with the movement of the spindle, that the driving belt would be unable to operate the machine. Special lathes have been built for cutting steep worm threads, in which the power has been applied to the lead-screw, the spindle being driven from it through the change gears. A lathe so arranged would have as much difficulty in cutting fine pitches as the ordinary lathe does in cutting coarse ones.

Different methods of indexing may be used for the lathe. It will be noticed that in Fig. 78 the face-plate used has the same number of slots as the required number of teeth. After one tooth space has been cut, the work can be removed, and replaced again between the centers with the tail of the dog in another slot. After this space has been completed, the next one is cut, and so on until the whole six are finished. Other methods are in use, such as slipping of change gears A and B past each other a certain number of teeth, as determined by calculation.

Special lathes are built for threading, some of which are automatic in their action. One of these is shown in Fig. 79. It is built by the Automatic Machine Co., Bridgeport, Conn.* The size shown is especially adapted to cutting worms. It is provided with mechanism for duplicating the action of a

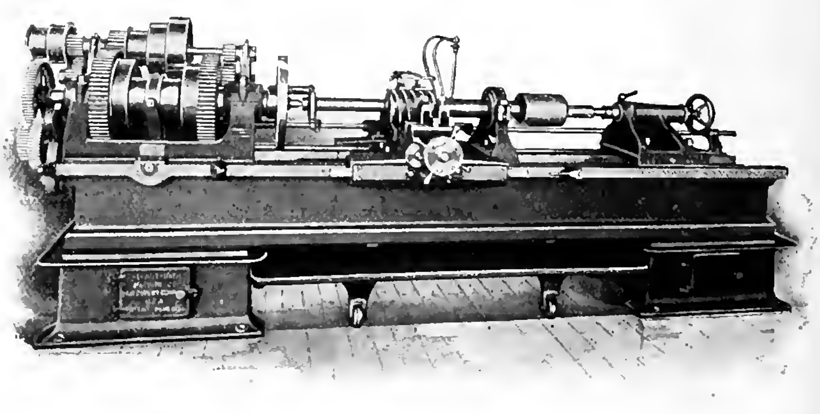

Fig. 79. Automatic Threading Lathe for Worms, made by The Automatic Machine Co.

manually operated lathe engaged in threading. After a piece of work has been placed between the centers and the machine has been started, the work revolves, and the carriage feeds forward until the proper length thread has been cut; then the tool is withdrawn, and the carriage returns to begin again on a new cut—and so on without attention from the operator. The tool is fed in a certain suitable amount, at the beginning of each cut, the amount of this feed being automatically diminished to give a fine finish for the final cuts. When the depth for which the tool has been set is reached, the operation of the mechanism is automatically arrested. In cutting multiple threaded worms in this machine, multiple tools may be used, thus avoiding the necessity for indexing the work. As many as eight cutting tools have been used at once on this machine, giving a total length of cutting edge of 8 inches.

Machines Using Formed Milling Cutters.

We have spoken hitherto of the formed tool or cutter method of shaping the teeth of gears, as being one in which the tool accurately reproduces its shape in the tooth space it forms. This is true in cutting straight tooth spur gears, and in planing the teeth of spiral gears by the process just described. It is not exactly true, however, of any possible process of milling spiral teeth. This is best seen in Fig. 80. In the three cases here shown, we have first, a planer tool; second, a disk milling cutter; and third, an end milling cutter—all formed

* See "New Tools of the Month" section of MACHINERY, February, 1908.

to the same identical outline, and cutting helical grooves of the same lead and depth in blanks of the same diameter. The section in each case is a plane one, taken normal to the helix at the pitch line. (Of course the true section to take would be that of the helicoid normal to the helicoid of the groove being cut. The plane in which we have taken the section, however, so nearly approximates this helicoid that the error is negligible.)

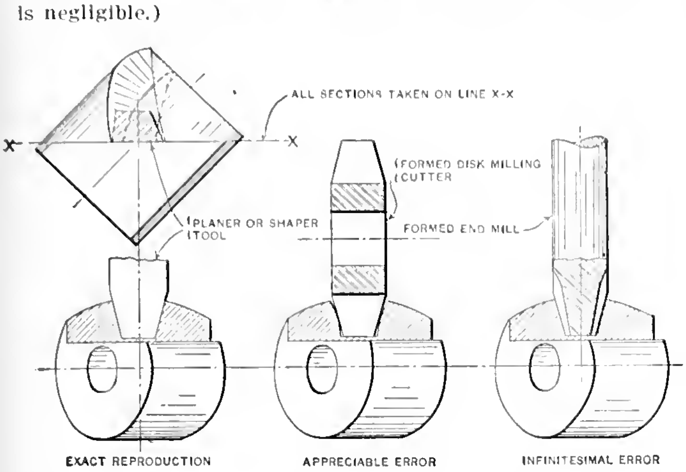

Fig. 80. Comparison of the Accuracy of Form Reproduction Obtainable by Formed Planing Tool, Formed Disk Cutter, and Formed End Mill

The planer tool necessarily cuts a groove of the same shape as its outline, the plane of its outline being the same as the plane of the section shown. The disk milling cutter, however, interferes with the sides of the groove it cuts. This interference takes place on one side as the teeth are entering, and on the other as the teeth are leaving. This results in a generating action, which takes place in addition to the simple forming action, so that the tooth cut is not an exact duplicate of the outline of the cutter. In the case of the formed end mill there is also an interference of the same kind as with the formed disk cutter, but it is so slight as to be absolutely undetectable, in all ordinary cases. We only know of its presence from theoretical considerations.

In spite of its imperfect reproduction of the desired form, the disk cutter is the type generally used for milling, since it may be so relieved as to retain its shape even after repeated

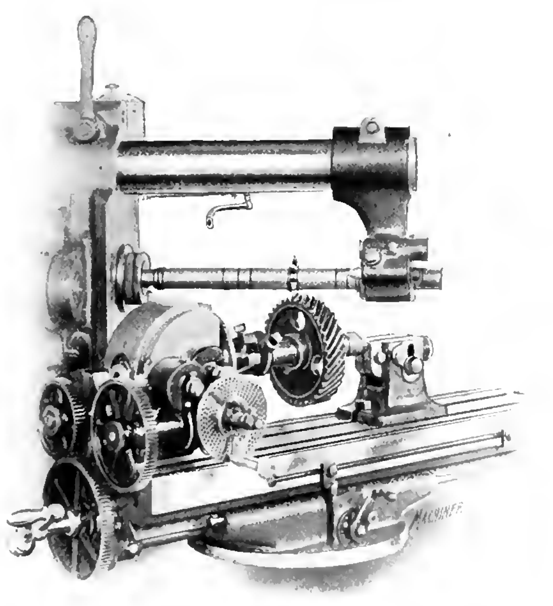

Fig. 81. Brown & Sharpe Milling Machine arranged in the Usual Manner for Cutting Spiral Gears

grinding. The end mill type of formed cutter cannot remove so much stock in a given time, and it is difficult to make it so that it can be ground without changing its form. The only way in which this grinding can be practically performed, is by the use of some form of templet grinding machine,* such as has recently been described in these columns. The formed end mill is used to a limited extent, nevertheless.

The simplest way of using the milling process for cutting helical gears or worms, makes use of the universal milling machine. With this machine, the work, and the feed-screw of the table on which it is mounted, are so connected by means of gearing that the forward feeding gives a rotary movement to the work, producing a helix of the required lead. The mechanism is identical in principle with that shown in Fig. 78 for the lathe, and in Fig. 76 for the shaper, the only difference being that in the milling process the longitudinal movement is a steady feeding motion, made once for each tooth space, instead of being a continuously reciprocating motion, as in the previous cases. The simple indexing devices shown in Figs. 76 and 78 are replaced by the more elaborate index plate and worm-wheel device of the spiral head.

This mechanism, as exemplified in the Brown & Sharpe universal milling machine with its spiral head, etc., is illustrated in Fig. 81. The work has to be swung at an angle with the cutter to agree with the helix angle at the pitch line, as indicated. This is done by swiveling the table of the universal

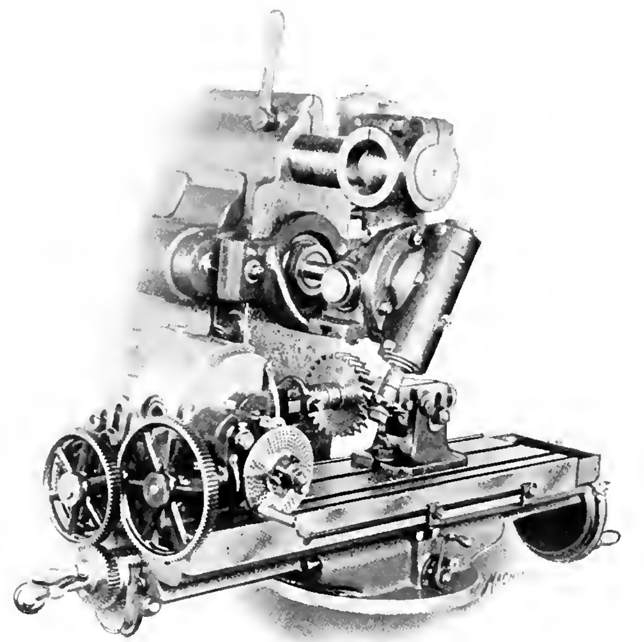

Fig. 82. Cutting Spiral Gears of Helix Angle too Great to Allow the Method of Fig. 81; employing the Brown & Sharpe Vertical Milling Attachment.

milling machine to bring the work to the proper angle with the cutter. In most makes of machines, it is inconvenient, if not impossible, to swivel the table to a greater angle than 45 degrees. For greater angles, special attachments are provided for swiveling the cutter, leaving the table in its normal position at right angles to the spindle of the machine. Two examples of this are shown in Figs. 82 and 83. The first case, Fig. 82, shows a Brown & Sharpe milling machine engaged in cutting a spiral gear, using for the purpose a vertical milling attachment, which has been set to the required helix angle. The change gearing used for connecting the spiral head with the feed-screw of the table can be plainly seen at the left. In Fig. 83 an attachment of another form is shown, built by the Cincinnati Milling Machine Co., Cincinnati, Ohio. In this case the cutter is adjustable about a vertical axis, being driven from the spindle by bevel and spiral gears. It may be set at any angle throughout the whole circle, and cuts on top of the blank, the table being set in the normal position, the same as in Fig. 82. The vertical attachment shifted to a horizontal position, or a rack-cutting attachment, may also be used in milling helical gears to bring the cutter spindle at right angles to the main spindle of the machine. By this means it is possible to mill gears having a greater helix angle than 45 degrees, without shifting the table more than 45 degrees, since the table is set at the complement of the helix angle, thus making it possible to cut even fine pitch worms.

These various attachments allow the milling machine to work throughout a wide range of angles for helical gears and

* See article "Notes on the Manufacture and Upkeep of Milling Cutters" in the engineering edition of the March, 1908, issue of MACHINERY.

worms, the only limitation being one similar to that imposed on worm cutting in the lathe, though the limitation is reversed. For worms or gears of too small lead as compared with their diameter, the rotary movement of the blank is so great that

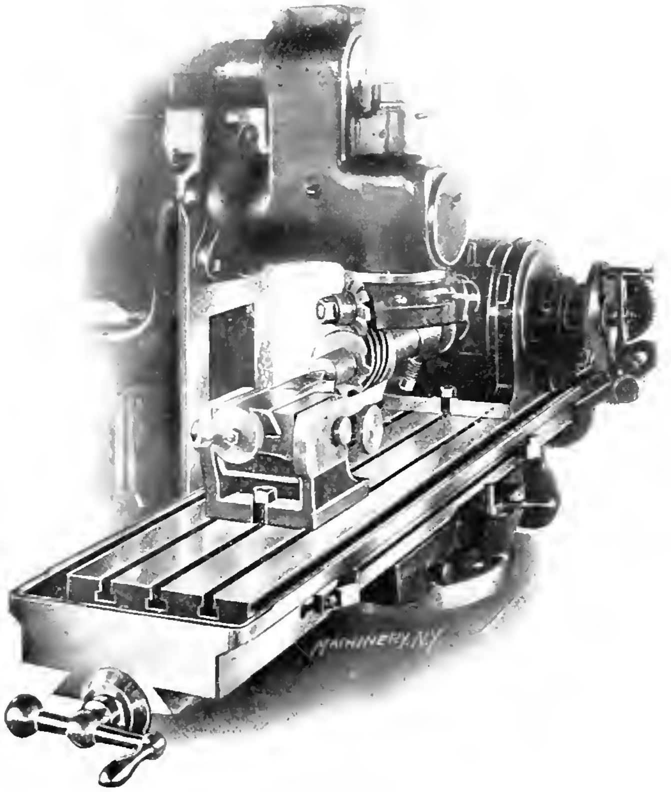

Fig. 83. Universal Milling Attachment of the Cincinnati Milling Machine Co in use Cutting Gears of Large Helix Angle.

the comparatively slow-moving feed-screw is unable to speed up the spiral head mechanism to get the required movement, and still furnish power enough for feeding the work against the cutter.

Specialized Forms of Milling Machines for Cutting Spirals by the Formed Cutter Method.

The principle of the universal milling machine for cutting spiral gears and worms has been applied to the design of various special machines for the same purpose. A number of these are shown in Figs. 84 to 88. The specialization of the machine includes making the spiral and indexing mechanisms integral parts of the tool, so that they have a much greater capacity for taking heavy cuts than is the case where they are merely attachments, as in the cases previously shown.

In the first case we show, the spiral cutting mechanism is still something in the nature of an attachment, the machine being designed for cutting other kinds of gears as well. This tool (see Fig. 84) is the universal gear-cutting machine made by Nya Aktiebolaget Atlas, Stockholm, Sweden, already illustrated in Figs. 34 and 61. The cutter spindle is mounted in a swiveling head, which may be set at the required angle for the helix to be cut, the angular adjustment thus being identical with that in Fig. 83. The cross rail with the cutter is fed down through the work, which is rotated by its gearing connections so as to produce the helix required. In this machine, the indexing is done by power, being regulated by change gears as in the orthodox automatic spur gear cutter. There must, then, be some sort of a differential gear mechanism combining the indexing movement and the rotation of the work for the helix, both of which must be allowed to operate on the work without interfering with each other. We are not informed as to the exact nature of this mechanism, though it is doubtless similar in principle to that described for the following machine.

It was stated that the spur gear cutting machine shown in Fig. 51 is a modification of a universal gear cutting machine made by J. E. Reinecker, of Chemnitz-Gablenz, Germany. In Fig. 85 is shown a side elevation, and in Fig. 86 a diagram of the index worm connections, of the universal machine referred to, as arranged for cutting helical gears by the formed milling process. The machine is arranged, like the Becker-Brainard machine (see Fig. 20), on the general lines of the milling machine, excepting that the work spindle is at the top of the column, and the cutter spindle on the knee.

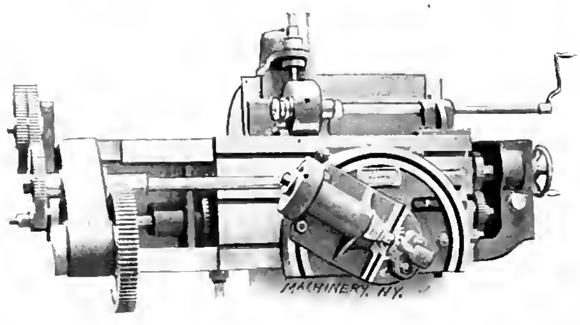

Fig 84. Helical Gear-cutting Attachment used with the Atlas Gear-cutting Machine shown in Fig. 34.

The cutter, at *B*, is driven by an internal gear *A* of large diameter (see also Fig. 51) and is mounted on a swivel table *C*, which can be set to the required helix angle. The form of cutter slide shown will give any angle up to 30 degrees. For greater angles, this is replaced with a slide which can be rotated to any angle throughout the whole circle.

The screw which feeds cutter slide *C* along the knee is driven from cone pulley *D*, through vertical shaft *E* and its gear connections. Cone pulley *D* is also connected with change gearing *F*, which is, in turn, connected with the index worm, so as to rotate index wheel *G*, and the work properly for any desired helix. The principle of this is the same as in the universal milling machine, change gears *F* acting the same as the change gears used to connect the spiral head with the table feed-screw in Fig. 81. Now the worm-wheel *G* is used for indexing, as well as for rotating the work for the helix,

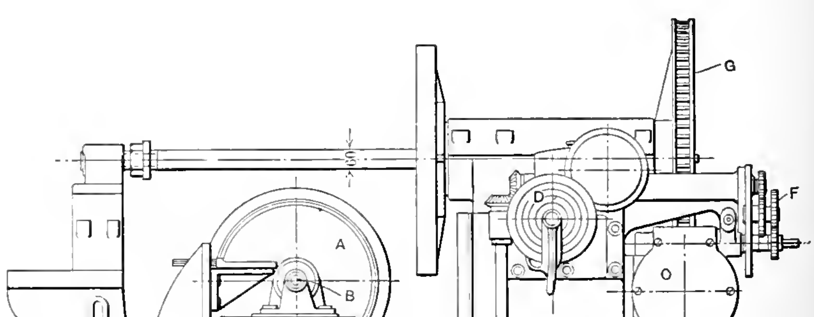

Fig. 85. Side View of the Reinecker Universal Gear-cutting Machine, showing the Geared Connections between the Index Worm-wheel and the Feed of the Cutter Slide.

in unison with the feeding of cutter slide *C*. The way in which these two motions are imparted to *G* without interfering with each other, may be understood by reference to Fig. 86; similar parts have similar reference letters in this engraving and the preceding one.

At *H*, on the opposite side of the machine from that shown in Fig. 85, are mounted the change gears by which the index-

ing is accomplished. These gears drive bevel gear J. Index worm K, meshing with index worm-wheel G, is mounted on a hollow sleeve, keyed fast to the bevel gear L. Shaft M carries a hub with projecting pivots on its right-hand end, on which are mounted bevel pinions N. Shaft M is driven by worm-wheel O, connected with the feed of the slide cutter through change gears F. Gears J, L and N form a differential mechanism of the well known "jack-in-the-box" type. The

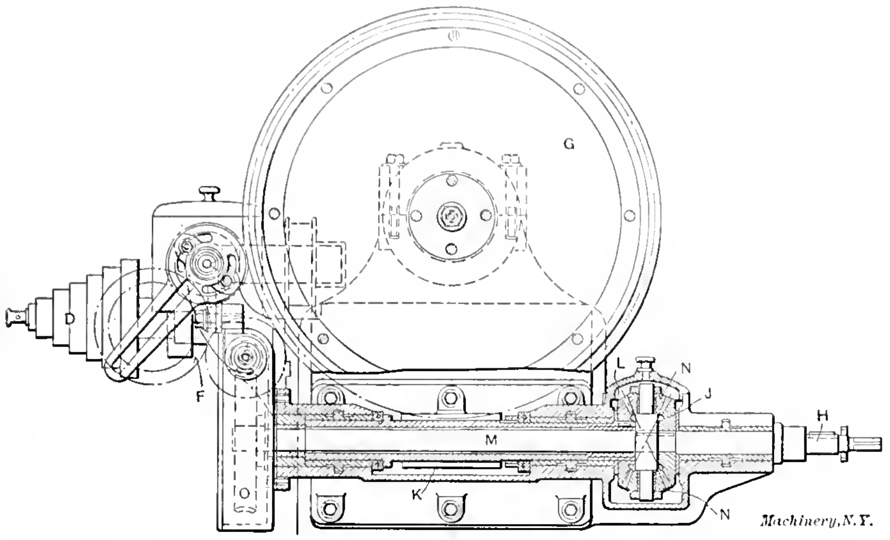

Fig. 86. Detail of the Machine in Fig. 85, showing the Differential Mechanism by which the Motions for Helical Cutting and for Indexing are combined to Rotate the Work.

action of this mechanism is such that if shaft M be at rest, change gears at H may be operated for the indexing, transmitting the motion from gear J to L through pinions N as idlers, thus revolving index worm K. On the other hand, with the indexing mechanism still and the cutter slide feeding, the movement thus imparted to shaft M may be transmitted (by the rolling of pinions N on stationary bevel gear J, and the consequent rotation of bevel gear L), to worm K, and thence to worm-wheel G and the work. It will thus be seen that the indexing, and the rotation for the helical cutting, can take place independently of each other. But more than this, the two motions can be operated together without interference. In fact, either of the motions imparted to shaft M or gears at H, may be stopped or reversed independently, and each will have its proper influence on the index wheel and the work.

With this understanding of the differential mechanism, the operation of the machine is easily comprehended. Change gears H are connected through a one-revolution friction trip with the main driving shaft. The cutter, set at the proper angle, is fed forward through the work, which is rotated by change gears F, shaft M, and worm K, at the proper rate to cut the proper helix. The cutter is then dropped down to clear the work (provision for this being made in the machine), and returned, ready to begin on a new tooth. The indexing mechanism is then tripped by hand, and the work is rotated into position for the new tooth, by change gears at H, gear J, and worm-wheel K. This is repeated until the gear is done.

A gear-hobbing machine made by Maschinenfabrik Lorenz of Ettlingen, Baden, Germany (to be described in the next installment of this series), cuts spiral gears in a fashion similar to the Reinecker machine just described. Owing to the fact that it is primarily designed for hobbing, however, it will be described with other machines of that type.

In the machines hitherto shown, power is applied to the feed-screw, from which the work is rotated through change gearing. This arrangement is best for helices of great lead. When it comes to milling helical gears with small leads, or worms, it is necessary to use the lathe principle and apply the power to rotating the work, the longitudinal feed being driven from the work spindle through change gearing. We show two examples of machines of this kind in Figs. 87 and 88.

The well-known thread milling machine made by Pratt & Whitney, Hartford, Conn., is illustrated in Fig. 87. Probably few mechanics have ever thought of this as being a gear-cutting machine, but it is here shown engaged in the perfectly legitimate work of cutting a worm, so that it should be classified with gear-cutting machinery of the kind described in this section of the article. The machine is so well known as to scarcely need description. The cutter spindle is mounted in a head which can be swiveled to any angle, and the slide which carries it is fed lengthwise along the bed, the proper lead being obtained by connecting the head-stock spindle and feed-screw by change gearing.

A second machine of this kind is shown in Fig. 88. It is built by J. E. Reinecker, of Chemnitz-Gablenz, Germany, and is intended especially for milling worms, although it is well adapted for small spiral gears also. The cutter, driven by worm gearing, is mounted in a heavy swiveling head, which is fed along the bed on ways at the rear of the machine. The adjustment for diameter is made by moving the work table, with its head- and foot-stocks, away from or toward the cutter. Cone pulleys and gearing are provided for varying the rate of feed of the cutter head, while the connection between the feed movement of the cutter and the rotation of the work is governed by change gears. On the worm-wheel which drives the

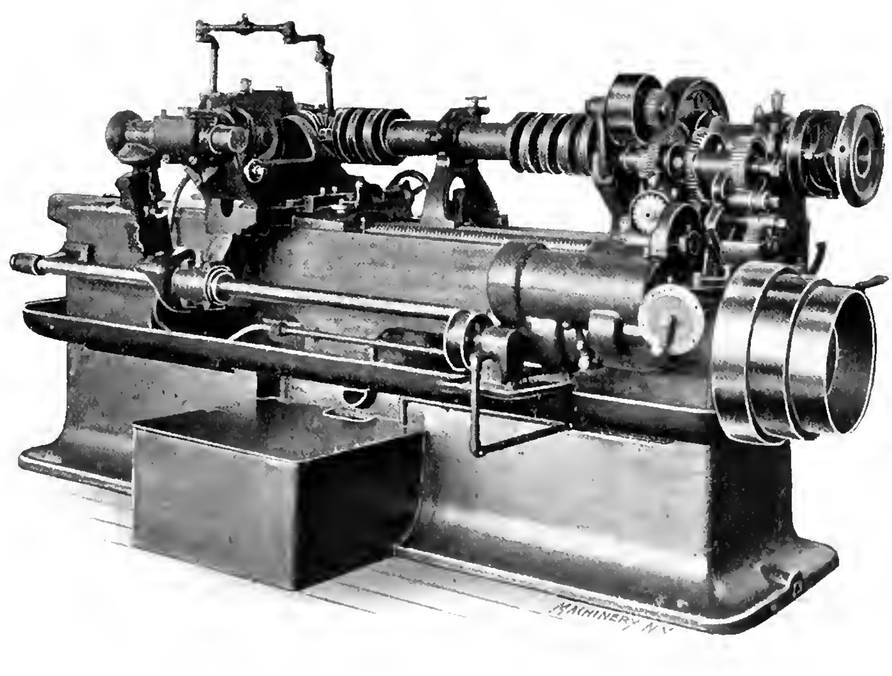

Fig. 87. The Pratt & Whitney Thread Milling Machine, engaged in Cutting a Worm

work spindle will be seen mounted a change gear mechanism which is used for indexing. The indexing is by hand, and the whole mechanism is carried around by the spiral movement, so that a differential mechanism is unnecessary.

Specialized Form Milling Machines for Herring-bone Gears.

A machine for helical gear cutting, but provided with some special features, is shown in Fig. 89. This machine is used by C. E. Wüst & Co., Seebach, Zurich, Switzerland, for cutting

herring-bone gears of a special form, in which it is unnecessary to cut the two halves separately, in separate sections, as is the usual case. As may be seen in Fig. 90, the cuts are staggered so that the teeth on one side run into the spaces on the other, in such a way as to permit cutting them with rotary cutters without having one side interfere with the other. The machine for doing this is built on a very simple plan, as may be seen. It consists of a vertical spindle carrying the work, which is apparently indexed by power. The

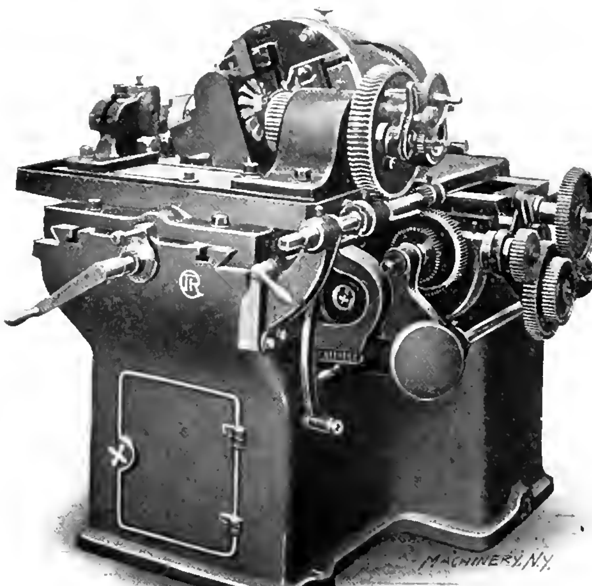

Fig. 88. The Reinecker Worm Milling Machine.

indexing wheel is connected by the usual change gearing with the two vertical slides on which the cutters are mounted on either side. These cutters work simultaneously, one feeding downward to cut the upper half, while the other is feeding upward to cut the lower half. It is not possible to say, from the information at hand, whether or not the machine is fully automatic. Probably it is not. The most interesting thing about the machine is its product; the large gear shown in the machine in Fig. 89, and the pinion shown in Fig. 90, are examples of two extremes in the range of work for which the process is applicable.

There is another specialized form of herring-bone gear which has been illustrated in MACHINERY,* that made by André Citroën & Co., 202 Rue de Faubourg St. Denis, Paris. The teeth of these gears, we are informed, are shaped by an

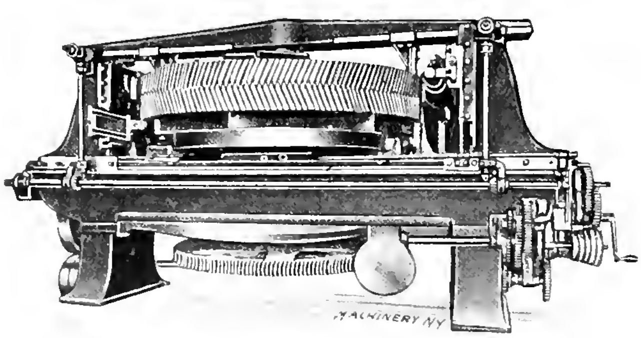

Fig. 89. Machine for Cutting Solid Herring-bone Gears by the Wust Process.

end cutter like that shown in Fig. 80, guided by suitable mechanism to produce the continuous "wavy" form of herring-bone teeth characteristic of these gears. This process also has the advantage of not requiring the blank to be made in two pieces. The same principle has been applied by the builders to the cutting of herring-bone bevel gears.

Other manufacturers make use of the formed end mill, to a limited extent, at least. The arrangement devised by Gould & Eberhardt for milling large helical gears in the lathe, recently illustrated in MACHINERY,* used this form of cutter, and the worms or spiral gears which drive the racks of the Sellers drive planers, made by at least one of our prominent planer builders, are cut by end mills in a specialized milling machine of simple design, made especially for this purpose.

* See article "Herring-bone Gearing with Cut Teeth," in the engineering edition of the April, 1903, issue of MACHINERY.

* See Figs. 3 and 4, in the article entitled "Emergency Methods in Gear Cutting," in the November, 1907, issue of MACHINERY.

* * *

PAINTING GALVANIZED IRON.

It is well known that ordinary paints will not adhere for any length of time to galvanized surfaces, unless the surface has been exposed to the weather for a long time—and not always then. Galvanized materials are usually dipped in a non-drying oil for the purpose of preventing atmospheric corrosion, and this neither combines with paint, nor permits a bond between the surface and the paint. Even when this oil has been removed, ordinary paints will not adhere to the zinc surface, and it is necessary to prepare the surface by changing it to an oxide of zinc. Exposure to the weather does this naturally, but slowly. The same thing may be accomplished in a short time by neutralizing the oil by an acid. The acid also forms a thin coating of zinc oxide, to which certain paints adhere very well. A very satisfactory wash for the purpose indicated consists of two ounces each of copper chloride, copper nitrate and sal-ammoniac, all dissolved in one gallon of soft water. After these are dissolved, add slowly two fluid ounces of crude hydrochloric (muriatic) acid, and stir carefully. Do not inhale the fumes. Of course, the solution must be made and kept in glass or earthenware jars or bottles, not only to avoid corrosion of the containing vessel, but to prevent precipitation of the copper salts.

Fig. 90. A 7-tooth Pinion, Formed by the Wust Process.

Cover the surfaace to be painted with this solution, using, preferably, a wide brush. The black appearance of the surface which immediately follows disappears within a few hours, and is replaced by the gray appearance characteristic of zinc oxide, the same as is seen after galvanized surfaces have been exposed to the weather for several months. Red lead, mixed with raw linseed oil and turpentine, half and half, will adhere very well to this surface. This may be followed by coats of any desired paint. A preliminary wash of vinegar, nine parts, and muriatic acid, one part, is recommended. It is to be followed by a priming coat of Prince's mineral brown, thinned with turpentine. Still another wash, consisting of nothing but vinegar or another dilute acetic acid, is recommended as giving satisfactory results in most cases. This, also, is to be followed by a priming coat of Prince's mineral brown, as above. O. M. B.

* * *

A gas engine of rather interesting design is described in a recent issue of the *Engineering Record*. In this design, the so-called "hit-and-miss" type of valve mechanism has been applied to the exhaust valve, the gear being spring-retained in its unlatched or inoperative position, so that unless specially actuated, the valve does not open to exhaust on the exhaust stroke. The spring, holding the latch or dog, is attached to a piston in a miniature cylinder, connected with one side of the main engine cylinder at such a point at the crank end that the engine piston uncovers the opening at the extreme outer stroke only, and admits the pressure of the exploded gases. The movement of the exhaust valve is so timed in relation to the admission of pressure to the miniature cylinder that the latch, which is forced out by the piston in the latter, is caught, and causes the exhaust valve to open for the regular exhaust of the cylinder; but, if the explosive mixture should not explode, due to omission of spark for speed regulation, then the miniature piston is not actuated, and the explosive charge is not exhausted and wasted, as with the usual gas engine construction.

JIGS AND FIXTURES.—1.*

EINAR MORIN.†

Einar Morin.‡

Jigs and fixtures may be defined as special devices made of cast iron, steel, or sometimes of wood, used in the manufacture of duplicate parts of machines, and intended to make possible interchangeable work at a reduced cost, as compared with the cost of producing each machine detail individually. The jigs and fixtures serve the purpose of holding and properly locating a piece of work, while being machined, and are provided with necessary appliances for guiding, supporting, setting, and gaging the tools in such a manner that all the work produced in the same jig or fixture will be alike in all respects, even with the employment of more or less unskilled labor. When using the expression "alike," it implies, of course, simply that the pieces will be near enough alike for the purposes for which the work being machined is intended. Thus, for certain classes of work, wider limits of variation will be permissible without affecting the proper use of the piece being machined, while in other cases, the limits of variation will be so small as to make the expression "perfectly alike" literally true.

Object of Jigs and Fixtures.

The main object of using jigs and fixtures is, of course, the reduction of the cost of machines or machine details being built or made in great number. This reduction of cost is obtained in consequence of the increased rapidity by which the machines may be built, and on account of the employment of cheaper labor, which is possible when using tools for interchangeable manufacturing. Another purpose, however, not less important, is the accuracy with which the work can be produced, making it possible to assemble the pieces produced in jigs without any great amount of work in the assembling department, thus also effecting a great saving in this respect.

The use of jigs and fixtures practically does away with the fitting, as this expression was understood in the old-time shop; it eliminates cut-and-try methods, and does away with the so-called patch work in the production of machinery. It makes it possible to have all the machines turned out in the shop according to the drawings, a thing which is rather difficult to accomplish if each individual machine in a large lot is built without reference to the other machines in the same lot.

The interchangeability obtained by the use of jigs and fixtures, makes it also an easy matter to quickly replace broken or worn-out parts without great additional cost and trouble. When machines are built on the individual plan, it is necessary to send somebody from the shop where the machine was built to the place where it is installed, in order to fit the part replacing the broken or worn-out piece, in place, and this would, in a great many cases, involve considerable extra expense, not to mention the delay and the difficulties occasioned thereby.

As previously mentioned, jigs and fixtures permit the employment of practically unskilled labor. There are a great many operations in the building of a machine, which, if each machine were built individually, without the use of special tools, would require the work of expert machinists and toolmakers. Special tools, in the form of jigs and fixtures, permit equally good, or, in some cases, even better results to be obtained by a much cheaper class of labor, provided the jigs and fixtures are properly designed and correctly made. Another possibility for saving, particularly in the case of drill and boring jigs, provided with guide bushings in the same plane, is met with in the fact that such jigs are particularly adapted to be used in multiple-spindle drills, thereby still more increasing the rapidity with which the work may be produced, and at the same time making the machine extremely productive, so as to reduce the shop cost of this machine to a minimum. In shops where a great amount of duplicate parts are made, containing a number of drilled holes, multiple spindle drills, of complicated design, which may be rather expensive as regards first cost, are really cheaper, by far, than ordinary simple drill presses.

Another point of advantage which has been gained by the use of jigs and fixtures, and which should not be lost sight of in the enumeration of the points in favor of building machinery by the use of special tools, is that the details of a machine that has been provided with a complete equipment of accurate and durable jigs and fixtures, can all be finished simultaneously in different departments of a large factory, without inconvenience, thus making it possible to assemble the machine at once after receiving the parts from the different departments; and there is no need of waiting for the completion of one part into which another is required to fit, before making this latter part. This gain in time means a great deal to a manufacturing concern in cases where the orders are coming in with great rapidity, so as to require the utmost speed in production. This rapidity was entirely impossible under the old-time system of machinery building, when each part had to be made in the order in which it went on the finished machine and each consecutive part had to be lined up with each one of the previously made and assembled details. Brackets, bearings, etc., had to be drilled in place, often with ratchet drills, which of course, was a slow and always inconvenient operation.

Difference between Jigs and Fixtures.

To exactly define the word "jig," as considered apart from the word "fixture," is rather difficult, as the difference between a jig and a fixture is oftentimes not very easy to decide. The word jig is frequently, although incorrectly, applied to any kind of a work-holding appliance used in the building of machinery, the same as, in some shops, the word fixture is applied to all kinds of special tools. As a general rule, however, we can say that a jig is a special tool, which, while it holds the work, or is held on the work, at the same time also contains guides for the respective tools to be used, while a fixture is only holding the work, while the cutting tools are performing the operation on the piece, without containing any special arrangements for guiding these tools. The fixture, therefore, must, itself, be securely held or fixed to the machine on which the operation is performed, hence the name. A fixture, however, may sometimes be provided with a number of gages and stops, although it does not contain any special devices for the guiding of the tools.

The definitions given, in a general way, would therefore define jigs as special tools used particularly in drilling and boring operations, while fixtures, in particular, would be those special tools used on milling machines, and in some cases, on planers, shapers, and slotting machines. Special tools used on the lathe may be either of the nature of jigs or fixtures, and sometimes the special tool is actually a combination of both, in which case the expression drilling fixture, boring fixture, etc., is in place.

Fundamental Principles of Jig Design.

Before entering upon a discussion of the minor details of the design of jigs and fixtures, we will briefly outline the fundamental principles of jig and fixture design. Whenever a special tool is made up for a component part of the machine, it is almost always required that a corresponding jig

* The following articles on the subject of jigs and fixtures have previously been published in MACHINERY: Milling Fixtures, November and December, 1905, January and February, 1906; Drill Jigs, November and December, 1906, January, 1907.

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is made up for the place on the machine, or other part, where the first-mentioned detail is placed. It is, of course, absolutely necessary that these two jigs be perfectly alike, as to the location of guides and gage points. In order to get the holes and guides in the two jigs in perfect alignment, it is advisable, and almost always attended with less cost, and with a gain in time, to transfer the holes or the gage points from the first jig made, to the other. In many instances, it is possible to use the same jig for both parts. Instances where the one or the other of these principles is applicable will be shown later in the detailed descriptions of drill and boring jigs. There are also cases where it is not advisable to make up two jigs, one for each of the two parts, which are to fit together. It may be that it is impossible to properly locate the jig on one of the parts to be drilled, or it may be that if the jig were made, it would be so complicated that it would not be economical. Under such conditions the component part, itself, may be used as a jig, and the respective holes or slots in this part used as guides for the tools when machining the machine detail into which it fits. Guide bushings for the drills and boring bars may then be placed in the holes in the component part itself. In many cases, drilling and boring operations are also being done, to great advantage, by using the brackets and bearings already assembled and fastened onto the machine body as guides.

One of the most important questions to be decided before making a jig is to what extent it is permissible to expend money on a special tool for the operation required. In many cases, it is possible to get a highly efficient tool by making it more complicated and more expensive, whereas a less efficient tool may be produced at very small expense. To decide which of these two types of jigs and fixtures should be designed in each individual case depends entirely on the circumstances. In any well managed shop there should be a careful comparison of the present cost of carrying out a certain operation, the expected cost of carrying out the same operation with an efficient tool, and the cost of building that tool itself. Unless this is done, it is likely that the shop is burdened with a great amount of special tools and fixtures which, while they may be very useful for the production of the parts for which they are intended, actually involve a loss. It is readily seen how foolish it is to make up an expensive jig and fixture for a machine or a part of a machine, that would only have to be duplicated a few times. In some cases, of course, there may be a gain in using special devices in order to get extremely good and accurate results.

Regarding the design of the jig, the most important requirements are that good facilities are provided for locating the work, and that the piece to be machined may be easily inserted and quickly taken out of the jig, so that no unnecessary time is wasted in placing the work in position on the machine performing the work. In some cases, a longer time is required for locating and binding the piece to be worked upon, in place, than is required for the actual machine operation itself. In all such cases the machine performing the work is actually idle the greater part of the time, and, added to the loss of the operator's time, is the increased expense for shop cost, incurred by such a condition. For this reason, the question of locating and binding the work in place quickly, and at the same time accurately, should be carefully studied by the designer before any attempt to design the tool is made. In choosing the locating surface or points of the piece or part, consideration must be given to the facilities of locating the corresponding part of the machine in a similar manner. It is, of course, highly important that this be done, as otherwise, although the jigs may be alike, as far as their guiding appliances are concerned, there may be no facility for locating the corresponding part in the same manner as the one already drilled, and while the holes drilled thus may coincide, other surfaces also required to coincide may be considerably out of line. For this reason, one of the main principles of location is that two component parts of the machine should be located from corresponding points and surfaces.

If possible, special arrangements should be made in the design of the jig so that it is impossible to insert the piece in any but the correct way. Mistakes are often made on this account in shops where a great deal of cheap help is used, pieces being placed in jigs upside down, or in some way other than the correct one, and work that has been previously machined and a great deal of time spent on, is entirely spoiled. Therefore, whenever possible, a jig should be made "foolproof."

When the work to be machined varies in shape and size, as for instance in the case of rough castings, it is necessary to have at least some of the locating points adjustable, and placed so that they can be easily reached for adjustment, but, at the same time, so fastened that they are, to a certain extent, positive. In the following installments different kinds of adjustable locating points will be described in detail. The strapping or clamping arrangements should be as simple as possible, without sacrificing effectiveness, and the strength of the clamps should be such as to not only hold the piece firmly in place, but to take the strain of the cutting tools also without springing or "giving."

When designing the jig, the direction in which the strain of the tools or cutters act upon the work should always be considered, and the clamps so placed that they will have the highest degree of strength to resist the pressure of the cut.

A cardinal principle in the application of clamps to a jig or fixture is that they should be convenient for the operator, quickly operated, and when detached from the work still connected with the jig or fixture itself, so as to prevent the operator from losing them, or, at least, from losing time hunting for them. Many a time, looking for lost straps, clamps, screws, etc., causes more delay in shops than the extra cost sometimes incurred in designing a jig or fixture somewhat more complicated, in order to make the binding arrangement an integral part of the fixture itself. Great complication in the clamping arrangements, however, is not advisable. Usually clamping arrangements of this kind work very well when the fixture is new, but as the various parts become worn, complicated arrangements are more liable to get out of order and the extra cost incurred in repairing often outweighs the temporary gain in quickness of operation.

Some of the principles mentioned may seem contradictory, and in fact, they are. There is, therefore, all the more reason to refer to the fact that the judgment of the designer is, in every case, the most important point in the design of jigs and fixtures. Definite rules for all cases could not be given. General principles can be studied, but the efficiency of the individual tool will depend entirely upon the judgment of the tool designer in applying the general principles of tool design to the case in hand.

When designing the jig or fixture, the locating and bearing points for the work, and the location of the clamps must also be so selected that there is as little liability as possible of springing the piece or jig, or both, out of shape, when applying the clamps. Either the one or the other part being sprung, will, of course, cause incorrect results when the piece is taken out of the jig, as it will then spring back into its natural position, and its surfaces will be out of alignment with the holes drilled or the faces milled. The clamps or straps should, therefore, in as far as it is possible, be so placed that they are exactly opposite some bearing point or surface on the work.

The designer must use his judgment in regard to the amount of metal put into the jig or fixture. It is desirable to make these tools as light as possible in order that they may be easily handled, be of smaller size, and cost less in regard to the amount of material used for their making, but, at the same time, it is poor economy to sacrifice anything of the rigidity and stiffness of the tool, as this is one of the main considerations for efficient results. On large-sized jigs and fixtures, it is possible to core out the metal in a number of places, without decreasing, in the least, the strength of the jig itself. The corners of jigs and fixtures should always be well rounded, and all burrs and sharp edges filed off, so as to make them convenient and pleasant for handling. Smaller jigs should also be made with handles in proper places, so that they may be held in position while working, if it be a drilling jig, and also for convenience in moving the jig about.

Boring jigs and drill jigs should always be provided with feet on all sides which are opposite the holes for the bushings.

or other provisions for guiding the tools, so that the jig can be placed square on the table of the machine. These feet also greatly facilitate the making of the jig, making it much easier to lay out and plane the different finished surfaces. On the sides of the jig, where no feet are required, if the body is made from a casting, it is of advantage to have small lugs, projecting out, for bearing surfaces when laying out and planing. While jigs are most commonly provided with four feet on each side, in some cases it is sufficient to provide the tool with only three feet, but care should be taken in either case that all bushings and places where pressure will be applied to the tool are placed inside of the geometrical figure obtained by connecting, by lines, the points of location for the feet.

While it may seem that three feet are preferable to use, because the jig will then always obtain a bearing on all the three feet, which it would not with four feet, if the table of the machine were not absolutely plane, it is not quite safe to use the smaller number of supports, because a chip or some other object is liable to come under one foot, and throw the

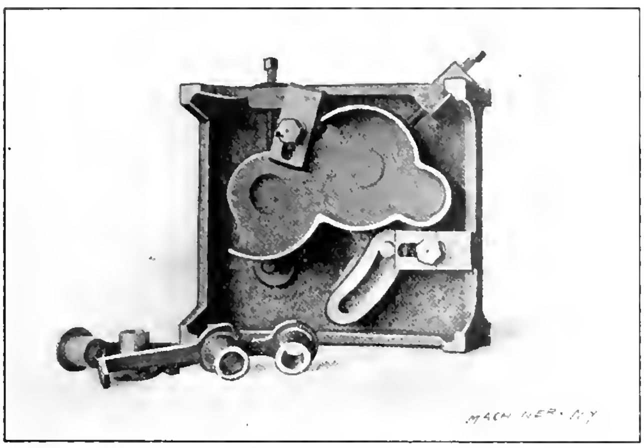

Fig. 1. Typical Open Drill Jig for Gear Guard.

Fig. 2. Open Drill Jig, showing Commonly Used Design.

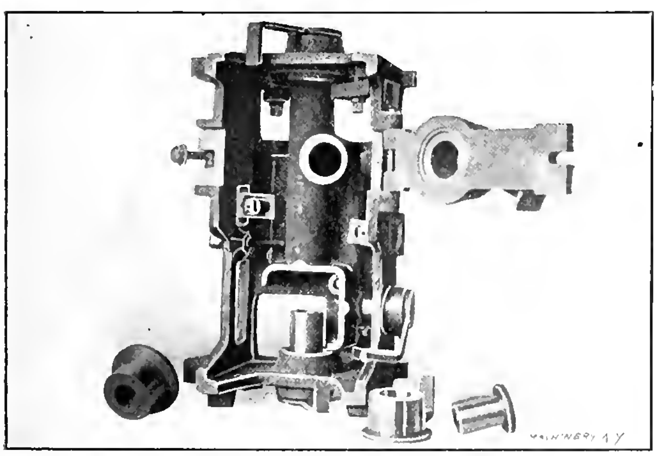

Fig. 3. Closed Drill Jig, showing Leaf Opened.

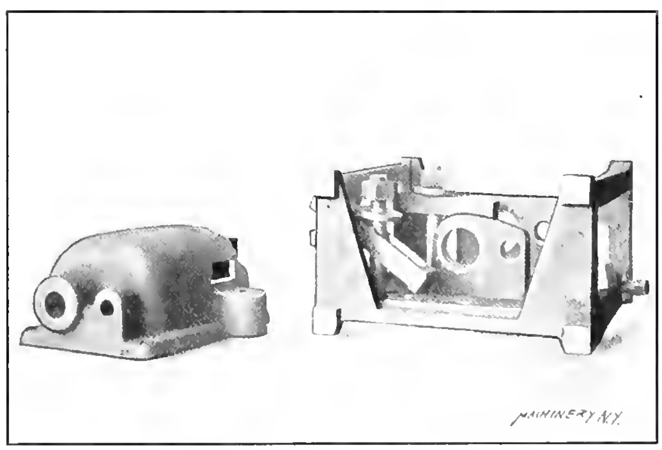

Fig 4 Combination Drill and Boring Jig.

jig and the piece out of line, without this being noticed by the operator. If the same thing happens to a jig with four feet, it will rock, and invariably cause the operator to notice the defect. If the table is out of true, this defect, too, will be noticed for the same reasons.

One mistake, quite frequently made, is giving too little clearance between the piece to be machined and the walls or sides of the jig used for it. Plenty of clearance should always be allowed, particularly when rough castings are being drilled or machined in the jigs; besides, those surfaces in the jig which do not actually bear upon the work, are likely to be made up with some slight variation from the dimensions on the drawing, particularly in a cast iron jig, and allowance ought to be made for such differences as well.

In regard to the locating points, it ought to be remarked that, in all instances, these should be visible to the operator when placing the work in position, so that he may be enabled to see that the work really is in its right place. At times the construction of the piece to be worked upon may prevent a full view of the locating points. In such a case a cored or drilled hole in the jig, near the locating seat, will enable a view of same, so that the operator may either see that the work rests upon the locating point, or, if the work be very particular, so that he can get a feeler or thickness gage between the work and the locating surface, to make sure that he has got the work in its correct position. Another point that should not be overlooked is that jigs and fixtures should be designed with a view to making them easily cleaned from the chips, and provision should also be made so that the chips, as far as possible, may fall out of the jig and not accumulate on or about the locating points, where they are liable to throw the work out of its correct position, and consequently spoil the piece.

The principles so far referred to have all been in relation to the holding of the work in the jig, and the general design of the jig for producing accurate work. Provisions, however, should also be made for clamping the jig or fixture to the table of the machine, in cases where it is necessary to have the tool fixed while in operation. Small drilling jigs, for instance, are not clamped to the table, but boring jigs, and milling and planing fixtures invariably have to be firmly secured to the machine on which they are employed. Usually plain lugs, projecting out in the same plane as the bottom of the jig, or lugs with a slot in them to fit the body of T-bolts, are the common means for clamping fixtures to the table. For boring jigs, it is unnecessary to provide more than three such clamping points, as a greater number is likely to cause some springing action in the fixture. Some springing effect is almost unavoidable, no matter how strong and heavy the jig is, but, by properly applying the clamps, it is possible to limit this springing to so small a limit as to permit it to be commercially disregarded.

When jigs are made, before they are used, they should always be tested so as to make sure that the guiding provisions are placed in the right relation to the locating points and in proper relation to each other.

Summary of Principles of Jig Design.

Summarizing the principles referred to in the previous discussion, we may state the following rules as being the main points to be considered in the designing of jigs and fixtures.

1. Before planning the design of a tool, compare the cost of production of the work with present tools, with the expected cost of production, using the tool to be made, and see that the cost of building is not in excess of expected gain.
2. Before laying out the jig or fixture, settle upon the locating points and outline a clamping arrangement.
3. Make all clamping and binding provisions as quick acting as possible.
4. In selecting locating points, see that two component parts of a machine can be located from corresponding points and surfaces.
5. Make the jig "fool-proof," that is, arrange it so that the work cannot be inserted except in the correct way.
6. For rough castings, make some of the locating points adjustable.
7. Locate clamps so that they will be in the best position to resist the pressure of the cutting tool, when at work.
8. Make, if possible, all clamps integral parts of the jig or fixture.
9. Avoid complicated clamping arrangements, which are liable to wear or get out of order.

Classes of Jigs and Fixtures.

The two principal classes of jigs are drill jigs and boring jigs. Fixtures may be grouped as milling, planing, and splining fixtures, although there are a number of special fixtures which could not be classified under any special head.

Drill Jigs.

Drill jigs are intended exclusively for drilling, reaming, tapping and facing. Whenever these four operations are required on a piece of work, it is usually possible to provide the necessary arrangements for all these operations being performed in one and the same jig. Sometimes separate jigs are made for each one of those operations, but it is doubtless more convenient and cheaper to have one jig do for all, as the design of the jig will not be much more complicated. Although it may be possible to make a distinction between a number of different types of drill jigs, it is almost impossible

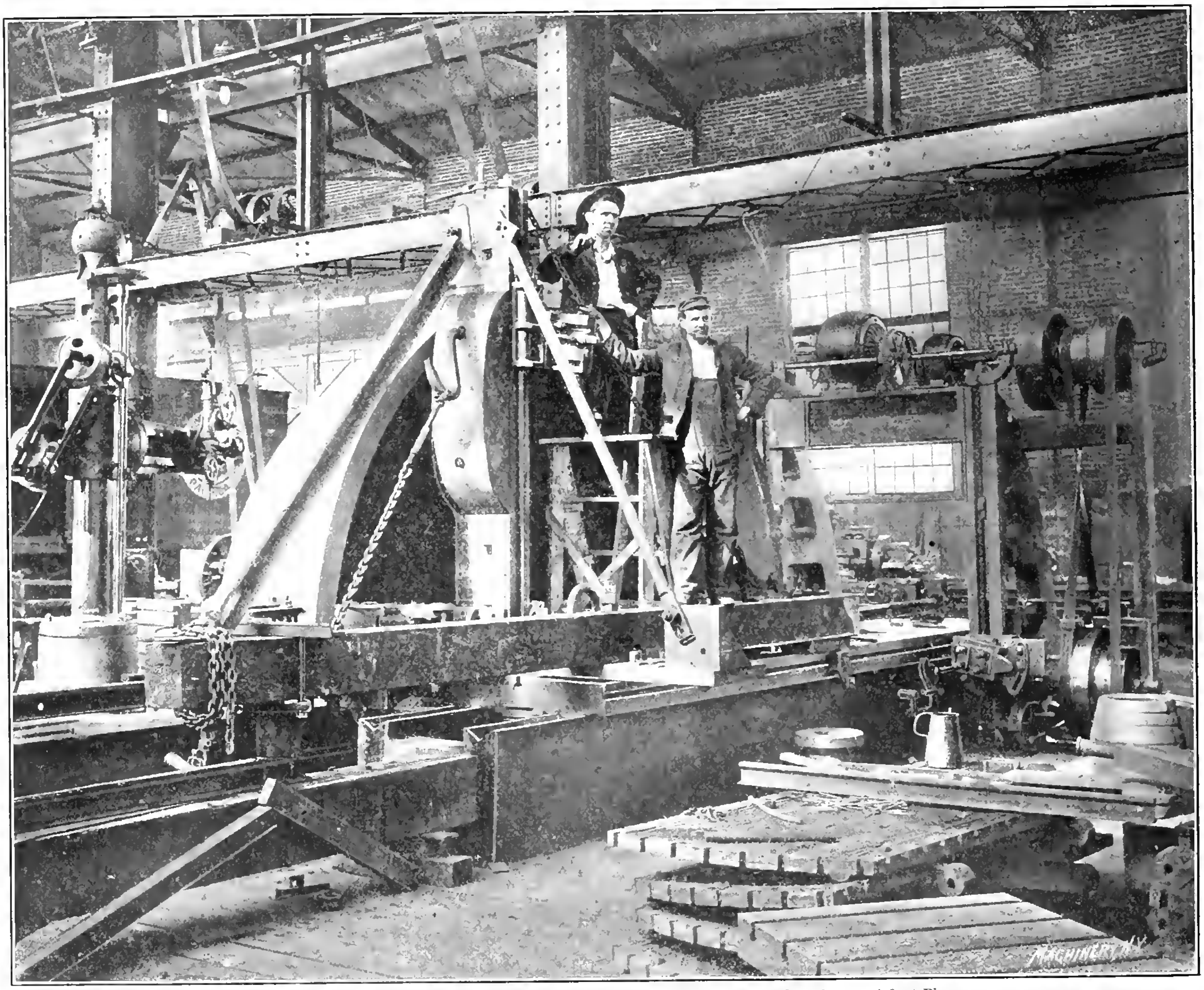

Fig 1 View showing how the Large Casting Illustrated in Fig 2 was planed on a 4-foot Planer.

10. Place all clamps as nearly opposite some bearing point of the work as possible, to avoid springing.
11. Cut out all unnecessary metal, making the tools as light as possible consistent with rigidity and stiffness.
12. Round all corners.
13. Provide handles wherever these will make the handling of the jig more convenient.
14. Provide feet, preferably four, opposite all surfaces containing guide bushings in drilling and boring jigs.
15. Place all bushings inside of the geometrical figure formed by connecting the points of location of the feet.
16. Provide abundant clearance, particularly for rough castings.
17. Make, if possible, all locating points visible to the operator when placing the work in position.
18. Provide holes or escapes for the chips.
19. Provide clamping lugs, located so as to prevent springing of the fixture, on all tools which must be held to the table of the machine while in use, and tongues for the slots in the tables in all milling and planing fixtures.
20. Before using in the shop, for commercial purposes, test all jigs as soon as made.

to define and to get proper names for the various classes, owing to the great variety of shapes of the work to be drilled. There are, however, two general types that are most commonly used, the difference between which is really very noticeable at sight. These types may be classified as open jigs and closed jigs, or box-jigs. Sometimes the open jigs are called clamping jigs, although it is difficult to see a good reason for this name. The open jigs usually have all the drill bushings in the same plane, parallel with one another, and are not provided with loose or removable walls or leaves, thereby making it possible to insert the piece to be drilled without any manipulation of the parts of the jig. These jigs are often of such a construction that they are applied to the work to be drilled, the jig being placed on the work, rather than the work being placed in the jig. The work is held to the jig (or the jig to the work) by straps, hook bolts or clamps. Figs. 1 and 2 show types of open drill jigs.

The closed drill jigs, or box-jigs, frequently resemble some form of a box, and are intended for pieces where the holes are to be drilled at various angles to one another. As a rule, the walls are solid with the face of the jig, and the piece to be drilled can be inserted only after a leaf or some leaves or covers have been swung out of the way. Sometimes it is necessary to remove a loose wall, which is held by screws and dowel pins, in order to locate the piece in the jig. The work in the closed drill jig is generally held in place by set-screws and sometimes by screw bushings, as well as by straps and hook bolts. Fig. 3 shows an example of a typical closed jig. Another type of closed jig is exemplified in a combination of drill and boring jigs, which are designed to serve both for drilling and boring operations.

Before designing a combination drill and boring jig, the relation between, and number of, the drilled and bored holes must be taken into consideration, and also the size of the piece to be machined. In case there is a great number of holes, it may be of advantage to have two or even more jigs for the same piece, because it makes it easier to design and make the jig, and very likely will give a better result. The holes drilled or bored in the first jig may be used as means for locating the piece in the jigs used later on. It is plain that combination drill and boring jigs are not very well adapted for pieces of large size. In Fig. 4 is shown a typical combination jig, where the bushings for guiding the drills are indicated in the bottom surface, the work upon which the operations are performed being shown at the left-hand side in the cut.

* * *

DIFFICULT PLANING JOB.

JOHN McLEOD.

The accompanying half-tone and line cut show how a difficult and unusual job was planed in the Payne & Jouberts shop, Birmingham, Ala. The work to be planed consisted of eight halves of four 14-foot sugar-pan domes, which were required to be planed where the faces of the two halves were fitted together. This planing job was carried out on a 4-foot Pond planer in the following manner: Two 24x24-inch angle

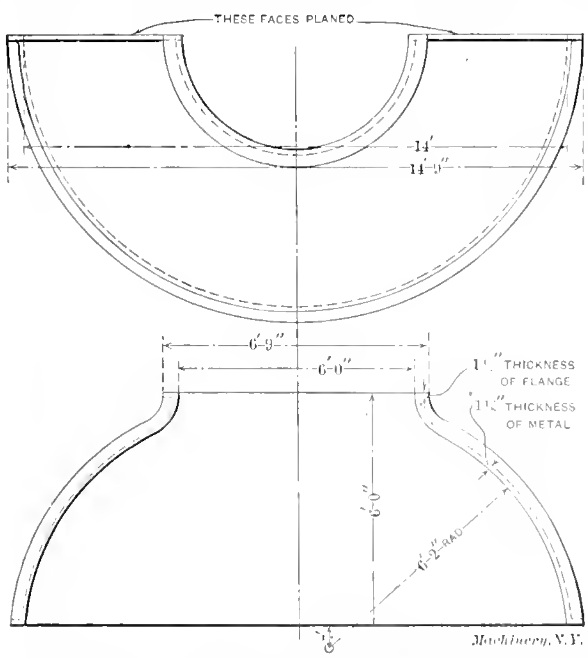

Fig. 2. Detail of the Casting which was planed as shown in Fig. 1.

plates were first bolted to the side of the planer bed, and the work then bolted to these angle plates, screw jacks supporting them at the other end, together with braces from the work to the planer housing. Then the cross-rail was taken off from its place, and securely bolted on end and braced on front and side, two foundry weights being clamped on the planer table for supports, as indicated in the half-tone, Fig. 1. In this manner the work was carried out to full satisfaction, and after the first half was finished, which, of course, took somewhat longer on account of the considerable rigging necessary, the balance of the work was finished at the rate of one-half of a dome in 12 hours.

THE LADY MANAGER AND THE FLY-WHEEL BID.

M. E. CANEK.

We read and hear much nowadays about the new woman and the wide swath she cuts in the business world. Personally, I think there is a good deal of nonsense written and talked about the matter. Most women are the same as their mothers and their grandmothers in preferring the quiet joys of housekeeping and domesticity to anything else. The hurly burly, trials and uncertainties of business life may be quite to the taste of a small percentage of women but not of the large majority. When a woman *does* take hold of a business job it is with deadly earnestness. She is "on the job" all the time, and woe to the unlucky chap who thinks that just because she is a woman he can play up monkeyshines instead of doing straight business. Now this story is not about a crooked business deal. On the contrary, it is about a gentleman general manager who pitted himself against a lady general manager in a straightforward business proposition, but who, nevertheless, felt very small after the deal had been consummated—entirely to the lady's liking. The incident occurred a few years ago in a thriving city not a thousand miles from New York.

Mr. Gray was the G. M. of the Snapshot Works, a concern noted for its enterprise, broad business policy and remarkable growth. Its handsome buildings, modern shop methods, fine business system and efficient selling department were the envy of would-be competitors the world over. Miss Brown was the G. M. of the Cog Works where cogs in all sorts of styles and shapes were whittled out of wood, brass, cast iron, steel or whatever material you wanted them made of. The "works" also made castings large and small, for all comers. I forgot to say that the cogs generally were on wheels. Some fastidious individuals may prefer to call them gears, and they are welcome to do so for all I care.

One morning late in September the engineer of the Snapshot Works discovered that the fly-wheel on the auxiliary engine used to run the lighting dynamo and to furnish power when part of the plant was working nights, had three spokes cracked. Though the wheel was in no immediate danger of breaking down, it was deemed advisable to get a new one as soon as possible. With characteristic energy and promptness, Mr. Gray issued calls to the large foundries of the city and the neighboring towns for bids on a new fly-wheel, fifteen feet diameter, weight about five tons, and *cast in one piece*. Now the only foundry in the home city that could or would handle the job was the Cog Works, and the G. M. of the Snapshot Works fully expected that this concern would get the job. The call for bids was more of a bluff to get a favorable price than anything else.

Well, a week passed and no bid was received from the Cog Works; in fact no acknowledgement was made of the letter asking for bids. Finally Mr. General Manager "called up" Miss General Manager, and in tones of some asperity demanded to know why no bid had been made on the fly-wheel.

"Is this Mr. Gray?"

"Yes."

"Well, Mr. Gray, we really haven't thought it worth while to make a bid on your fly-wheel."

"What! Don't you want the job?"

"I didn't say so. I simply said we didn't think it worth while to make a bid."

"How do you expect to get the job if you don't make a bid?"

"Can't you simply send the order over by a messenger, Mr. Gray?" (in sugary tones).

"Why, I tell you this job is going to be let to the lowest bidder."

"Yes, I know that, but aren't we just the same as the lowest bidder?"

"Why, how you talk. You haven't even made a bid, and you know that Jones of Pisgah and Smith of Ararat are just hot after such jobs."

"Yes, but they are not going to make your wheel. Now, Mr. Gray, have you thought of the fact that a fifteen-foot wheel is just a little too large to be carried on a railroad car?"

"Well, I'll be—er-er—excuse me, madam. Say, er-er—we'll send the order over this afternoon. Good-by."

"Good-by, Mr. Gray."

* * *

THE ARRANGEMENT OF FLOORING WITH REGARD TO SPRINKLERS.

The designs for the ordinary shop or mill are usually carried into material effect before the question of sprinklers is taken up. It may then be discovered that a different spacing of the timbers might have made a material change in the cost of the sprinkler system. Of course, prices will vary with localities, but taking a given case, an interesting comparison may be made. The fundamental rule of the insurance company was that no sprinklers should be called upon to serve a plain surface exceeding 100 square feet between timbers, and that for any less undivided space, unless a very small one, one sprinkler would be required. Fortunately the building was laid out on a 20-foot unit basis, and in the case of the roof, the timbers 20 feet long were spaced 10 feet on centers, keeping just within the limit, which called for two sprinklers for 200 square feet of space. But the main floors were planned for the spacing of timbers 20 feet long on 4-foot centers, leaving 3 feet between timbers, and establishing a plain surface under the floors measuring approximately 3 feet by 20 feet, or 60 square feet. As a result, five sprinklers were required instead of four in a given 20 feet square, an increase of 20 per cent in the sprinkler cost over what was required for the same total roof area. In this particular case, where the sprinkler equipment was installed on the basis of $3.00 per head, the cost for two floors was about $800.00 more than would have been necessary if it had been given an opportunity to serve the maximum area of 100 square feet. Here the expense of a framing arrangement to secure the minimum cost of sprinkler system per square foot would have increased the size of timbers through increasing their spacing on centers at a cost probably about equal to the saving in sprinklers. But in another building, in the same group, designed on different lines, the opportunity for a net saving was sufficiently manifest to attract attention, and suggest the necessity of giving thought to a matter not often considered.

* * *

Some interesting information regarding the over-supply of technically educated people in Germany, is furnished by the *Technik und Wirtschaft*, a supplement to the well-known *Zeitschrift des Vereines deutscher Ingenieure*. It appears that, at the present time, the German technical schools turn out a great many more well educated young men than there is actual demand for in the industries of the country. Even official opinions have been expressed in the matter, and the Bavarian press gives place to a statement from an official source, in which young men are discouraged, for the present, from entering into the technical field, as there is, at the present time, in the government service no opportunity for the great number of young men who have intended to enter into the service of the State Railways and the government Public Works department. Attention is also called to the comparatively small salaries received by technically educated men, caused, to a great extent, by the keen competition offered on account of the oversupply. In this connection, it may be of interest to mention the number of students at the ten highest German technical institutions. The total for the year 1907-1908 is 15,720, as compared with 15,453 in the previous year, the largest number of regular students being at the Hochschule at Munich, where there are 2,325, as compared with 2,291 regular students at the Berlin Hochschule.

A STUDY IN SPIRALS.

WALTER GRIBBEN.*

In cutting a spiral gear in a milling machine as ordinarily arranged, it is necessary to set the table to the helix angle in order that the sides of the cutter may not interfere, or drag in the cut. But the helix angle varies with the depth, being greatest at the top of the tooth, less at the pitch line, and still less at the bottom of the cut. In fact, if the cut were deep enough to reach all the way to the center of the piece being operated on, the helix angle would become zero, or parallel to

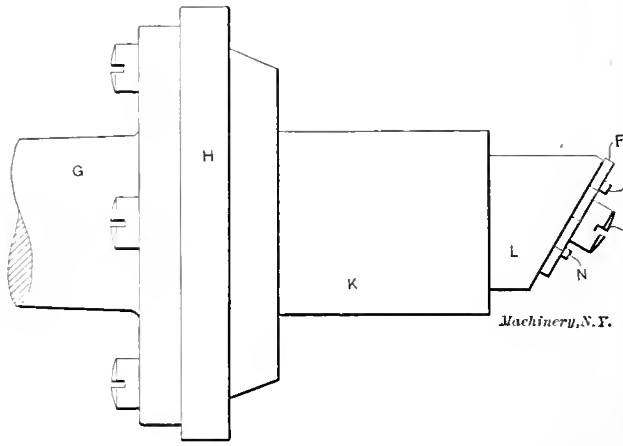

Fig. 1. Chuck for Mounting the Pieces shown in Fig. 2.

the center line. If the general run of mechanics were asked what would be the proper angle at which to set the table, I think they would say that the helix angle at the pitch line would be the one to determine the setting of the table, and I used to think so myself. This setting has the effect of making the width of the cut exactly right at the pitch line, but it does so at the expense of undercutting and weakening the teeth. For quite some time past I have thought that the helix angle at or near the bottom of the cut should be the one to set the table to in order to get a strong tooth, and to convince other mechanics of the correctness of this view I made the following experiments:

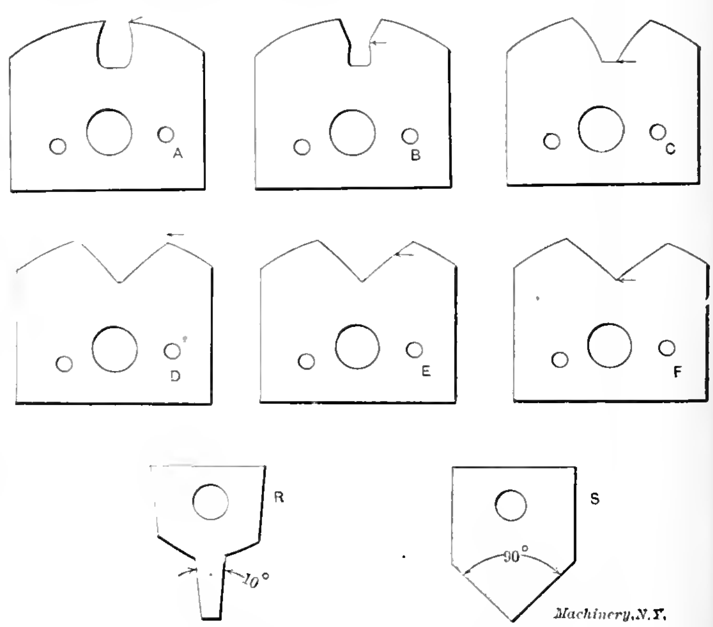

Fig. 2. Pieces milled on the Chuck, Fig. 1, with Fly-cutters R and S, showing the Effect of varying the Pitch Circle.

The piece *G*, Fig. 1, is a cast iron taper stem with a flange cast on, and fits in the dividing head of the milling machine. *H* is a brass chuck that was made for another job, and is fastened to *G* with four screws. *K* is a piece of 1¾-inch round brass, with the ends faced true, while *L* is a piece of scrap brass with two faces machined at an angle of 30 degrees, one of these faces being tapped for the screw *M*, and also containing the two dowel pins *N*. *H*, *K* and *L* are sweated together with soft solder.

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The six pieces of sheet brass, A, B, C, D, E and F, Fig. 2, were drilled so they would fit onto the dowel pins in the 30-degree face of the improvised chuck, F being shown in place in the line cut, Fig. 1. These six pieces were placed in succession on this chuck and the curved edges of all turned to a diameter of 1.23 inch. I wanted to make a spiral cut in each of these six pieces, varying the setting of the table angle, and also the shape of the cutter, and compare the shape of the cut with that of the cutter that made it.

The lead used was 5.33 inches to one turn, and the depth of cut ¼ inch, both these elements being alike in all six cases. The pieces of sheet brass were intended to stand at right angles with the cut, but, of course, this was impossible, as the helix angle varied with the depth, so I made them stand at right angles with the helix at half depth. Assuming this helix angle to be 30 degrees ,we can find the diameter of the imaginary cylinder whose surface is at half the depth of the cut by multiplying the lead, 5.33 inches, by the tangent of 30 degrees, and dividing by 3.1416, which gives 0.98 inch. Adding 0.25 inch to this, we get 1.23 inch for the outside diameter, and also by subtracting 0.25 from 0.98 we get 0.73 inch for the diameter at the bottom of the cut.

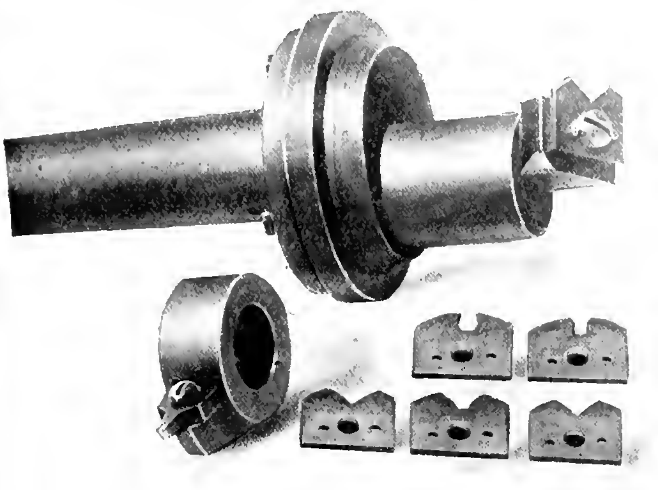

Fig. 3. Chuck, Fly-cutter, and Pieces milled in Experiments Described

Knowing the outside diameter to be 1.23 inch, we multiply this by 3.1416 and divide by 5.33 to get the tangent of the helix angle at the top, which we find to be 35 degrees 56 minutes. In a similar manner we multiply the bottom diameter, 0.73, by 3.1416 and divide by 5.33 to get the tangent of the helix angle at bottom of cut, which we find to be 23 degrees 17 minutes.

The cutter used in this job was a fly-cutter, the holder being shown in the half-tone illustration Fig. 3, while its blades, R and S, are shown in the line illustration Fig. 2. R was used to cut A, B and C, while S was used to cut D, E and F. The table setting was nearly 36 degrees for A and D, 30 degrees for B and E, and about 23¼ degrees for C and F.

The shapes of the cuts show that the width of the cutter is accurately reproduced only at the particular depth where the helix angle is the same as the table setting, this point being shown by the arrow heads at the sides of the various cuts. The shapes of the cuts also show that the departure from the true form of the cutter due to faulty table setting is less in the case of the more flaring cutter S than in the case of cutter R, whose sides come nearer to being parallel.

This demonstrates to my mind that the table setting for a spiral gear should be the same as the helix angle at or near the bottom of the cut, because at this point the sides of the cutter come closer to parallelism, while at the top of the cut they are more flaring, and the table setting not being correct for the helix angle at this point would produce a comparatively slight error.

This also suggests a slight modification in selecting a cutter to do the job, as the tops of the teeth would be rounded off somewhat more than in the case of a spur gear cut with the same cutter. Therefore, it would be well to select a cutter for a greater number of teeth than the spiral gear formula $T = \frac{N}{\cos^3 a}$ calls for.

Setting the table for a less angle than that of the pitch line helix also has the effect of slightly increasing the width of the cut at the pitch line, but not to the extent that a comparison of C and R would seem to indicate, as in the experiments here described the depth of the cut was purposely made a very large percentage of the diameter in order to accentuate the errors due to faulty setting of the table, and if the table is to be set correct for the bottom of the cut, it might be well to consider the normal circular pitch as slightly greater than that rightfully belonging to the cutter in use, and size the blank accordingly. These experiments were entirely of a qualitative nature, and were only intended to guide the judgment of the designer and the man who puts the design in material form in cold metal.

[Those not thoroughly familiar with universal milling machine use should carefully distinguish between the table angle and the helix angle produced by the gearing of the dividing head. The dividing head is geared to produce the required helix angle, measured on the pitch line the same as usual, of course. What Mr. Gribben advocates, in order to reduce interference, is simply setting the table to some helix angle between the pitch line and the dedendum or root circle rather than to the helix angle indicated by the pitch line. A point worth attention, also, is that the interference of a cutter increases with increase of diameter. Small cutters, therefore, tend to reproduce their outlines more accurately than large cutters, other things being equal.—EDITOR.]

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NOTES ON HIGH-SPEED STEEL.

In a discussion regarding the manufacture and up-keep of milling cutters, at a meeting of the Institution of Mechanical Engineers, of Great Britain, one of the speakers called attention to one valuable property of high-speed steel, which he has not seen referred to, namely, that of withstanding shocks. In one of the railway shops in England, the output of the crank-turning lathes had been practically doubled by the use of high-speed steel tools. The forgings were never very accurate, there being perhaps ¼ inch to take off one side of the diameter, and 1½ inch off the other, and a tool suited to such wide variation was greatly appreciated. If the high-speed steel tool dug in, it did not break, as invariably happened with ordinary carbon steel.

Another speaker called attention to an important factor affecting the life of high-speed steel milling cutters. The teeth, besides being correctly relieved at the back should have a front rake of 5 degrees, as indicated in the accompanying cut. The number of teeth in milling cutters, particularly when made of high-speed steel, plays a very important part. A cutter made of this material with a large number of teeth, has a considerably shorter life than one with fewer but deeper teeth. In a certain case, two milling cutters, one with 16 teeth, and one with 32 teeth, had been made. The one with the coarser teeth, of helical shape, would finish an article with as good a finish as the one with the finer pitched teeth, but the cost of making the coarse-pitched cutter was 35 per cent less than the cost of making the one with the fine-pitched teeth, and the life of the coarse-pitched cutter was four or five times as long as that of the other.

* * *

Messrs. Gebrüder Sulzer, Winterthur, Switzerland, have recently devised a method of working internal combustion compressed air engines, which consists in one of the two ingredients of the charge required for burning, that is, either the air or the combustible gas alone, being introduced under pressure into the engine cylinder, and enclosed therein. The other ingredient is introduced in such a manner that the combustion process takes place during the whole of the time of the introduction, and is regulated according to the load. The temperature required for ignition is produced inside the working chamber, by any ignition device, without the fuel previously having been heated to its ignition temperature.

TAPER TAPS.—2.

ERIK OBERG.*

English Taper Pipe Taps.

English taper pipe taps constitute a special class of taper taps. These, most tap manufacturers in this country make exactly like the Briggs' standard pipe taps in regard to dimensions, the only difference being that the English taper pipe taps are provided with Whitworth form of thread, and with such a number of threads per inch as is called for by the standard for Whitworth standard gas and water pipe thread. It appears, however, that in England these taps are made with 1 inch taper per foot, instead of ¾ inch, and at least one firm in this country makes these taps with the taper according to this practice.

Pipe taps and taper taps in general are often made with the interrupted or Echols' thread shown in Fig. 6. A more

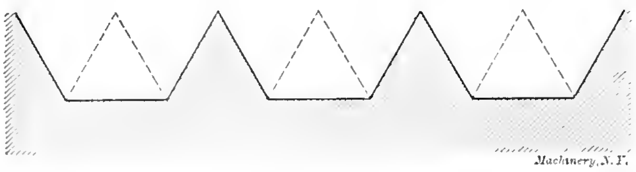


Fig. 6. Interrupted or Echols' Thread.

complete reference to this thread was made in an article entitled "Machine Taps," in the February, 1907, issue of MACHINERY. This form of thread is very well adapted for taper taps, and, in case of a very steep taper, is, in fact, almost essential if a smooth and perfect thread is to be cut. In hardening, pipe taps should be drawn to a somewhat higher temperature than ordinary hand taps of the same sizes. The correct temperature is about 470 degrees F.

Pipe Hobs.

Pipe hobs are used for sizing pipe dies, after the thread has been cut nearly to size either in a lathe or by a pipe tap. The length of the thread of a pipe hob is made longer than that of pipe taps, but there is not any very good reason why it should be so, excepting that it has become customary, and

TABLE V. DIMENSIONS OF PIPE HOBS.

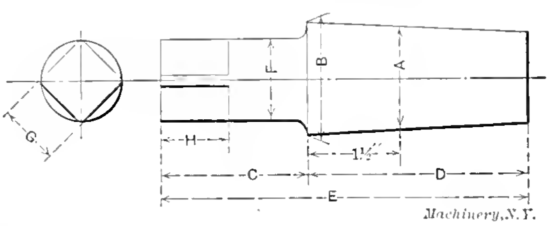


Fig. 7.

Nominal Size.	Actual Size.	Diameter at Large End.	Length of Shank.	Length of Thread.	Length over all.	Diameter of Shank.	Size of Square.	Length of Square.
	A	B	C	D	E	F	G	H
1/8	0.445	0.539	2	3 3/16	5 3/16	3/8	5/16	1/4
1/4	0.573	0.667	2	3 3/8	5 3/8	1/2	3/8	5/16
3/8	0.719	0.813	2 1/16	3 1/2	5 9/16	5/8	7/16	3/8
1/2	0.885	0.979	2 1/16	3 5/8	5 11/16	13/16	5/8	3/4
3/4	1.104	1.198	2 1/8	3 7/8	6	1 1/16	13/16	1
1	1.363	1.457	2 1/8	4	6 1/8	1 5/16	1	1 1/8
1 1/4	1.721	1.815	2 3/16	4 1/8	6 5/16	1 5/8	1 1/4	1 1/4
1 1/2	1.955	2.049	2 3/16	4 1/4	6 7/16	1 7/8	1 7/16	1 3/8
2	2.460	2.554	2 1/4	4 1/2	6 3/4	2 3/8	1 13/16	1 1/2
2 1/2	2.963	3.057	2 5/16	4 11/16	7	2 7/8	2 3/16	1 5/8
3	3.620	3.714	2 3/8	4 7/8	7 1/4	3 9/16	2 5/8	1 3/4
3 1/2	4.062	4.156	2 7/16	5 1/16	7 1/2	3 11/16	2 13/16	1 3/4
4	4.485	4.579	2 1/2	5 1/4	7 3/4	3 3/4	2 13/16	1 7/8
4 1/2	5.000	5.094	2 9/16	5 3/8	7 15/16	3 13/16	2 7/8	1 7/8
5	5.565	5.659	2 5/8	5 1/2	8 1/4	3 7/8	2 15/16	2
6	6.620	6.714	2 3/4	5 3/4	8 1/2	4	3	2

established custom is as unyielding in tool making as in anything else. Outside of the longer length of thread, the only essential difference from the pipe tap is the number and the form of the flutes. These latter are cut with a 50-degree double-angle cutter, 25 degrees angle on each side, which is the same kind of a cutter as is used for ordinary straight hob taps. The number of the flutes may be approximately determined by the formula

$$8.5\,B = N$$

in which B equals the diameter at large end of thread of hob, and N equals the number of flutes.

With this formula, the width of each land is about 3/16 inch, and the width of the space or flute is the same amount. According to this formula the number of flutes for various sizes of pipe hobs are as follows:

TABLE VI. NUMBER OF FLUTES IN PIPE HOBS.

Size of Pipe Hob.	No. of Flutes.	Size of Pipe Hob.	No. of Flutes.
1/8	5	2	22
1/4	6	2½	26
3/8	6	3	32
1/2	8	3½	36
3/4	10	4	40
1	12	4½	44
1¼	16	5	48
1½	18	6	58

Dimensions of Pipe Hobs.

The dimensions for lengths and diameters of pipe hobs are given in Table V. The dimension A is given according to the established standard of the manufacturers of taps. This is the essential diameter and is located 1½ inch from the large end of the thread of the hob. The limit of error for the location of this diameter is the same as the limit for the location of the size line of pipe taps which was stated in the March issue, and the gaging is done in the same manner. It is evident that a separate set of ring gages are required, and that the length of the gage in this case always should be 1½ inch, the large diameter of the hole in the gage being diameter B in Fig. 7, and the small diameter the dimension A. The taper of pipe hobs is, of course, the regular pipe thread taper, ¾ inch per foot.

The more important dimensions in Table V are figured from the formulas:

$$C = \frac{N + 16}{8}, \qquad D = \frac{5\sqrt{N} + 11}{4},$$

$F = A - 1/16$, for pipe sizes up to and including 3 inches,

$F = \frac{N}{8} + 3\frac{1}{4}$, for 3½-inch pipe sizes and larger.

TABLE VII. DIMENSIONS OF TAPER BOILER TAPS.

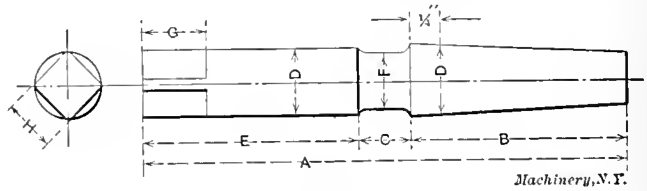


Fig. 8.

Diameter of Tap and Shank.	Total Length.	Length of Thread.	Length of Neck.	Length of Shank.	Diameter of Neck.	Length of Square	Size of Square.
D	A	B	C	E	F	G	H
1/2	4 1/4	2 1/4	1/2	1 1/2	11/32	1/2	3/8
9/16	4 7/16	2 5/16	1/2	1 5/8	13/32	9/16	7/16
5/8	4 5/8	2 3/8	1/2	1 3/4	15/32	5/8	15/32
11/16	4 13/16	2 3/8	9/16	1 7/8	17/32	11/16	1/2
3/4	5	2 7/16	9/16	2	19/32	3/4	9/16
13/16	5 3/16	2 1/2	9/16	2 1/8	21/32	13/16	5/8
7/8	5 3/8	2 9/16	9/16	2 1/4	23/32	7/8	11/16
15/16	5 9/16	2 9/16	5/8	2 3/8	25/32	15/16	11/16
1	5 3/4	2 5/8	5/8	2 1/2	27/32	1	3/4
1 1/16	5 15/16	2 11/16	5/8	2 5/8	29/32	1 1/16	13/16
1 1/8	6 1/8	2 3/4	5/8	2 3/4	31/32	1 1/8	7/8
1 3/16	6 5/16	2 3/4	11/16	2 7/8	1 1/32	1 3/16	7/8
1 1/4	6 1/2	2 13/16	11/16	3	1 3/32	1 1/4	15/16
1 5/16	6 11/16	2 7/8	11/16	3 1/8	1 5/32	1 5/16	1
1 3/8	6 7/8	2 15/16	11/16	3 1/4	1 7/32	1 3/8	1 1/16
1 7/16	7 1/16	2 15/16	3/4	3 3/8	1 9/32	1 7/16	1 1/16
1 1/2	7 1/4	3	3/4	3 1/2	1 11/32	1 1/2	1 1/8
1 5/8	7 5/8	3 1/8	3/4	3 3/4	1 15/32	1 1/2	1 1/4
1 3/4	8	3 3/16	13/16	4	1 19/32	1 1/2	1 5/16
1 7/8	8 3/8	3 5/16	13/16	4 1/4	1 23/32	1 1/2	1 7/16
2	8 3/4	3 3/8	7/8	4 1/2	1 27/32	1 1/2	1 1/2

* Associate Editor of MACHINERY.

In these formulas:
A = size of hob 1½ inch from the large end of the thread,
N = nominal size of hob (pipe size),
C = length of shank,
D = length of thread, and
F = diameter of shank.

Relief.

Pipe hobs, being provided with a taper thread, must be relieved both in the angle and on the top of the thread. In this respect they differ from straight thread hobs, which are not relieved at all, except on the top of the thread of the short chamfer at the point.

Taper Boiler Taps.

Taper boiler taps, as the name indicates, are used in steam boiler work, and, like the pipe taps, are in this work used where a steam tight fit is desired. The taper of the taps is the same as the pipe tap taper, ¾ inch per foot. In regard to their construction there is nothing to say that has not already been said either in connection with pipe taps, or about taper taps in general. The size by which these taps are designated is located ¼ inch from the large end of the thread.

TABLE VIII. DIMENSIONS OF PATCH BOLT TAPS.

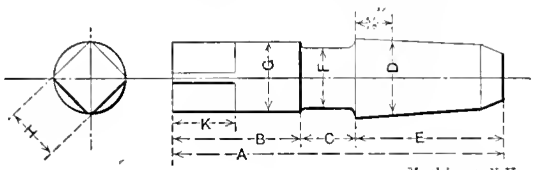


Fig. 9.

Diameter of Tap.	Total Length.	Length of Shank.	Length of Neck.	Length of Thread.	Diameter of Neck.	Diameter of Shank.	Size of Square.	Length of Square.
D	A	B	C	E	F	G	H	K
1/2	2 7/8	1 1/8	1/2	1 1/4	3/8	1/2	3/8	1/2
9/16	3	1 3/16	1/2	1 5/16	7/16	9/16	7/16	1/2
5/8	3 1/16	1 1/4	1/2	1 5/16	1/2	5/8	15/32	9/16
11/16	3 1/8	1 5/16	1/2	1 5/16	9/16	11/16	1/2	9/16
3/4	3 3/16	1 3/8	1/2	1 5/16	5/8	3/4	9/16	5/8
13/16	3 1/4	1 7/16	1/2	1 5/16	11/16	13/16	5/8	5/8
7/8	3 3/8	1 1/2	1/2	1 3/8	3/4	7/8	21/32	11/16
15/16	3 7/16	1 9/16	1/2	1 3/8	13/16	15/16	11/16	11/16
1	3 1/2	1 5/8	1/2	1 3/8	7/8	1	3/4	3/4
1 1/16	3 9/16	1 11/16	1/2	1 3/8	15/16	1 1/16	13/16	3/4
1 1/8	3 5/8	1 3/4	1/2	1 3/8	1	1 1/8	27/32	13/16
1 3/16	3 3/4	1 13/16	1/2	1 7/16	1 1/16	1 3/16	7/8	13/16
1 1/4	3 13/16	1 7/8	1/2	1 7/16	1 1/4	1 1/4	15/16	7/8
1 5/16	3 7/8	1 15/16	1/2	1 7/16	1 3/16	1 5/16	1	7/8
1 3/8	3 15/16	2	1/2	1 7/16	1 1/4	1 3/8	1 1/32	15/16
1 7/16	4	2 1/16	1/2	1 7/16	1 5/16	1 7/16	1 1/16	15/16
1 1/2	4 1/16	2 1/8	1/2	1 7/16	1 3/8	1 1/2	1 1/4	1

The permissible limits of error in regard to the location of the size line are the same as for pipe taps.

In Table VII dimensions are given for taper boiler taps. The most important of these are approximately figured from the following formulas:

$$A = 3D + 2\tfrac{3}{4} \text{ inches}, \qquad E = 2D + \tfrac{1}{2} \text{ inch}.$$

$$B = \frac{3D}{4} + 1\tfrac{7}{8} \text{ inch}, \qquad C = \frac{D}{4} + \tfrac{3}{8} \text{ inch}.$$

In these formulas:
A = total length of tap,
B = length of thread,
C = length of neck,
D = diameter of tap, measured ¼ inch from the large end of the thread.

These taps are provided with four flutes up to 1½ inch diameter, and with five flutes for sizes from 1⅝ to 2 inches. If made in sizes larger than 2 inches, six flutes should be given to the tap. Boiler taps are always provided with twelve sharp V-threads per inch, irrespective of the diameter of the tap.

Patch Bolt Taps.

Patch bolt taps are practically only a modified form of taper boiler taps. The taper is the same, but the threaded portion as well as the total length is shorter than the corresponding lengths of a taper boiler tap. The nominal size is measured ⅝ inch from the large end of the thread. These taps are used for purposes similar to the taper boiler taps, in boiler construction.

The dimensions for patch bolt taps are given in Table VIII. The essential dimensions are approximately figured from the formulas:

$$A = 1\ 3/16\ D + 2\ 5/16 \text{ inches}, \qquad B = D + \tfrac{5}{8} \text{ inch},$$

$$E = 3/16\ D + 1\ 3/16 \text{ inch}, \qquad F = D - \tfrac{1}{8} \text{ inch}.$$

TABLE IX. DIMENSIONS OF MUD OR WASHOUT TAPS.

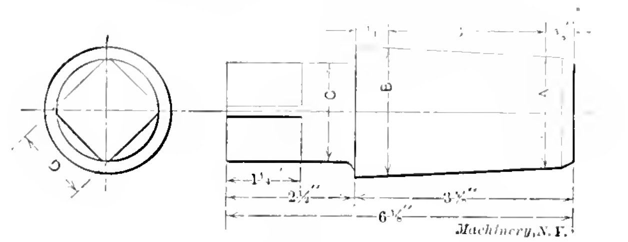


Fig. 10.

Number of Tap.	Diameter at Small End.	Diameter at Large End.	Diameter of Shank.	Size of Square.
	A	B	C	D
0	1 7/16	1 3/4	1 1/2	1 1/2
1	1 3/4	2 1/16	1 7/8	1 3/8
2	2 1/16	2 3/8	2	1 1/2
3	2 3/8	2 11/16	2	1 1/2
4	2 11/16	3	2	1 1/2
5	3	3 5/16	2	1 1/2

TABLE X. DIMENSIONS OF BLACKSMITHS' TAPER TAPS.

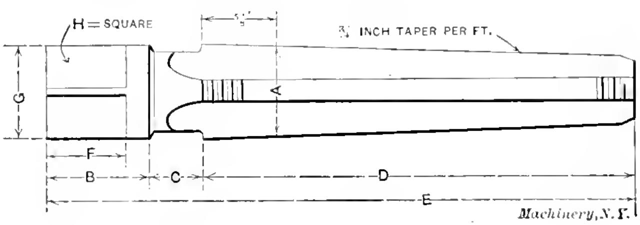


Fig. 11.

Nominal Diameter of Tap.	Length of Shank.	Length of Neck.	Length of Thread.	Total Length.	Length of Square.	Diameter of Shank.	Size of Square.
A	B	C	D	E	F	G	H
1/4	1/2	3/8	1 1/2	2 3/8	3/8	5/16	1/4
5/16	9/16	7/16	1 11/16	2 11/16	3/8	3/8	9/32
3/8	5/8	7/16	1 7/8	2 15/16	7/16	7/16	5/16
7/16	5/8	7/16	2 1/16	3 1/8	7/16	1/2	3/8
1/2	11/16	1/2	2 1/4	3 7/16	1/2	9/16	7/16
9/16	3/4	1/2	2 7/16	3 11/16	1/2	5/8	15/32
5/8	13/16	1/2	2 5/8	3 15/16	9/16	11/16	1/2
11/16	13/16	1/2	2 13/16	4 1/8	9/16	3/4	9/16
3/4	7/8	9/16	3	4 7/16	5/8	13/16	5/8
13/16	15/16	9/16	3 3/16	4 11/16	5/8	7/8	11/16
7/8	1	9/16	3 3/8	4 15/16	11/16	15/16	11/16
15/16	1	5/8	3 9/16	5 3/16	11/16	1	3/4
1	1 1/16	5/8	3 3/4	5 7/16	3/4	1 1/16	13/16
1 1/8	1 3/16	11/16	4 1/8	6	13/16	1 3/16	7/8
1 1/4	1 1/4	11/16	4 1/2	6 7/16	7/8	1 5/16	1
1 3/8	1 3/8	3/4	4 7/8	7	15/16	1 7/16	1 1/16
1 1/2	1 7/16	3/4	5 1/4	7 7/16	1	1 9/16	1 3/16

In these formulas,
D = diameter of tap (measured ⅝ inch from the large end of the thread),
A = total length of tap,
B = length of shank,
E = length of thread, and
F = diameter of neck.

The diameter of the shank equals the nominal diameter of the tap.

Patch bolt taps are always provided with twelve threads per inch, V form, irrespective of diameter. All sizes are fluted with four flutes up to 1½ inch diameter. Patch bolt taps are not manufactured in larger sizes.

Mud and Washout Taps.

Mud and washout taps are used in boiler work the same as the taps previously referred to. These taps are sometimes referred to as "arch pipe taps," but the former name is by far the most common. They are made in six sizes, usually known by the numbers as stated in Table IX. These taps taper 1¼ inch per foot and have twelve sharp V-threads per inch. The dimensions, as given in Table IX, conform in all essential details with the practice of the manufacturers of these taps. Number 0 tap is provided with five flutes, No. 1 with six, No. 2 with seven, and the remaining ones with eight flutes.

Blacksmiths' Taper Taps.

We have but one more class of taper taps generally manufactured, the blacksmith's taper tap. This tap has a long taper thread, and a very short shank, only sufficiently long for a square and a collar to prevent the tap wrench from slipping from the square down upon the body of the tap. The taper of the thread is ¾ inch per foot, and the size by which the tap is known is measured ⅝ inch from the large end of the thread. These taps are generally made with the standard number of V-threads per inch corresponding to their nominal diameter. The sizes given in Table X are the sizes generally made; these sizes all have four flutes.

Pipe Taps and Drill Combined.

Pipe taps are sometimes provided with a drill point, as shown in Fig. 12, for drilling the hole previous to tapping. Instead of a square for a wrench, they are then usually provided with square taper shank for a taper drill socket. The dimensions of the shank must, of course, suit the requirements. The threaded portion is an exact duplicate of the threaded part of a pipe tap. The drill part has two flutes like a twist drill, and the point is ground to the same angle, 59 degrees with the center line, as are ordinary twist drills. The diameter and the length of the drill point are the only dimensions necessary to state in this connection.

TABLE XI. LENGTH AND DIAMETERS OF DRILL POINTS IN COMBINED PIPE TAPS AND DRILLS.

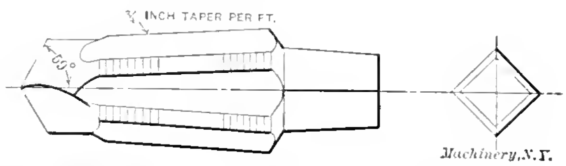


Fig. 12.

Pipe Tap Size.	Length of Drill Point.	Diameter of Drill.	Pipe Tap Size.	Length of Drill Point.	Diameter of Drill.
⅛	⅞	11/32	1	1½	1 9/64
¼	1	7/16	1¼	1⅝	1 ½
⅜	1⅛	37/64	1½	1¾	1 23/32
½	1¼	45/64	2	1⅞	2 3/16
¾	1⅜	29/32	2½	2	2 ⅝

* * *

Some interesting facts about alloys of silicon are reported in *Engineering*. Alloys containing from 5 to 15 per cent of silicon can, like nickel, be forged cold, but not when at a red heat. When the percentage of silicon exceeds 22, the hardness of the alloy increases. A regulus with 25 per cent of silicon cleaves like mica in sheets, and alloys containing more than 50 per cent of silicon can be powdered. It is interesting that an alloy containing 20 per cent of silicon is much harder when slowly cooled than when suddenly chilled.

* * *

The growth of the motor car industry, in which aluminum is now extensively used, has greatly increased the use of this metal. The present output of aluminum is between 15,000 and 20,000 tons yearly. In America there are at present 56 installations using aluminum wire for electric power transmission purposes, some of these being in connection with schemes of considerable magnitude and importance. This application of the metal has not been followed up in Europe, where doubts exist in the minds of engineers as to its suitability for outside work involving long-continued exposure to a humid atmosphere.

GRINDING AND GRINDING MACHINES.*

CARL OLSON.

The development of the grinding machine has made rapid progress during the last few years, and the process of grinding is more and more recognized as having both economical and technical advantages, as compared with the old methods of obtaining finish. This is especially true regarding plain cylindrical grinding, and this is due chiefly to the fact that the machines for this kind of grinding are easier to build, and in general more efficient than machines for other kinds of grinding.

It has often been claimed, by people who have had long and thorough experience in regard to this subject, and whose testimony, therefore, must be considered as having weight, that time can be saved in finishing a cylindrical piece of work by taking a roughing cut with an ordinary cutting tool, leaving about from 0.008 to 0.010 inch, and grinding off this amount, instead of taking a second cut in the lathe, and finishing the piece by filing. One great advantage of the grinding machine is the closer finish that can be obtained.

In some special cases, when the steel to be finished is so hard that it cannot be cut by means of a cutting tool, the grinding machine has to take the place of the lathe entirely. Of course, the work in this case cannot be done so cheaply as in the case of ordinary kinds of steel, but still it can be done with fair economy. As the piece is taken entirely rough and put up in the grinding machine, there is, considering the errors in casting, about ⅛ inch up to 3/16 inch on the diameter, that has to be ground off. When so large an amount of metal has to be removed by grinding, another problem than that dealt with when only 0.008 to 0.010 inch has to be ground off presents itself. The writer has recently designed three special grinding machines, two for external and one for internal work, all for very heavy duty. Herein are given a few of the conclusions arrived at while designing these machines. Being, as mentioned, mostly used for heavy grinding, the machines may differ some from the common light grinding machines, but the principles remain, in general, the same.

Any machine tool must, of course, be designed heavy enough not only to take all the strains produced by the action of the cutting tool or wheel, but to prevent all, or nearly all, vibration and chattering of the machine itself. This is true of the grinding machine more than of any other machine tool. Rigidity is a very important factor in the efficiency of the machine, both in regard to heavy grinding and grinding for very exact sizes and high finish.

Influence of Vibrations on Action of Grinding Machines.

The grinding wheel rotating at a high speed tends to jar its bearing and supports. Vibrations of this kind would result in an oscillating motion of the grinding wheel perpendicular to its own axis of rotation and along the line connecting the center of work with the center of the wheel. The frequency of these vibrations depends entirely upon the weight of the oscillating parts. The cause of the vibrations is that the center of gravity of the rotating parts, grinding wheel, shaft, pulley, etc., is not entirely the same as the center line of rotation. This is partly due to the uneven structure of the material. It is very plain to everybody, that the oscillating grinding wheel cannot cut to its full capacity. The length of the oscillations might not be large, perhaps only one-thousandth of an inch or a fraction thereof, but the cut will be just so much deeper one moment than the next following. Only at one moment, when the wheel is furthest in, will it cut to its full capacity.

It is very important, in order to secure nice running of the wheel, to have the belts in good order, and to have the boxes closely adjusted, even though they run a trifle warm. Because of the high speed of the shaft, the boxes ought to be made with ring-oiling devices. This would allow a closer adjustment, and secure a better running of shaft. However, as far as the writer knows, there are no grinding machines

* The following articles on this and kindred subjects have previously been published in MACHINERY: A Talk on the Disk Grinder, June, 1904; The Grinding of Thread Gages, October, 1904; The Cost of Grinding, October, 1906; Grinding Crank-shafts, March, 1907; and Grinding a Large Crank-shaft, April, 1907.

on the market equipped with ring-oiling boxes. The slides should, for the same reason as the boxes, be adjusted closely, even though they slide hard.

Speed of Grinding Wheels.

The peripheral speed of the grinding wheel should be approximately from 5,000 to 5,500 feet per minute. There are occasionally cases when higher speed is desirable, but with higher speed there is danger of the wheel breaking. The wheel should, however, never be run slower than 5,000 feet per minute, because it becomes less efficient at slower speeds.

Below will be found a table which gives the number of revolutions per minute for specified diameters of wheels to cause them to run at the respective periphery rates of 5,000 and 6,000 feet per minute.

TABLE OF SPEEDS OF EMERY WHEELS.

Diameter of Wheel, inches.	R. P. M. for Surface speed of 5,000 feet.	R. P. M. for Surface Speed of 6,000 feet.
1	19,099	22,918
2	9,549	11,459
4	4,775	5,730
6	3,183	3,820
8	2,387	2,865
10	1,910	2,292
12	1,592	1,910
14	1,364	1,637
16	1,194	1,432
18	1,061	1,273
20	955	1,146
24	796	955
30	637	764

Experience has shown that for grinding work with fairly large diameter, better results are obtained by using a comparatively small wheel than by using one with too large a diameter. The explanation of this fact is that the wheel of smaller diameter clears itself faster from the work, while the larger one has a larger contact surface, and, therefore, the specific pressure between wheel and work becomes reduced, and the metal removed by the wheel stays too long a time between the wheel and work, and prevents the particles of the wheel from cutting properly into the work. The peripheral speed must, however, be the same for the smaller wheel as for the larger one.

Surface Speed of Work.

The proper surface speed of the work varies somewhat with the material and kind of work to be done. The grinding machine builders recommend 15 to 30 feet as a good average speed range for ordinary kind of work. For cast iron this can be slightly increased. The writer has had experience in grinding a very tough and hard steel (manganese steel), and has found the right surface speed in this special case to be as low as 6 to 8 feet a minute for rough grinding. For finishing grinding, the speed should be somewhat higher than for rough grinding. For delicate work the speed should be slow, because the work could easily be damaged by forced grinding.

As a general rule, for determining the surface speed for a certain kind of material, one can say that a brittle material, as cast iron, takes a high speed, while a tough and hard material, as the best tool steel, takes a slow speed. For grinding close to size and for high finish, the depth of the cut must be small, and higher surface speed can consequently be used.

Many of the grinding machines on the market are built so as to have the work revolving on two dead centers. This is done more for the sake of being able to obtain accuracy than for the sake of increasing the cutting efficiency of the machine.

Traverse Speed of Grinding Wheel.

The traverse speed of the grinding wheel should for ordinary grinding be three-fourths of the width of the wheel, that is, for one revolution of the work the wheel should travel three-fourths of the width of the face. If the wheel be traversed slower, the new cut is overlapping the old one more than necessary, and too large a part of the wheel is idle. It is, however, necessary that the new cut overlaps the old one with about one-fourth of the width of the face, because the edges of the face easily become rounded off, and, if the travel be too rapid, the result is an uneven surface.

The capacity of the wheel, within certain limits, of course, is proportional to the width of the face. A certain specific pressure between wheel and work is required for the highest cutting capacity. A wider wheel requires consequently a larger total pressure. But many of the machines now on the market are not rigid nor heavy enough to stand the pressure needed for a fairly wide wheel, cutting at full load, without vibration and chatter. The grinding machines on the market have not, in the writer's opinion, yet reached their full capacity. Wider wheels should be used, and the machines be designed and built heavier in order to take the load of the cutting wheel, without perceptible vibration of the machine.

For the final smooth finish, a slower traverse speed should be used, especially if the face of the wheel is not kept a perfectly straight line. A smoother surface is obtained by using a slower traverse speed. The part of the wheel which is overlapping, while theoretically it does not cut, still wears away the unevennesses left from the first cut, and, by this, to some extent polishes the surfaces.

While grinding a plain cylindrical piece of work, the grinding wheel should not be allowed to travel too far past the ends of the piece before reversing; it is only waste of time. The wheel should be reversed when three-fourths of its width is past the end of the work.

Depth of Cut.

The depth of the cut to be taken depends upon the material, kind of wheel, and of work done. It should be deep enough to permit the wheel to do its utmost. This is, of course, true only about pieces that are rigid enough to stand a heavy cut. The grinding operator himself will have to determine the depth of cut for each individual case, judging it by the prevailing conditions of work, machine, and wheel.

When the piece to be ground, owing to the hardness of the material, cannot be roughly finished by a cutting tool before being placed in the grinding machine for the final finish, there is often up to 3/16 inch on the diameter to be removed by grinding. Employing the same principle as when the piece is previously to the grinding operation roughly turned in a lathe, the work should first be put up in a machine equipped with a coarse and wide grinding wheel. A wheel of this kind is capable of removing stock rapidly. The piece should be finished to within about 0.005 inch of the finish diameter in this machine, and then moved to a machine equipped with a finer grain wheel, and the final finish given to it. A fairly high grade of economy is thus obtained.

The Grinding Wheel.

For heavy grinding, the alundum wheel is the best for removing stock rapidly. The carborundum wheel will give a smoother finish, and is to be recommended for the large majority of other classes of grinding. Emery is less abrasive, but gives a higher polish. Most grinding wheel manufacturers recommend their medium grade, *M*.

TABLE OF GRADE OF WHEEL TO USE FOR DIFFERENT MATERIALS.

Material.	Grit No.	Grade.
Soft steel — Ordinary shafts	24 to 60	Medium.
Soft steel — Steel tubing or very light shafts	24 to 60	Two or three grades softer than medium.
Tool steel or cast iron. ...	24 to 60	Medium or one grade softer.
Internal grinding	30 to 36	Medium or several grades softer.

The question as to what is the very best wheel for finishing any particular piece cannot be definitely answered. Above will be found a table, giving wheels which can with advantage be used in the cases mentioned. This table is recommended by one of the largest grinding machine manufacturers.

Grit No. 24 may be too coarse for any but rough classes of work, but if mixed with No. 36 it gives a fair result. No. 30 used separately is capable of a very fair commercial finish, but if mixed with No. 16 will give as fine a finish as is

desired by the majority of the grinding machine users, and at the same time it retains the rapid cutting capacity. Nos. 46 and 60 are as fine as is necessary for almost any manufacture, although finer than these are used by some concerns who require a very high gloss finish.

A satisfactory grinding wheel is an important factor in the production of good work. In machine grinding, it is desirable, in order that the cut may be constant, and give the least possible pressure and heat, to break away the particles of the wheel after they have become dulled by the act of grinding. It is the faculty of yielding to or resisting the breaking out of the particles which is called grade. The wheel from which the particles can be easily broken out is called soft, and the one that retains its particles longer is called hard. It is evident that the longer the particles are retained the duller they

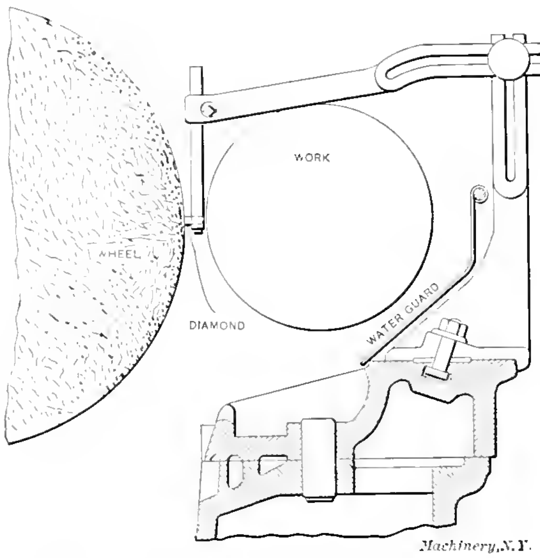


Fig. 1. Fixture for Truing Emery Wheel with Diamond

will become, and the more pressure will be required to make the wheel cut. Retaining the particles too long causes what is familiarly known as glazing. A wheel should cut with the least possible pressure, to effect which it must always be sharp. This is maintained by the breaking out of particles. Therefore, a wheel of proper grade cutting at a given speed of the work possesses "sizing power," or ability to reduce its size uniformly without breaking away its own particles too rapidly; obviously if the work is revolved at a higher speed, the particles will be torn away too fast, and the wheel will lose its sizing power.

The properties of toughness and hardness of the material to be ground has a retarding influence on the grinding because it makes the material stick to or clog the wheel. The ground-off material, instead of being thrown away from the wheel by the centrifugal force, gets in between the particles of the grinding wheel. It is self-evident that this has a greatly retarding effect on the cutting quality of the wheel. A brittle material, on the contrary, does not have the tendency of clogging the wheel, but the stock ground off is immediately thrown away from the wheel, leaving the particles free to cut without the retarding action of undue friction, and generation of more than the due amount of heat. If we take into consideration only these properties of the material to be ground, the tough or leady material requires a soft wheel, because the particles must break away fast enough to prevent the wheel from being clogged. In this case, the particles do not wear enough to become dull, but must break away before this. When grinding a brittle or hard material, on the contrary, the wheel is less liable to be clogged, the particles do not need to break away so soon, and, therefore, a harder wheel should be used. However, the wheel must not be so hard that the particles get too dull and become inefficient as cutting agents before they break away.

Importance of Wheel Running True.

In order to obtain the full efficiency of the grinding wheel, it must be run perfectly true; that is, cut evenly all the way around. The grinding wheel detects its own errors. A slight difference in the sparks indicates that the wheel is out of true. The eccentric wheel has about the same kind of action as the one which is vibrating because of too weak supports. Furthermore, the edge of the grinding wheel should be kept perfectly straight. If the edge be curved, however slightly, a curved cut will be the consequence. Many grinding machines give inefficient results because the edge of the wheel is not kept in a true straight line. The operator seldom appreciates the great importance of this, and, therefore, the foreman should watch the man closely in regard to this point.

The best tool for truing the wheel is the diamond, but, this being rather expensive for shops where not very much grinding is done, the usual emery wheel dresser can be used with good advantage. In truing the wheel, the dressing tool should be kept stationary and rigidly supported, and the wheel should be traversed back and forth, until the true edge is obtained. Fig. 1 shows a fixture and arrangement for wheel truing with a diamond.

Wet and Dry External Grinding.

Nearly all plain cylindrical grinding is now done wet. There are many reasons why the wet method is to be preferred to the dry. Because of the friction between the grinding wheel particles and the work, as well as between the cut-off material before it leaves the wheel and the work, more or less heat is generated. If this heat is not carried away, the work will be burned. Besides, the edge of the grinding wheel would be highly heated, but the center would still remain comparatively cool, the outer part would expand and there would be danger of the wheel breaking. It is found that the water has a softening effect upon the wheel, therefore a harder wheel is required for wet grinding than for dry.

Machines with Two Grinding Wheels.

The grinding machines on the market are equipped with only one grinding wheel, but there is no reason why two grinding wheels cannot be employed to advantage. In this case one wheel is to operate on each side of the work. As both of the wheels are to throw the sparks and the water down, one of the wheels has to cut with the revolving of the work, that is, the peripheries of the wheel and the work are going downwards. This is, of course, not the ideal condition, but, when the work is revolving at a slow peripheral speed, there is not much difference in the cutting capacity of the two wheels.

It is self-evident that, when employing two wheels, one at each side of the work and right opposite each other, the traverse speed of the wheels must be twice as fast as in the case of only one wheel, or three-fourths of the width of the wheel for one-half revolution of the work. Otherwise one wheel will overlap the cut of the other.

The two machines for external grinding which the writer has recently designed, and of which one is in operation and one being built, have two wheels working according to the principle previously described, and the machine already in operation is giving entire satisfaction. Fig. 2 gives an idea of the arrangement used on one of these machines. The principal features of the design can be studied direct from the cut without any further comments.

One new feature of these machines is that each grinding wheel is driven independently by a motor. This motor is mounted above the wheel spindle, and is belted directly to same. Special attention has been paid to designing the support of the motor in order to prevent the vibrations of the motor from being transferred to the grinding wheel.

Internal Grinding.

The development of internal grinding is not, by far, so advanced as that of external grinding. To be sure, there are a few machines and fixtures on the market that are designed and built for the internal grinding of holes of various kinds, but the machines suffer from lack of rigidity, and some of the most conscientious grinding machine builders do not recommend them very highly, but admit their inefficiency for removing any comparatively large amount of stock. It has even gone so far that one man holding a prominent position with one of the largest grinding machine manufacturing concerns in the country has said, that in his opinion, the internal

grinding machine is a mistake from start to finish, and that it will never be made a success.

This state of affairs has not come about without good reason. As we already have seen, the rigidity of the arrangement for supporting the grinding wheel is a very important factor for all efficient grinding. But the internal grinding machine does not very well lend itself to the employment of any rigid and heavy fixtures, and the grinding wheel must necessarily be small, and therefore lacks the strength to stand a heavy cut. The designer, when designing the fixtures for internal grinding, has an entirely different problem to solve than when designing those for external grinding, where it is comparatively easy to obtain ample rigidity. The internal grinding wheel must be mounted at the end of a small spindle which projects past the bearing far enough to enable the wheel to reach past the end of the hole to be ground. Such a spindle rotating at a high speed is liable to vibrate, especially if a pressure be applied at the end of it, as is here the case.

Sometimes, however, it becomes absolutely necessary to grind, internally, even a comparatively large amount of stock.

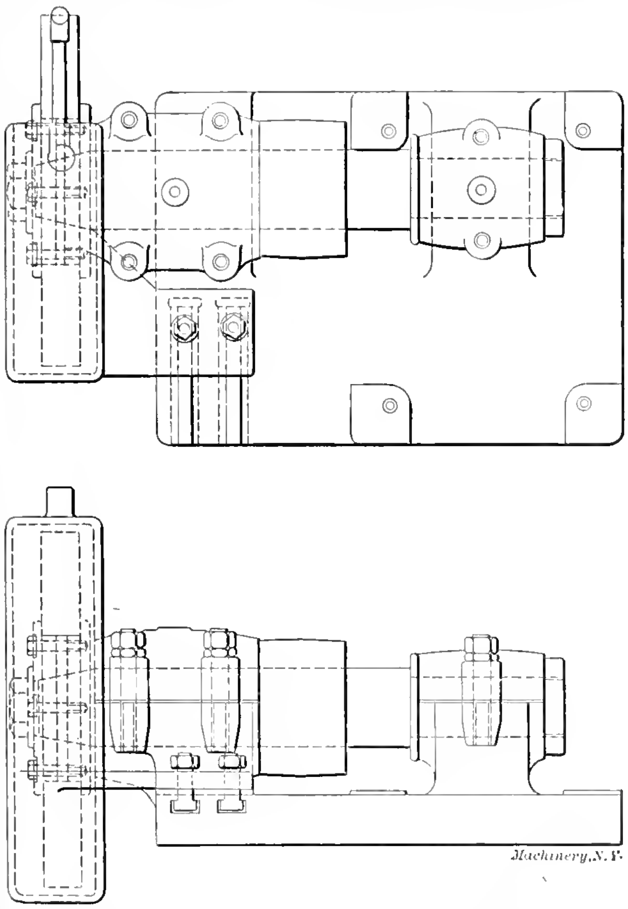


Fig. 2. Grinding Head for External Grinding Machine.

This is the case, when finishing manganese steel, this material being so hard that it cannot be cut by any kind of tool steel. Take the case of bores of manganese steel car wheels. As the grinding of the bores must be done without any stock having previously been removed from the rough casting, on the average, about one-eighth inch of metal must be ground off from the hole. All the errors in the cored hole, as eccentricity in reference to the circumference of the wheel, etc., must be corrected by grinding. A hole cored in a manganese steel casting is always comparatively much rougher than a hole cored in cast iron, and all this must be taken into consideration, when determining the amount of stock to leave for the grinding process.

The old method for finishing the bores of these wheels was to cast an ordinary steel bushing in the hole. This then was bored in the usual manner in a lathe or boring mill. But this method had several objectionable features, and, besides, it was too expensive.

Design of Fixtures for Internal Grinding.

The fixture used in the internal grinding machine designed for grinding these wheels is shown in Fig. 3. Internal grinding fixtures, generally have a long extension bearing, as shown in Fig. 4. This serves to support the spindle as near to the grinding wheel as possible; but the diameter at the root of this extension, that is, nearest to the box, cannot exceed the diameter of the grinding wheel.

The spindle, shown in Fig. 3, is made solid, and has the largest diameter possible for the size of the grinding wheel. An increased amount of rigidity and a greatly increased simplicity is gained by this design.

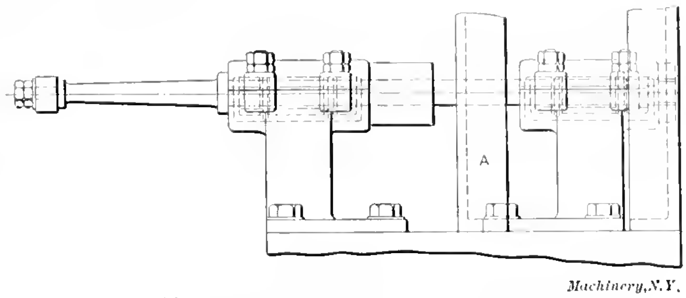


Fig. 3. Grinding Head for Internal Grinding.

When working, the grinding wheel produces, especially in dry grinding, very much dust. When inside a hole the dust cannot very easily get away, but whirls about in the hole. If the spindle has a bearing near to the grinding wheel, the dust will find its way into the journal. This drawback is entirely eliminated by having a large solid spindle without a bearing near to the grinding wheel.

As to the relation between the overhanging part of the spindle and the distance between centers of the boxes, there are many factors that come into consideration in regard to this relation, such as the design of the boxes, the diameter of the spindle, how close the spindle can be allowed to run in the boxes, etc. However, the distance between the centers of the boxes should be made as large as the general design conveniently permits.

The cut shows at *A* the support for the motor. This support is placed on the top of the top rest. The driving pulley is placed between the bearings, so that the support could be made as rigid as possible.

It was found by actual experience with these fixtures, that when the grinding wheel was taking a fairly heavy cut the spindle did not vibrate nearly so much as when the wheel was running idle. The springing quality of the spindle, and the pressure between work and wheel, made the wheel cut without any chattering worth mentioning.

Regarding the peripheral speed of the grinding wheel, what has already been said with reference to external grinding is equally applicable to internal grinding.

Because of the lighter fixtures the speed of the work should be slower than for external grinding. The writer has found the right cutting speed for manganese steel to be, for heavy grinding, about seven feet a minute. For the finishing, the speed can, with advantage, be somewhat higher. Because of the combined hardness and toughness of this steel, the cutting speed is exceptionally low in this case. Regarding the

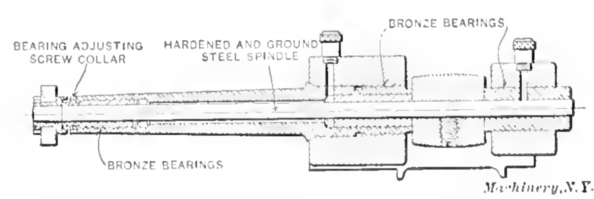


Fig. 4. Common Construction of Grinding Heads for Internal Grinding.

traverse speed of the wheel, it should travel three-fourths of its width for one revolution of the work, the same as for external grinding.

Wet and Dry Internal Grinding.

One point that has been much discussed in regard to internal grinding, is whether it shall be conducted wet or dry. Some grinding machine designers have advanced the opinion that it, by all means, must be done dry, but others claim the wet method to be superior. For light finishing grinding one method might be considered as good as the other, because so small an amount of heat is generated that there is no danger of burning the material or breaking the wheel. But, for

heavier grinding, a considerable amount of heat is generated, and it becomes necessary to carry it off by water. At least, such is the writer's own experience on this subject. At a test recently conducted to find out the actual difference between dry and wet internal grinding, it was found that the cutting quality of the grinding wheel was about the same in both cases, but, with a heavy feed and dry grinding, the work was highly heated, and the wheel broke after about half an hour's run, while, with wet grinding, the wheel stood the heavy cut continuously without breaking.

The water can be injected into the hole in a stream about one-sixteenth inch in diameter. In addition to carrying away the heat, the water serves to wash away the removed stock from the hole.

The writer conducted, a short time ago, a test on the above mentioned internal grinding machines, in order to find out and supply the sales department with a figure of the time required to grind the bores of a certain kind of manganese steel car wheels. Two different kinds of wheels were tested. The first one, a 20-inch diameter wheel, had a bore 2⅞ inches in diameter and 5⅞ inches long, and it was to be ground for a press fit. The second one, an 18-inch diameter wheel, had a bore 3¼ inches in diameter and 4½ inches long, and was also to be ground for a press fit. Four wheels of each kind were ground during the course of the test, and it was found that the actual time for the grinding operation, not including the time required for putting up the work in the machine, was, for the first kind of wheels 1 hour and 23 minutes for all four, and for the second kind, 1 hour and 9 minutes for four wheels. Considering that the bores of the wheels were not previously turned, but entirely rough, as the wheels were taken directly from the foundry, and considering the hardness and toughness of the steel, the results obtained were considered good. The time of putting up the work in the machine was about 6 to 8 minutes for each wheel. As the machines work automatically, one man is able to run three machines. Counting 8 minutes for the putting up of each wheel, the man is able to grind one wheel in 30 minutes of the first kind, and one wheel in 26 minutes of the second kind.

The work was revolved at a speed of 7.7 revolutions per minute. This makes a peripheral speed, for the first case, of 5.8 feet a minute, and for the second case, of 6.6 feet a minute. The grinding wheel used was a 2-inch diameter, 1-inch face, No. 46 grit, O grade alundum wheel. It was run at a speed of 4,750 feet a minute.

The traverse speed of the work was as high as 0.84 inch per revolution of work. This allowed the wheel to overlap the old cut by only 0.16 inch but, as the grinding wheel was trued very carefully, this was found to be all there was required for obtaining a nice smooth surface. The traverse feed was not slowed down, but remained the same while doing the final finishing, and a very satisfactory finished hole was obtained. The test was made throughout with wet grinding.

For heavy cylindrical grinding, that which I especially referred to, the width of the wheel used varies between 1½ and 2½ inches, regardless of the diameter. In some special cases narrower wheels than 1½ inch are used, but these special cases are exceptions to the general practice, and must be recognized as such by the machine builders and users. Although larger wheels are used, it is my opinion that the best range of diameters of wheels is between 12 and 18 inches. For how wide a wheel the grinding machine in the future can be designed, has yet to be decided; but, wider wheels and heavier machines point the direction of the road which the designer and machine builder should follow for the development of the grinding machine.

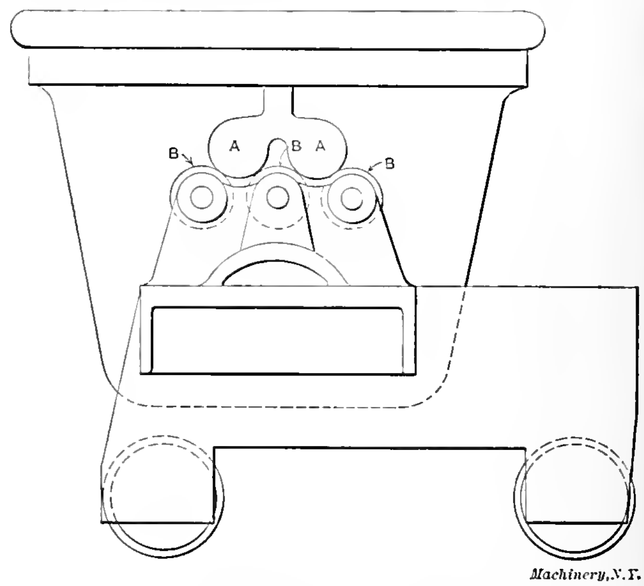
* * *

The output of the world's shipyards for the year 1907 was 1,930 vessels of over 100 tons displacement, with an aggregate of 3,099,299 tons. The tonnage of the vessels built in the United States amounted to 474,675 tons, which is 33,400 tons greater than the output for the previous year. Of the total tonnage of the vessels built in this country, considerably more than half was constructed for the Great Lakes.

ITEMS OF MECHANICAL INTEREST.

UNIQUE BEARING FOR END-TIPPING SLAG LADLE.

Another interesting application of roller bearings is shown in the diagrammatical sketch, herewith, of an end-tipping slag ladle made by the Dewhurst's Engineering Company, Ltd., Attercliffe Road, Sheffield, England. In this design double trunnions *A* are cast on each side of the ladle, and are located slightly above its center of gravity so that the ladle will right

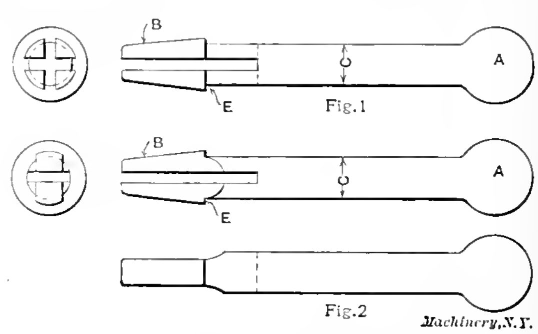


End-tipping Slag Ladle with Roller Bearings.

itself from any point to which it may be tipped. Roller bearings *B* are provided on the carriage on which these trunnions rest, and this greatly reduces the power required for tipping, as the trunnions roll easily along the surface of the rollers. The principle exhibited is a very interesting one, and shows how simple means may be adopted for solving a rather difficult problem of machine design, and indicates the possibility of the efficiency of the least elaborate devices which are not likely to get out of order, and which hardly need any attendance whatever.

SUBSTITUTE FOR COTTER PINS.

The accompanying cut shows an interesting little appliance, used instead of the common split cotter pin. The pin shown is manufactured by a Swedish firm, Aktiebolaget Bofors-Gullspang, Bofors, Sweden. Its simplicity and general usefulness of application seem to warrant that attention be called to it. As will be seen, the pin in Fig. 1 simply consists of a round piece of stock, provided with a ball-shaped head *A* at one end, and a tapering head *B*, at the other, the corner *E* being quite sharp. The pin is split, as shown, crosswise, so that when pushed into a hole, it will spring sufficiently to



Figs 1 and 2. Showing Pins which take the Place of the Common Split Cotter Pin.

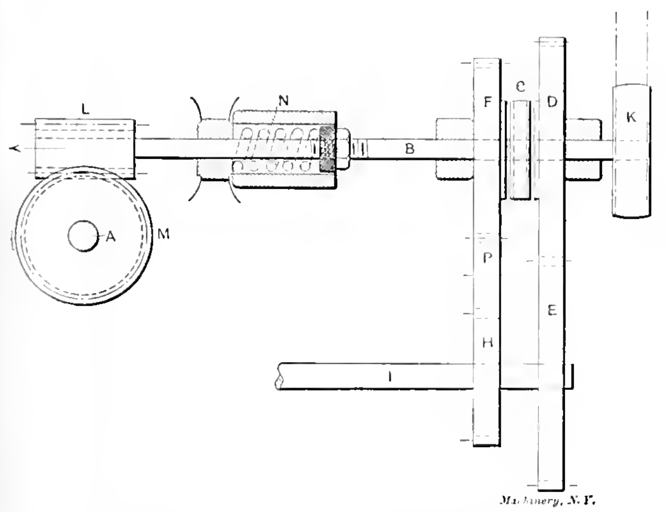
permit being pushed through, but as soon as part *B* has passed through the hole, it will spring out again, and on account of the sharp corner at *E*, it is not possible for the pin to slip out of the hole again, excepting if a special tool (a socket with a hole in it of the same diameter as the body *C* of the pin) is applied at the end to force the prongs together, so as to make the head small enough to enter the hole. These pins are also made by simply having one slot through them,

and then flatted on the two sides a trifle below the diameter of the central portion C, of the pin, as shown in Fig. 2. In applying these pins, nothing is necessary but to put the tapered end into the hole, and gently press with the hand on the top of the head A, until the pin is in place.

DEVICE FOR ADJUSTING THE FEED OF A ROTATING CUTTING TOOL IN PROPORTION TO THE WORKING PRESSURE.

The *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, shows, in its issue for December 5, 1907, an interesting mechanism for automatic adjustment of the feed in proportion to the working pressure on the cutting edges of a rotating cutting tool. The principle of the device is shown in the diagrammatical view in the accompanying cut. This device is intended to make it possible to automatically throw out the feed, when the pressure on the cutting edges of the tool becomes heavier than normal, and to completely reverse the feed in case this pressure still continues to be abnormally high when the feed is thrown out.

Referring to the cut, A represents the spindle of the machine to which the cutting tool, say a drill, is attached. This spindle is driven through worm gear M and worm L from the driving shaft B, which, in turn, receives its motion from the counter-shaft through the belt on pulley K. The driving shaft B is free to move in its axial direction, within certain limits. The clutch C is keyed to the shaft B, so that it will rotate and also move axially with the shaft. On each side of clutch C gears D and F are mounted on shaft B, in such a manner that they remain stationary in the axial direction. These gears are not keyed to the shaft B, but turn freely, and motion is imparted to them from clutch C, one of the gears being engaged at a time. The sides of gears D and F, which face toward the clutch C, are themselves provided with clutch teeth, so that the clutch can engage with either of the gears. The gear D in turn engages with gear E, on the feed-shaft I, so that if clutch C is driving gear D, motion will be imparted to the feed-shaft I, and the tool will be fed forward. If, again, the clutch disengages gear D, and



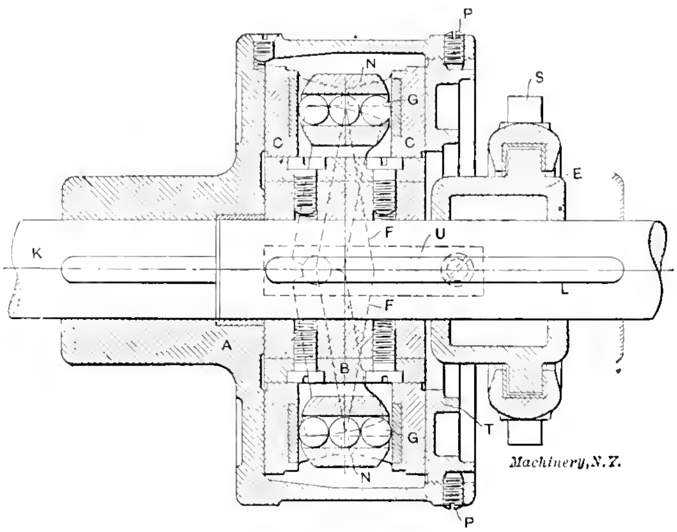
Diagrammatical View of Device for Automatically Adjusting Feed in Proportion to Pressure on Cutting Edge of Tool.

occupies a neutral position, no motion whatever will be imparted to the feed-shaft I. If, again, clutch C engages with the gear F, then the feed-shaft I will be driven through an intermediate gear P and gear H, thereby reversing the motion of feed-shaft I, as compared with the direction when receiving motion directly through gears D and E.

The engagement or disengagement of the clutch C with the clutches on gears D and F is accomplished as follows: Spring N is, through the nuts shown, adjusted to the proper tension, so that it will normally hold the driving shaft B in such a position that clutch C engages with the clutch on gear D, when, as we have seen, the feed shaft feeds forward. In case the load on the cutting edges of the tool should exceed the normal load, however, the worm-wheel will exert such a pressure on the teeth of the worm as to pull the worm in the direction of the arrow, shown at the end of the worm, thereby compressing the spring N, and pulling the clutch C out of engagement with the clutch on gear D. Clutch C then takes a central position and the feed is stopped. Should the resistance to the rotation of the cutting tool still continue to be strong enough to compress the spring still further, the clutch will enter into engagement with the clutch on gear F, in which case motion will be transmitted to the feed-screw I through the gears P and H, as mentioned before, which then reverses the feed motion.

HAEBERLIN FRICTION COUPLING.

The accompanying cut shows an interesting and ingenious friction coupling for transmitting power from one shaft to another, if these are situated in a straight line with one another. Of course, the design may be applied to almost any kind of a friction coupling, if suitably modified. If we assume that the shaft K is the driving shaft, and the shaft L the driven shaft, power is transmitted from the one to the other through the medium of rollers G. The construction is, briefly, as follows: The flanged sleeve A is keyed to the shaft K, but is independent of the shaft L. To the outside of this sleeve, a pulley, spur gear, or other means for trans-



Friction Coupling of Ingenious Design

mitting power, may be attached. The action of the device, of course, is the same whether the shaft K or the shaft L is the driving shaft.

The driver B is attached to the shaft L and is also keyed to friction disks C C, so that if the friction disks are actuated by the power, and rotate, they will carry with them the driver B and the shaft L. The friction disks C rotate with the sleeve B, but are still free to move in a longitudinal direction. The opening of the sleeve A is closed at the right-hand end by the cover T, which is prevented from turning by the set-screws P. The threads on the cover permit a fine adjustment, so that the inside width of the sleeve, between the outside of rings C, can be adjusted within very small limits, and the transmission of power can thus be controlled.

The characteristic feature of this design is to be found in the simple and practical mechanism for producing pressure on the friction disks C, so that these will be carried around with the sleeve A and its cover T. This arrangement consists, in general, simply of two levers N, provided with hardened steel rollers G. When the mutual center line of these three rollers is parallel with the axis of the shaft, which is the case when the coupling is in the driving position, then the distance between the friction disks C, and also the pressure on the friction surfaces, are the greatest. When the levers N, by pulling out sleeve E, which is attached to the ring S for its operation, are pulled from the position shown, and brought into the position indicated by the center lines F, shown by the dotted lines, the center lines through the rollers G will form an acute angle with the axis of the shaft, and the pressure between the surfaces C C and the sleeve A or the cover is released. The link u combines the sleeve E with the levers N, which are operated through this connection. These friction couplings are made by Düsseldorfer Maschinenbau-Aktiengesellschaft, Düsseldorf-Grafenberg, Germany.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1908.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

DIVIDENDS AND FOUL AIR.

If there is in the dictionary a stronger word of its kind than "asinine," we would like to use it to describe the mental caliber of those responsible for the heating and ventilating arrangements in some shops and drafting-rooms with which we are acquainted. In the absence of a stronger word, perhaps the one we have used will do. Good air and an equable temperature have come to be recognized as necessary to the proper accomplishment of physical or mental labor, and the neglect of these provisions is the exception rather than the rule; but there are still shops in which the proprietor handicaps his workmen and diminishes his own profits by the unsanitary condition of his plant.

We were reminded of this recently by a visit to a large drafting-room, connected with a plant the responsible heads of which are surely old enough to know better, and prosperous enough to act on their knowledge without even temporary financial embarrassment. The air was thick and heavy and foul, and listlessness and sluggishness were apparent everywhere in the faces and actions of the draftsmen. It would seem as though a single clear-eyed glance at the room and its occupants (assisted perhaps by an analytical sniff of the tainted atmosphere) would have been enough to show the proprietors on which side their bread was buttered.

* * *

AN ASPECT OF PATENT RIGHTS.

The daily newspapers recently gave considerable space to an alleged wonderful improvement in firearms, made by the son of a well-known inventor of rapid-fire guns. The invention is in the nature of an automatic valve placed transversely in the barrel near the muzzle, which is required to close immediately following the passing of the bullet so as to divert the gases to the atmosphere through small side openings. The object is to prevent the sudden expansion of the gases, and thus render the firing of the piece noiseless. The principle of action is somewhat similar to that of the gas engine muffler in breaking up and dispersing the gases, and so destroying the sharp reports of the explosions.

An examination of the patent specification (No. 880,386) discloses a curious fact. The invention is covered by a basic patent of twenty-three claims, but it is, as described and illustrated, practically inoperative. In fact, we very much doubt the practicability of the idea as outlined by the inventor—for one reason, because of the inertia of the necessary moving parts, but the patent has suggestive value and it may eventually lead to the solution of the problem. The field for following inventors is what we are concerned about.

The patent is basic, and no matter how ingeniously some really practical intercepting valve scheme for rendering firearms noiseless is worked out, its inventor is barred from its use by an impracticable invention which has been awarded basic claims. To say the least, this seems unfair to future genius. It is not quite just, that, because an inventor had a lucky thought, but apparently not the ability to devise a working model, he should be given such sweeping rights. It is analogous to giving the discoverer of a new country title to all the land that he found, simply because he first saw it. The simplest general remedy for such abuses in patent practice would appear to be to limit the life of all patents to a short period, say two or three years, provided the inventor does not reduce his invention to actual working shape, and then enter into its manufacture. Such a provision of patent law would also tend to discourage the buying up of patents by corporations to stifle competition.

* * *

THE ESSENTIAL AND UNESSENTIAL.

When an industrial plant grows, so that the final product is lost sight of in the production of each detail, it is a great temptation to forget the relation between one's own work and the final result arrived at. The essential feature in producing a machine is that it shall possess productive qualities when placed in the hands of the user. The drawings for the machine, for instance, are only a means to an end, and are essential only inasmuch as they aid the economical and accurate making of the machine. The outside finish and polish of the machine is not essential in itself, excepting as it aids in attracting customers who may not be able to judge so much of quality as of appearance.

The whole shop system of a plant is unessential in itself, and is of value only to the extent to which it aids the production. Yet—and here is the fatal danger in the growth of a large undertaking—when we get used to certain ways of doing work, and to certain shop systems, these seem essential in themselves, and the final end of the work is lost sight of. A draftsman finishes his drawings without judgment as to the actual purpose of his work. He lays down a great deal of work on fancy lettering and wonderful border lines, when these things are entirely unnecessary for the purpose of the drawing. A simple, correct, distinct drawing, giving the directions for the work in a clear-cut manner, is the best drawing, no matter if it looks plain to the artistic eye. The same is true of the shop and its methods. A certain foreman has a hobby that all parts shall be finished in a certain way, regardless of the final use of the part made. Many of the men get into the same habits; they complete their details of the machine often not with a view to the ultimate object of the work, but simply thinking of delivering a "nice job" to the next department. The tool-maker is, in common with the draftsman, often the worst offender. Jigs and fixtures are finished all over, an entirely wasted amount of work is laid down on dimensions not essential, and the work, while carefully done, does not show good judgment.

The success of an individual as well as of a firm depends largely on this judgment of essential and unessential features of work. Careful work does not mean unnecessary work. The greatest care should be taken with the necessary parts, and no time wasted which involves a useless expense. It is gratifying to see that our latest designs of machine tools show no machined surfaces excepting the working surfaces. Fifteen or twenty years ago many machines were practically finished all over, excepting the bed and legs, and this involved a double waste of labor as it increased the work of keeping the machines clean. The tendency of to-day is toward greater economy by means of *new methods*, but there is a great deal to be gained in the *elimination of the waste of the old methods* as well.

COMPRESSED AIR VS. ELECTRICAL TOOLS.

A great deal has been written in the engineering press regarding the relative superiority of compressed air and electricity for driving portable machine tools. Some writers have attempted to prove with figures and calculations that electricity is the cheaper, while others have presented arguments equally good on the face that compressed air is the better of the two motive powers. Very likely, however, an unbiased view of the subject would disclose the fact that either the one or the other of the motive powers may, at times, be the preferable one. For such purposes as riveting and calking, the use of compressed air is a foregone conclusion, but for almost all other small portable tools, electricity has gained on compressed air in popularity. It cannot be denied that in point of weight, the compressed air motor has advantages over the electric motor. The electrically-driven tools, are, as yet, considerably heavier, and their repair bills are higher than for their pneumatic competitors. The electric drive, however, is more efficient. Some experiments carried out by an English engineer indicate that 1¾-inch holes drilled in steel would take only 2 horse-power at the dynamo, while a compressed air drill on the same size of hole, at the same speed, takes 9 horse-power at the air compressor, so that the use of compressed air for motive power is rather more expensive, even if the repair bills for the electric tools are, say, twice as heavy as for pneumatic appliances. It seems then, in general, that the electric motor possesses advantages over its competitor, but in establishments where riveting and calking have to be done, compressed air is able to hold its own. There are in the market some fairly good electric riveting machines, but they do not possess the convenience and portability of the pneumatic hammer. In shops where an air compressor is required for some pneumatic tools for the purposes mentioned, it may be advantageous to use the air for other operations as well.

* * *

RAPID LOCOMOTIVE TIRE TURNING.

The development of powerful locomotive driving-wheel lathes during the past few years is well worth attention. The time when it required from one and one-half to two days to turn a pair of locomotive driver tires is not long ago, and to most of us it seems but yesterday when the turning of a pair of hard tires in four or five hours was considered a feat worth mention. The advent of high-speed steel revealed the general inadequacy of machine tools in power and rigidity, and the driving-wheel lathe was one of the first machines to be re-designed so as to work the new tool steels to the limit of capacity. What is the result? Within the past three years we have seen the notable exploit of turning ten completely finished pairs of locomotive tires in ten hours, or at the rate of one pair per hour. This feat has since been outdone, and now it appears commercially possible to turn a pair of badly-worn tires for, say, 56-inch wheel centers, in forty minutes, counting in the time required for putting in and removing the wheels from the lathe.

But there is quite obviously a chance for further reduction of time, if we are willing to provide still greater power and strength in the lathe. At the present time, the tire is broken down with a round-nose roughing tool which removes the worn tread and the top of the flange. Then follow three forming tools, the first removing the corners of the flange, the second forming the flange and the tread, and the third forming the outer coned part of the tread and rounding the edge.

These forming tool cuts require enormous driving power, but progress will require that the operations of turning a tire shall be reduced to two, these being the roughing cut made by round-nose tool, and the finishing operation, which will be done by a broad-faced tool of exact contour of the tire, forming the tread, edge and flange to the required shape all at the same time. The immediate objections raised will be the great power required of the lathe and the expense of keeping up the forming tools. The first objection will be valid so long only as it can be shown that the interest on the increased investment is not more than offset by the greater earning capacity, and the second objection already has been met by the proved durability of existing tire forming tools. When it can be shown that a forming tool will last for some weeks of constant use, its economy is proved.

With the two-operation wheel lathes fully developed, we may expect to see 60-inch tires turned in twenty minutes, counting the time required for putting in and removing the pair from the lathe. We fully expect to see twenty pairs of average locomotive tires turned in a day of ten hours. This will be increasing productive capacity with a vengeance. The first question that the individual thinks of is: "What good will it do labor?" That question is one that the twentieth century must answer.

* * *

ECONOMY OF NON-PRODUCTIVE LABOR.

It seems difficult for many persons in charge of industrial undertakings to comprehend that so-called productive labor, *i. e.*, labor directly or manually engaged in making the actual product sold, is not the only part of the organization actually profitable or productive. While, of course, it is recognized that the non-productive labor is a necessity, it is by a great many considered as a necessary evil, and any contemplated increase of a non-productive department is viewed with distrust and with the fear that its expense may mount so high as to devour the profits of the productive departments. An example of substantial economy effected by increasing the "non-productive" labor cost may be cited.

In a certain shop, where a great part of the work consisted in making certain tools to order, the customers ordering such tools often simply sent in samples, and requested that one or more tools be made exactly like the sample. The manufacture was of such a varied character that often many different machine operations were performed before the parts were finished, so that they had to pass through, say, six or seven different departments before completion. It was the custom, until lately, to send these samples directly into the shop, without making any drawing or sketch from them, and to let the men work directly to the samples, reproducing them as closely as possible. It is evident that, as the sample passed from department to department, the same dimensions were measured over and over again, perhaps half a dozen times. If the machinist working on the parts did not note down the dimensions at the time when measured, it might occur that each machinist working on a part had to measure the same dimension two or more times. The waste is evident; still, the time was charged as *productive* labor.

Later, somebody suggested that the proper thing would be to hire one more draftsman who would make sketches of all these samples, as they came in, and to have another man check the figures on the sketches from the samples before the sketch was sent in the shop. This necessitated that each tool be measured twice. The sample tool was then sent with the sketch into the shop, but the machinists were required to work to the sketch, the sample merely giving them an idea of the general appearance of the tool required. Now, the additional cost of another draftsman and the cost of checking by a more expensive man was, of course, charged as *unproductive* labor, and considered practically as a loss, but there is no doubt that a great saving was accomplished on each particular tool sketched up in this manner, inasmuch as the necessity of measuring the sample in every department, and in some departments several times, was avoided. At the same time, many mistakes that had previously occurred when one man had measured the sample and then worked to an incorrect figure, were also avoided by the checking before the sketch of the sample left the drafting-room. A permanent record of the tool made was also provided by this method.

The system referred to, is one of the very simplest kind, of course, but it is undoubtedly true that in hundreds of different cases the same principle can be applied in a great many shops to-day. Work is constantly done in a wasteful way by so-called productive labor, which, if properly systematized, could be done by so-called unproductive labor in less time, with greater accuracy, and with the possibility of saving considerable in the running shop charges. Let it not be forgotten then when men running machines do "unproductive" labor, their machines are idle, but the interest account on the cost of these machines runs along just the same.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

According to the *Mechanical World*, the Marconi Wireless Telegraphy Co., on February 3, commenced to accept messages from the public for transmission between London and Montreal. The charge is 15 cents a word, including land rates.

Notwithstanding the financial depression which prevailed during the last months of the past year, the trade and industry of the United States during 1907 exceeded all previous records. According to a table of summaries issued by the Bureau of Statistics, the production of anthracite and coke pig iron in 1907 exceeded 25,315,000 tons, while in 1906 the figure was 24,808,000 tons. Shipments of all kinds of products in nearly every case exceeded by from 5 to 12 per cent those of the previous year.

In the January issue of MACHINERY, engineering edition, we mentioned that the German government has taken considerable interest in the question of airships. How serious this interest really is is shown by the fact that, according to *Engineering*, the German Reichstag, after having granted the sum of $125,000 for the erection of a balloon shed, and for other incidental expenses, has made another supplementary allowance of $100,000 for the building of a second airship for experiments.

Not only is the large Krupp Works, in Essen, Germany, the largest industrial establishment anywhere in the world, but it also appears to be one of the best paying of all large industrial undertakings. It is reported that the dividend for the year 1906-7 was maintained at 10 per cent, the same as the year previous, the net profits for the year amounting to $6,250,000, after taxes, interest and all similar expenses had been paid. The capital of the concern was increased, during the year, from $40,000,000 to $45,000,000.

An interesting method, taken from a German source, for sharpening files when worn is given in *Industritidningen Norden*. The file is connected with the positive pole of a battery, consisting of 12 Bunsen elements, and is then placed in a bath consisting of 40 parts sulphuric acid, to 1,000 parts water. The negative electrode consists of a copper wire, coiled in a spiral around the file, but not touching it. The file is then exposed to the action of the current for about ten minutes. It is stated that files treated in this manner can be sharpened so that they are nearly as good as new.

An International Industrial Exhibition is to be held at Toulouse, France, beginning May 1, and continuing until September 20, 1908. American firms are invited to exhibit, and the directory of the exhibition has offered to undertake to receive their exhibits, and to send them back at the end of the exhibition. Applications for admittance are to be made either to the American Consul, or to the Directory of the Exhibition (Commissariat-General, Exposition Industrielle, Toulouse, France). The goods will be transported back to the French sea-port, free of charge, by the French railway companies.

A practical test of reinforced concrete to determine whether it is safe to remove the forms and supports, was, according to *Engineering News*, given by Mr. C. A. P. Turner, in the course of an address to the Northwestern Cement Products' Association, at Chicago, Ill. The speaker said that it was difficult to formulate a comprehensive rule, covering the variable conditions entering into the problem of the setting of concrete, but it is easy to demand that concrete not frozen shall be set sufficiently hard, so that, if tested by driving a 20-penny wire spike into it, with an ordinary carpenter's hammer, the spike shall double up after penetrating approximately one inch, and if the concrete is not sufficiently good to withstand this test, after having had ample time to set, it is not good enough to remain and do business in a structure that may be deemed safe.

The *Engineering Record* mentions some interesting tests which have been made by Mr. A. E. Outerbridge some time ago for establishing the amount of swelling of cast iron by subsequent heating and cooling. These tests proved that it is possible to increase the volume of cast-iron bars as much as 40 per cent. A bar measuring one inch square by 14 13/16 inches long was heated in a gas furnace to 1,450 degrees F., and then cooled 27 times, after which careful measurements showed that the bar had increased in length to 16½ inches, and to a cross section 1⅛ inch square. Further heatings, however, increased the size of the bar only slightly. As this action is identical with the action of cast iron in super-heating steam fittings, it is quite generally thought that the difficulties experienced with such fittings are direct results of the many variations of temperature rather than the high temperatures themselves.

It has been stated by several authorities that high-speed steel milling cutters are not very successful in cutting hard materials. Messrs. Armstrong's Arms factory, England, however, constantly employ high-speed steel milling cutters for cutting nickel-chrome steel armor-plate, using a cutting speed of 75 feet per minute. Experience with high-speed steel cutters, used for cutting the teeth of gears for motor cars, which are made of a very hard material, putting a severe strain on the cutters, has shown that, under such circumstances, high-speed steel milling cutters will last three and one-half days, without grinding, as compared with one day when ordinary carbon steel milling cutters are used, and at the same time, the feed per revolution could be increased 1/3, so that the high-speed steel cutter, in addition to cutting at a higher speed, and lasting a greater length of time, without being ground or recut, would stand a greater strain as well.

An Italian correspondent to the *Times Engineering Supplement* states that at a meeting of naval and mechanical engineers, held in Genoa early this year Signor L. d'Adda, an Italian naval engineer, presented a proposition for the protection of armored war vessels with reinforced concrete instead of steel plates. This system, he stated, has been used with excellent results for land fortifications. While following the operations of the Russo-Japanese war in the Far East, he had been impressed by the resistance offered by reinforced concrete against heavy projectiles. The weight of plates made of this material would be about the same as of plates made from steel, and the space required was not more than of a metal armor, while the cost would be very considerably less. It is stated that the Ministry of Marine of Italy has directed that some of this concrete protection shall be thoroughly tested at one of the naval stations.

In a paper, read some time ago, before an English engineering society on the subject of illumination, the speaker called attention to the false economy of requiring people to work by poor light. In comparison with the cost of labor, the cost of light is but trifling. He took the illustration of a man receiving from $2.00 to $2.50 a day, or about 25 cents an hour, and compared this labor cost with the cost of a 16 candle-power lamp, burning 10 hours, which he estimated to be only about 1½ cent. Yet there are thousands of skilled mechanics, who are handicapped in their work by insufficient and ill-directed light. In the case of bad light in a factory or shop, the personal inconvenience caused thereby means a reduction both in the quality and quantity of the output, thus producing a loss, in comparison with which the cost of illumination is trifling. One must bear in mind that most men, engaged in mechanical work, are guided almost exclusively by the sense of sight, and the importance of furnishing good illumination ought to be apparent, although it cannot be denied that this question, in many cases, is sadly overlooked. To furnish up-to-date machinery and tools, to pay good wages for skilled labor, and then to handicap the men by insufficient, or improperly placed, light, ought to be so apparent a fallacy that it would hardly be necessary to call attention to it.

The following interesting information regarding the influence of variable load on iron beams, is taken from *Industritidningen Norden*. It is usually assumed that variable load, that is, continued loading and unloading of iron beams, diminishes their strength, but it is claimed that at the laboratory for the testing of materials in Grosslichterfelde, near Berlin, it has been found that this assumption is not based on actual facts. On application of a department of the Government Railroads, 24 beams taken from an old railway viaduct, which had been built in 1856, were tested. Investigations were made to establish the relationship between the original and the present strength of the iron, by comparing the beams from the heaviest loaded and the less heavy loaded portions of the bridge, and also by comparing the strength of two identical parts of the same beam, of which one had been annealed, while the other had been left in its original condition. As is well known, the reduced strength and elasticity of iron, caused by too heavy stresses, can be regained by annealing. If then, by the variable load, the strength of the iron had been reduced, the annealed beams would have shown a greater strength, when tested, than those which had not been annealed. The testing of the strength of the materials, however, showed that the strength of the iron had not been decreased by the variable load, which, for 51 years, had been applied to the bridge. On the other hand, in nearly all cases, it was proved that the parts which had been most heavily loaded showed greater strength than those which had been exposed to less heavy loads.

STORING COAL UNDER WATER.

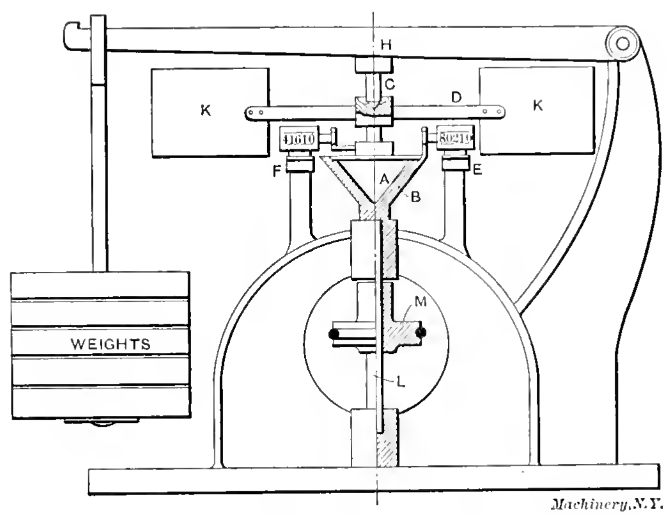
In our July and December, 1906, issues, we referred to the practice of the Western Electric Company of storing coal under water. This is admittedly the best way known for minimizing deterioration, as well as of avoiding spontaneous combustion or accidental ignition. The advantages of this method of storage, says the *Railroad Gazette*, have been determined by experiments in Great Britain within the past five years. The British Admiralty has been the most noted as well as the most extensive investigator, although the studies were antedated by individual experimenters, who were able to record definite and conclusive results. That the idea has been in use in this country since about the time attention was first drawn to it in England, may, however, be new to many, for already in 1902 the Western Electric Company, having had much trouble from spontaneous combustion with Illinois coal stored in quantity, determined on water storage as the simplest and most effective preventive. A large hole was dug in the ground, the coal dumped in, and flooded. When the large new plant at Hawthorne was built about two years ago, the scheme was elaborated to its present proportions. A concrete pit to hold 10,000 tons was built, with tracks across on concrete arches, and the reserve supply of coal is kept in the bins thus formed. To deposit the coal in these submerged bins costs about 5 cents a ton. It is removed by a locomotive crane with a grab bucket. The water for the bins comes from the roofs of nearby buildings. The cost of the pit, which is 310 feet by 114 feet by 15 feet deep, was at the rate of $7,000 per 1,000 tons of capacity. When the coal is used, it is loaded into cars, allowed to stand 24 hours to drain, and then put into the overhead bunkers of the power station, from which it feeds to the stokers. It is therefore used within 48 hours after coming from the pit, and burns well. Since the water removes all of the finely pulverized material, it is equivalent to using washed coal. The British experiments included storage in both sea and fresh water, and in the former instance the quality of the coal actually was improved, presumably from its permeation by the salt. The effect of salting the water has not been tried at the Western Electric Company's pit.

APPARATUS FOR TESTING THE LUBRICATING QUALITIES OF OIL.

Engineering, February, 1908.

An interesting little apparatus intended for testing the lubricating qualities of oils, made by Messrs. John Blake, Ltd., Accrington, England, is shown in the cut below. The apparatus, in general, consists of a vertical shaft *L*, driven by a belt on pulley *M*. At the upper end of the shaft *L* is mounted a conical cup *B*. Into this cup is accurately fitted a metal cone *A*, on which, in turn, is mounted a vertical spindle *C*, carrying two horizontal arms *D*, provided with two vanes *K*. When the spindle *C* is revolving, the air resistance on the vanes *K* will tend to retard the movement. A revolution counter or speedometer *E* is connected to the revolving cup *B*, and one speedometer *F* to the revolving cone *A* inside of the cup. The action of this device is as follows:

A small quantity of the oil or lubricant to be tested is placed in the cup *B*, and the loose cone *A* with its vertical spindle and vanes is placed in the cup. The cone has a groove in its side, in which a small quantity of oil may remain, so as to prevent all the oil being pressed out of the cup *B*, when the cone *A* is placed in position. The lower spindle, with the



Apparatus for Testing the Lubricating Qualities of Oil.

cup attached, is then revolved by means of its belt and pulley, at a speed of about three hundred revolutions per minute, and as the cup revolves with the cone inside it, the friction between the cup and the cone causes the latter to revolve also, but at a lower speed than the cup, on account of the resistance offered by the vanes, when passing through the atmosphere. After the machine has been running for a given time, say a couple of hours, the number of revolutions made by the cup and those made by the cone are noted. Then a second oil or lubricant may be put in, after first removing completely all traces of the one previously tested, and a note made of the number of revolutions made respectively by the cup and cone during the same period of time as in the first

TESTS OF LUBRICANTS.

Sample Number.	Quality of Oil.	Duration of Test.	Revolutions of Cup.	Revolutions of Cone.	Percentage of Cone Revolutions to Cup Revolutions.
1	Sperm	2 hours	36,540	12,300	33.6
2	Mineral	2 hours	36,800	14,800	40.2
3	Mineral	2 hours	36,300	16,100	44.4
4	Mineral	2 hours	36,350	17,400	47.8
5	Mineral	2 hours	36,580	18,600	50.8
6	Mineral	2 hours	36,280	22,100	60.9

test. If the number of revolutions made by the cone be less with the second oil or lubricant than with the first, it naturally follows that the friction between the cup and the cone has been less, and therefore that the second oil or lubricant is better. Many oils can be compared in this way, and their lubricating value can be put down in the exact order of merit. The accompanying table gives the results of a few tests which have been made on a number of different kinds of oils with this device.

When heavy oils are tested, the lever *H*, having weights hung on its end, as shown in the cut, is used for producing the required pressure between the cone and the cup.

THE STUB-TOOTH GEAR.

Abstract of pamphlet entitled "The Stub-Tooth Gear," published by the Fellows Gear Shaper Co., Springfield, Vt.

This little pamphlet deals with the advantages of the "stub-tooth" gear, a form of shortened and strengthened involute tooth cut with stub-tooth cutters. The pamphlet states the case for short teeth of greater obliquity than 14½ degrees standard so conveniently that it seems worth while to make the following condensed abstract of it, largely in the words of the original:

With the constantly increasing use of gears for transmitting power in widely varying quantities, the question of the correct shape and size of gear teeth becomes of far greater importance than ever before. It is not sufficient that a gear be well cut and the teeth properly spaced, but the shape and proportions of the tooth itself must be carefully considered.

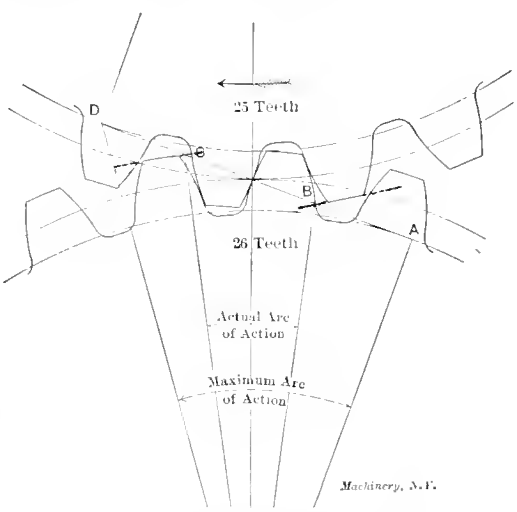


Fig. 1. Comparison of Actual with Maximum Arc of Action in the 14 1-2 Degree System.

The two most important features are the securing of the nearest approach to a rolling action that it is possible to obtain and the strongest tooth that will meet this condition. The first includes easy running, reduces the friction to the lowest point, and consequently has the least wear in action.

In the matter of length, it is a fallacy to argue that teeth should be made as long as possible in order to have two or more teeth in contact at once. An equal division of the load is never possible between two contact points, and it can be shown that the lengthening of the tooth to produce more points of contact gives an excessive sliding action at certain portions of the tooth action, especially with gears 14½

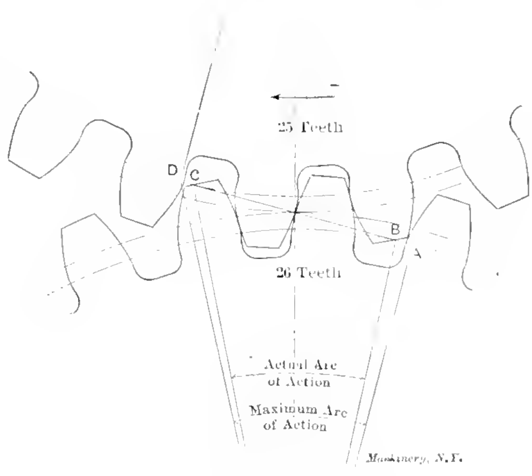


Fig. 2. Comparison of Actual with Maximum Arc of Action in the Stub-tooth System.

degrees of standard angle. By increasing this angle, the teeth may be shortened so that only such portions of the curve are used as will give nearly a complete rolling action. This increase in obliquity has been advocated before, but its advantages are very limited, if a tooth of the standard length is retained.

In Figs. 1 and 2 are shown comparisons of the tooth form of a gear of the standard and of the stub-tooth, the driver having 25 and the driven 26 teeth. If, in the diagrams, the gears are supposed to rotate in the direction of the arrow, the theoretical action begins at A and ends at D, the line $A\,D$ being termed the "line of action." It is obvious, however,

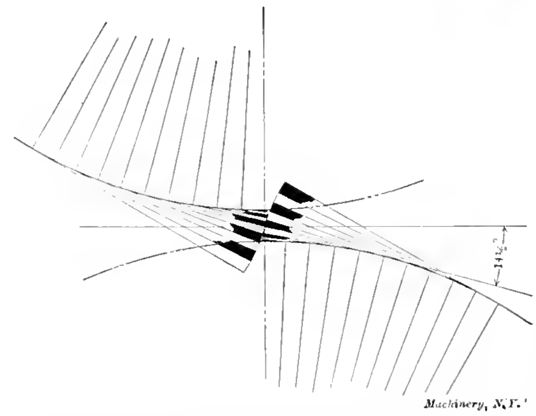


Fig. 3. The Involutes are those of Fig. 1. The Alternate Shaded Divisions show the Portions of Each which are in Contact with the Corresponding Portions of its Mate during Equal Angular Movements.

that the actual action can only begin at B, where the outside diameter of the upper gear intersects the line $A\,D$, and ends at the corresponding point C. Drawing the radial lines from these points to the center O (not shown) the triangle $A\,O\,D$ defines the maximum or the greatest possible arc of action, and $B\,O\,C$ the actual arc of action.

In Fig. 3 is shown an involute curve of 14½ degrees obliquity of each of the gears, the curves being of sufficient length to cover the maximum arc of action, and drawn to the same scale as Figs. 1 and 2. The alternately shaded divisions of the curves show the portion of each that is in contact with its mate during an equal angular movement of the gears. In Fig. 4 is seen a similar diagram for a tooth having an angle of obliquity of 20 degrees.

In Figs. 5 and 6 the involute curves of Figs. 3 and 4 are developed into straight lines, marked off into divisions corresponding with the divisions on the involutes. These division

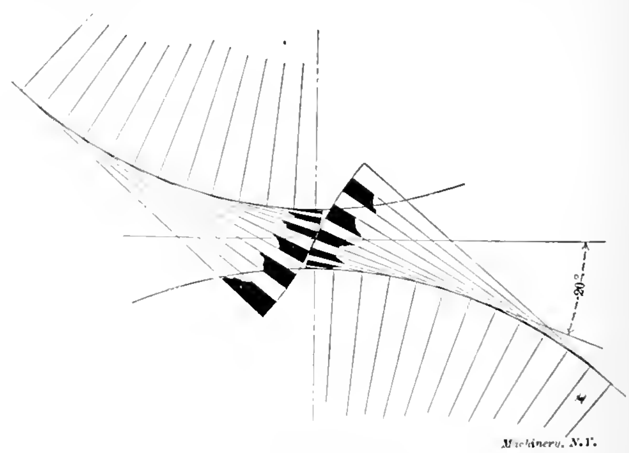


Fig. 4. The Involute of the Stub-tooth Gear in Fig. 2, treated as in the Preceding Figure.

points are connected by cross lines. It will at once be seen that the angularity of these cross lines may be taken as a measure of sliding that takes place at any given point, since a large division on one involute making contact with a small division on the other involves an amount of rubbing measured by the difference between the two distances. To any one who has labored under the impression that if the involute curves of a pair of gears are correct, the action is nearly a rolling one, a comparison of these diagrams will be both interesting and instructive. Two points will be noted.

First, on account of the greater angle of the line of action of the stub-tooth, the maximum arc of action is much increased.

Second, the ratio of the *actual* to the *maximum* arc of action of the stub-tooth is much less than in the standard.

This latter point is a very important one, as we thus eliminate contact at both ends of the line of action. When we

realize that this is the portion of the action in which the greater part of the sliding takes place, with its inevitable wear, we see that it is a good thing to cut it out if possible. The point of the tooth which wears out the flank of its mate is removed with the adoption of the stub-tooth, and this reduces the friction while increasing the efficiency. A comparison of Figs. 5 and 6 shows that the action of the stub-tooth is as nearly a rolling one as it is possible to obtain. The action of the standard tooth at the base line is that of a stone-boat being dragged over the ground, while the action of the stub-tooth can be compared with the same stone-boat mounted on wheels.

It is, of course, impossible to entirely eliminate the wear between the teeth of gears working under a load. But if the wear can be evenly distributed over the entire working face of the tooth, the correct form of tooth is retained indefinitely, and a worn-out gear should, aside from the excessive back-

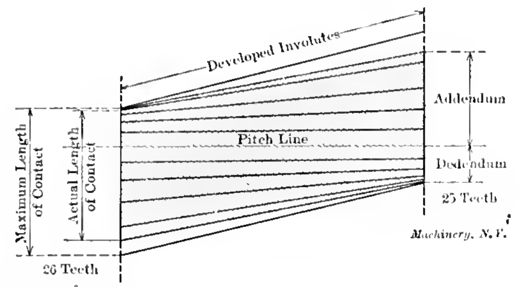


Fig. 5. The Involutes of Fig. 3 Separated and Developed into Straight Lines with the Division Points Connected as shown. The Angularity of the Connecting Lines is a Measure of the Rubbing.

lash, run as well as a new gear. And, if this wear can be evenly distributed, the durability of any gear will be increased many times.

We have so far discussed only the points of efficiency and durability, but there is another advantage of the stub-tooth over the standard form, and one which some might think entitled to first consideration, especially in the transmission of any considerable amounts of power; this is the advantage of greatly increased strength.

A comparison of the two diagrams in Fig. 7 (drawn according to the well-known method proposed by Mr. Wilfred Lewis) shows an increase in strength for the stub-tooth form of 80 per cent. It will be noted by comparing different combina-

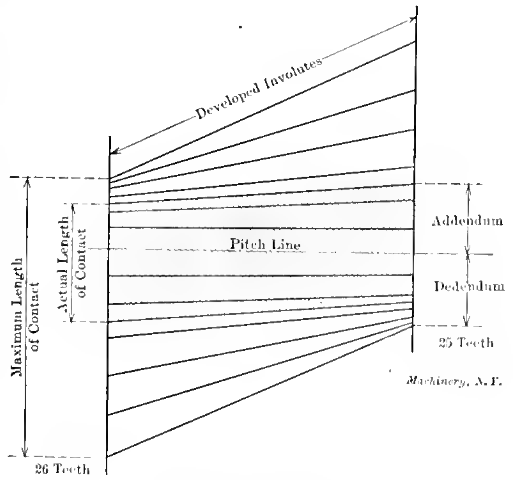


Fig. 6. The Involutes of the Stub-tooth Gear in Fig. 4 treated as in the Preceding Figure.

tions of gears that the increase in strength is greatest for pinions, which are almost invariably weaker than the gears they run with.

To understand the importance of this consideration of strength, it may be mentioned that if comparisons are made between a 15-tooth 6-pitch 14½-degree gear and one with 20 teeth 8/10 pitch of the stub-tooth standard, both having the same diameter, it can be shown that the stub-tooth, though shorter and of finer pitch, has 20 per cent greater strength, and while the bearing surface per tooth is shorter, the total area of bearing surface is 6 per cent greater.

Some of those who are not entirely familiar with this system of gear teeth have made the mistake of thinking that it consists simply of the shorter tooth than the standard form, while retaining the same pressure angle, and have therefore opposed it on the ground that the arc of action, in the case of a small pinion, is not equal to the pitch arc, and that the action is therefore not continuous, because one tooth is out of action before the next tooth takes up the load.

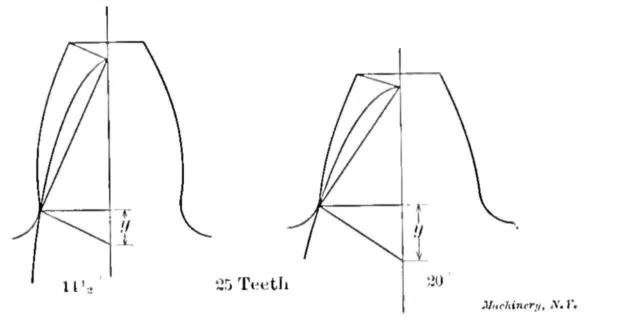


Fig. 7. The Strength of a 14 1-2 Degree Tooth and a Stub Tooth Compared by the Wilfred Lewis Method; the Strength is measured by Dimension y.

It should be thoroughly understood, and we wish to emphasize the fact as much as possible, that the increased angle of obliquity is an essential and vital part of the stub-tooth system, and that with this increased angle, the arc of action is as long as that of the 14½-degree tooth.

Fully one-third of the cutters made by the Fellows Gear Shaper Co. are now of the stub-tooth form.

[We have described the method of sizing the stub-tooth gear in a previous issue of MACHINERY. See "How and Why" in the July, 1907, issue. This method of sizing the teeth is very convenient for use with the Fellows gear shaper, in which the depth of cut is obtained by referring to graduations numbered to correspond with the diametral pitch used. We cannot escape the belief, however, that it is a serious error to inaugurate a system in which the addendum of the tooth bears no definite relation to the pitch. While the convenience of the operator is worth consideration, we believe it could have been obtained in other ways that would not have involved the irregular determination of the addendum, as now practiced.

The argument for shortened addendum and increased pressure angle, given in this pamphlet, seems to us worthy of the serious attention of mechanics. The conclusions are, we believe, inescapable, and perhaps even more might be said from the standpoints of efficiency and durability in behalf of a change from the old standard form.—EDITOR.]

FRICTION AND LUBRICATION.

Abstract of paper read by Dr. J. T. Nicolson before the Manchester, England, Association of Engineers, November 23, 1907.

The present paper does not give much attention to dry friction, or to the laws of resistance when one solid moves over another. Its chief aim is to attempt to give some definite ideas about the resistance offered to the relative motion of lubricated surfaces, and, in particular, relates to journals and bearings as used in engineering practice. Experimental results obtained by Stribeck, Dettmar, Heimann, Lasche, and others, have been utilized for framing rules which indicate that some views commonly held in regard to bearings are not correct. In particular, the idea that the length of the bearing should increase in proportion to the speed, is shown to be erroneous.

Dry Friction.

When one solid rubs upon another without any lubricant, the resistance offered to relative motion is due either to actual abrasion or to molecular interference between the two surfaces. Even though a metallic surface may appear to be perfectly smooth to the eye, its real condition, if viewed with a powerful microscope, resembles that of a rugged mountain system. When one surface is slid upon another, these surfaces exercise a resisting force. The following laws may be considered as generally covering the question of dry friction:

1. Within certain limits, the frictional resistance may be said to be proportional to the load, and to be independent of

the extent of the surface over which the load is distributed; but when the pressure or load per unit area is large, the friction increases at a greater rate than the load, or, in other words, the coefficient of friction increases with the pressure.

2. The coefficient of friction varies with the speed of motion. It is greatest when the motion is slowest, and when one body is just commencing to move relative to another, we have what is called friction of repose. This friction has been found by experiments to be from 0.3 to 0.4 for iron upon iron; for moderate speeds, the friction varies from 0.15 to 0.25 for the same material; and for speeds from 10 to 90 feet per second, the coefficients of from 0.10 to 0.20 have been found by experiments.

3. The friction of solids with no lubricant interposed has been found to diminish as the temperature increases. This is due to the fact that abrasion is easier at high temperatures.

Friction with Lubrication.

When some lubricant is placed between moving bodies, the valleys or the uneven surfaces are leveled up, and the intensity of the molecular action is diminished. For the frictional work when a shaft rotates in a well-lubricated bearing, we may state the following formula, expressing the frictional work done per revolution:

$$\text{Frictional work per revolution} = \frac{\pi\, d\, u\, W}{12} \text{ foot-pounds.}$$

In this formula,

d = diameter of shaft, in inches,

u = coefficient of friction (0.15 on an average),

W = load on the bearing in pounds.

This formula holds true when there is plenty of oil, so long as the speed is small. If we take as an example the case of the spindle for a 10-inch lathe, running slowly, with a weight of 3,000 pounds carried by the front bearing, which is $3\frac{1}{2}$ inches in diameter, then the friction work per revolution is

$$\frac{\pi \times 3.5 \times 0.15 \times 3{,}000}{12} = 412 \text{ foot-pounds per revolution.}$$

If a cut were ¼ inch × 1/16 inch on soft steel, the cutting force would be, say, 3,500 pounds, and on a 20-inch face-plate diameter the work spent in cutting per revolution would be

$$3{,}500 \times \frac{20\,\pi}{12} = 18{,}300 \text{ foot-pounds.}$$

The work lost in friction by the journal is therefore 2.26 per cent of the useful work. A similar calculation for a 48-inch lathe would show a loss of about 10 per cent. These great frictional losses constantly occur with lathe spindles or other rotating shafts, revolving slowly, even when abundantly fed with oil, and indicate the necessity for using measures to preserve a separating film of oil between the shaft and bearing, and not to allow them to run in metallic contact. This is more difficult to accomplish at slow than at high speeds.

Automatic Lubrication.

The following rules for supplying bearings with oil will give the best results in practice: If the oil is fed in by the ordinary cup and syphon, or by a ring or centrifugal method of supply, it should be made to flow onto the journal at the place where the pressure is least. The oil should therefore be fed from a point situated in the top rear quadrant of the bearing when the journal is loaded by gravity only, and the point should be further back the slower the speed. This applies, then, especially to the large lathes. If the loading of the journal is principally due to cutting force acting upward upon it, the feed should be placed in the bottom front quadrant, and nearer the front, the slower the speed of rotation. This meets the case of the smaller-sized lathes.

The compromise ordinarily effected to enable the lubricant to enter, whatever may be the direction of the loading, is the simple one of fitting the oil cup on the top of the bearing. This seems almost the only thing to do in the case of automatic lubrication, but it is the correct position only when the resultant force upon the journal, due to gravity and cutting force, etc., acts nearly horizontally and from front to rear.

Forced Lubrication.

When the lubricant is supplied by mechanical means at a fixed rate and at any required pressure, it must be fed in at the points of greatest oil pressure in the bearing. For large lathes, where gravity is more important, the region of greatest pressure lies in the rear bottom quadrant. For small lathes, on the other hand, in which the force on the spindle acts upward, owing to the cutting force being relatively greater, the maximum oil pressures occur in the front top quadrant. To meet all contingencies, it would appear on the whole best, in the case of forced lubrication, either to force the oil in at the back of the bearing, well below the center, or preferably to fit three alternative branches from the oil pressure supply pipe to the back, top, and front, any one of which may be turned on at will to suit the conditions of working.

Frictional Resistance Due to Viscosity.

In describing the phenomena occurring when a journal rotates in a bearing, we have, so far, not alluded to the nature or magnitude of the frictional resistance experienced when there is an abundant supply of lubricant completely separating the former from the latter, and preventing any metal-to-metal contact. It is frequently stated that "there is no friction without abrasion," or, in other words, that unless two metals rub against each other, there can be no resistance due to relative motion. This, however, is not the case. When a film of lubricant is interposed between two metallic surfaces, there is a resistance to relative motion of these surfaces due to the shearing or transverse distortion of the oil film.

This resistance does not depend on the load. It is governed only by the area of viscous fluid to be sheared, and the viscosity of the oil, *i. e.*, the kind of oil and its temperature (with which the viscosity greatly alters), and it also gets greater the smaller the thickness of the film, so that if the shaft is a close fit within its bearing, the resistance to motion will be greater than if the fit is an easy one.

There are very few cases in engineering practice where a journal rotates with a uniform thickness of oil around it, and it is only at very high speeds that this takes place. At moderate and low speeds, the shaft moves to one side an amount depending on the speed of the load, the eccentricity for any given load becoming less, the greater the speed. We have already said that the frictional resistance depends on the thickness of the oil film. Experiments have shown, however, that the thickening of the film on one side of the shaft is more than counteracted by the thinning of the film on the other, so that, in general, the friction gets greater when the journal becomes more eccentric.

Considering, therefore, the bearing running slowly, in which a lubricant has just formed a complete film all around the shaft, it will have its maximum amount of eccentricity, and the frictional resistance will, on this account, be large. As the speed increases, the eccentricity diminishes. The friction increases with the speed, but it diminishes, on the other hand, with the eccentricity. Experiments show that at first there is a diminishing and then an increase, so that the coefficient of friction attains a minimum value which depends on the circumstances in each case. With further increase in speed, the diminishing of friction, due to the lessening eccentricity, becomes insignificant, and after a certain interval, the simple law of friction is followed, whereby friction increases in proportion to the velocity of rubbing.

For speeds greater than at from 20 to 80 feet per minute, the temperature of the oil film also exerts its influence. This temperature rises above that of the bearing, and its viscosity becomes reduced. The frictional resistance then increases less rapidly than in exact proportion to the speed. The faster the journal runs, the more the temperature of the oil film rises above that of the bearing, and the thinner or less viscous becomes the oil. Thus, for speeds from 50 to 90 up to about 450 feet per minute, the coefficient of friction is proportional to the square root of the speed of rubbing. For speeds between 450 feet and 800 feet per minute, the friction increases more slowly, and varies as the fifth root of the velocity. For speeds as high as 3,600 feet per minute and upward, the influence of the speed disappears altogether, and the conclusion is arrived at that for bearings of high speed generators, for

instance, driven by steam turbines, whose rubbing speeds are nearly a mile a minute, the coefficient of friction is the same, whatever be the speed.

Application of Results of Experiments to the Design of Bearings.

In endeavoring to apply the theoretical explanations and the experimentally found formulas, the question arises: What is the proper proportion of length to diameter, under any given condition, as to load, speed and kind of lubrication? According to hitherto accepted rules, the length of the bearing should increase with the load and with the number of revolutions. The experiments and formulas arrived at by the author, indicate, however, that the heat developed in the bearing depends only upon the rubbing velocity, and is quite independent of the length of the journal. We cannot, therefore, hope to lower the temperature by lengthening the bearing. The heat generated increases as fast as the area for dissipating it increases, and, although by lengthening the journal, the bearing pressure is diminished, the frictional resistance and the heat generated are increased. On the other hand, we know from experience that journals must be made long for high speeds, and the above calculations seem, at first sight, to be in conflict with accepted practice. The explanation of this is as follows: While it is true that the final temperature to which the bearing will rise after a long run, under a given load, and with a given lubricant, depends only on the diameter of the spindle and the speed of revolution, that is, only upon the rubbing velocity, and not at all upon the length of the journal, we have to remember that if the finally attained temperature be too high, the lubricant will be squeezed out unless the bearing pressure is low.

Another conclusion arrived at by these experiments, contrary to the view usually accepted, is that the length of the bearing must be greater, the slower the speed. This, however, is clearly correct, for the slower the speed, the greater difficulty has the shaft in dragging in its supply of oil to meet the required demand, in opposition to the bearing pressure which is squeezing it out, and consequently the unit bearing pressure should accordingly be lower in order to enable the journal to maintain its oil film unbroken.

Journals for Heavy Loads at Slow Speed.

One kind of bearing which presents special conditions, and which is frequently met with and has to be dealt with in practice, is that in which a journal has to run under a heavy load at a very slow speed. What we have here to guard against is the entire collapse or tearing asunder of the film of lubricant, owing to the slow speed at which the bearing is being worked; and when once the tearing of the oil film begins, the journal is unable to bring up a fresh supply, owing to its small surface speed.

Calculations and experiments show that it is impossible to give the large dimensions to the front bearing of a heavy lathe that would be necessary to prevent the oil film from being broken at such slow speeds; and, as a matter of fact, lathe spindles turning at the slow speeds used for heavy cuts inevitably run metal-to-metal with their bearings, giving rise to the high frictional resistance corresponding to the coefficient of friction of 0.15 for greasy metals. The work thus spent and wasted on friction and wear may amount to from 2 per cent to 10 per cent of the total useful work expended on cutting. From 1/4 to 9 (according to size) horse-power is, therefore, wasted on the friction of the front journal alone when the lathe is running at these slow rates with a heavy job between centers. Even if the working pressure is light, and the thrust on the front journal is due to the standard cut only, it can be shown that 2 1/2 per cent of the useful work is spent on friction on any size of lathe when the speeds are so low as to squeeze out the oil film.

We are here face to face with a very serious loss of power, and a correspondingly large amount of wear of the spindle and in the front bearing, not at all due to high speeds of rotation of the spindle; and it is owing to this that the elaborate arrangements for adjustment of the spindle in a lathe headstock have to be provided.

It is impossible to give enough area in the front bearing of a lathe head-stock to prevent metallic contact of journal and brass at the slower speeds, if dependence is placed upon the lubricant being carried in by the ordinary action of the shaft's rotation, the supply being automatic. By using a force pump, however, and injecting a stream of moderately heavy oil into the bearing at the place where the pressure is greatest, it is possible to raise the journal off the brass even when at rest, and to keep it floating with a film of oil interposed between itself and the bearing when in motion, be that motion as slow and the load as high as it may. If metal-to-metal contact can in this way be prevented at slow, and by the ordinary methods at high speeds, there seems to be a possibility that wear may be entirely eliminated. If this be so, it follows that adjustments for wear are unnecessary, and instead of the elaborate and expensive designs of front and back bearings which are now used, we may expect that a simple solid bush of ample thickness will meet every requirement. Such a solid bush, of hard bronze round the steel spindle, has a great deal to recommend it from the point of view of accuracy of fit, solidity, and stiffness, as compared with the intricate methods of adjustments now common.

Modern Practice for Lubricating Bearings.

The chief distinction between the modern and the older methods of lubricating bearings lies in that the oil is no longer supplied drop by drop, as formerly, but in an abundant stream, the oil serving the purpose not only of lubrication, but of carrying away the heat.

For high speed bearings, the principle most often adopted is that of the "closed circuit," that is, the oil is used over and over again; after dropping off the journal into a collecting reservoir, it is filtered and used anew, being automatically supplied to the journal at any suitable point. A cooling arrangement is sometimes fitted in the reservoir so as to remove the heat from the oil, and consequently also from the bearings. The system of forced lubrication is also adopted to a great extent. The oil is then, by means of a pump or other suitable device, pressed in between the rubbing surfaces so that the journal floats on the heavy film of lubricant.

Lubricating Horizontal Bearings.

The most common method of lubrication for horizontal journals running at high speed is the ring-oiled bearing, in which a loose ring, resting on the shaft, turns with it, dipping into the oil reservoir at the lower side, and bringing up the oil to the top surfaces of the journal, from where it flows over into the oil grooves. No ribs or other projections should be fitted on the rings, as such arrangements produce a resistance to their passage through the oil bath, and bring them to a stand-still. At high speeds, the centrifugal force renders the flow of oil from the ring to the journal difficult, and scrapers are used for diverting the oil into the oil channels. These, however, should never touch the ring, as they will then stop its motion.

Self-oiling bearings having rings fast on the shaft are not much used. The fast ring cannot stick, but it requires a longer design of bearing. The ring may act as a collar where end-wise motion is to be prevented; but as such motion is usually an advantage, the ring should ordinarily be attached to the shaft so that it can slide on its key. For high speeds, the scraper may be used with fast rings, to overcome the centrifugal force.

Forced Lubrication.

By the use of a pump to force the oil drawn from the reservoir into the bearing, to the point of maximum pressure, the length of the bearing can be very much diminished even for the slowest speeds, especially for journals whose load and rotation direction do not change. For such bearings, the length need, in all probability, not be more than equal to the diameter of the shaft. With such bearings there ought hardly to be any wear at all. The system is extensively used in high speed steam engines and gas engines.

* * *

The best way to get along with a competitor is to treat him well. If you abuse him unjustly, you get the name of being envious, and do yourself harm. Pry into your own business instead of his, and you will be better respected and more prosperous.—*Cincinnati Enquirer.*

DERIVATION OF FORMULA FOR DETERMINING SPUR GEAR CUTTER NUMBER FOR SPIRAL GEARS.*

H. W. HENES.†

The formula $N_c = \dfrac{N}{\cos^3 a}$ is generally accepted as the correct one for determining the proper spur gear cutter to be used in cutting a desired spiral gear. In this article is given the derivation of the formula. The following notation is used:

N_c = number of teeth in spur gear for which cutter is intended.

N = number of teeth in the desired spiral gear.

a = the angle which the direction of the spiral makes with the axis of the gear.

Let P_n be the perpendicular distance between two consecutive teeth on the spiral gear, and let D_1 be the diameter of the spiral gear. Let the gear be represented as in the cut, and pass a plane through it perpendicular to the direction of the teeth. The section will be an ellipse as shown in *CEDF*. Designate the semi-major and semi-minor axes by a and b respectively.

Now, N_c is the number of teeth which a spur gear would have if its radius were equal to the radius of curvature of

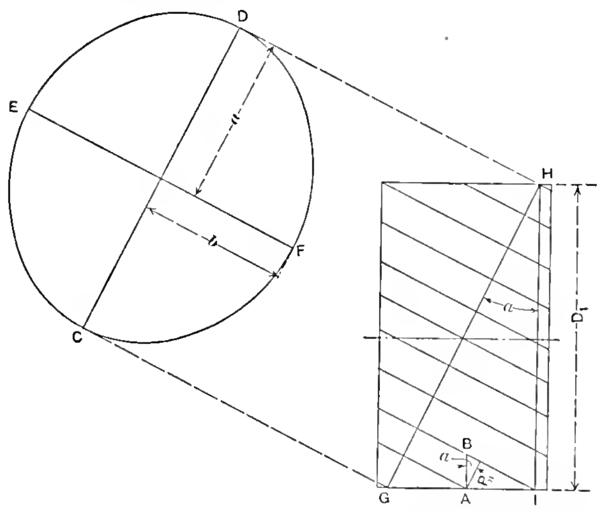


Diagram for Deriving the Formula for Determining Spur Gear Cutter Number for Cutting Spiral Gears.

the ellipse at E. Therefore, it is required to determine the radius of this curvature of the ellipse. This is done as follows:

From the figure we have:

$$2b = \text{axis } EF = D_1 \tag{1}$$

$$2a = \text{axis } CD = GH = \frac{HI}{\cos a} = \frac{D_1}{\cos a} \tag{2}$$

From (1) and (2) we have for a and b,

$$b = \frac{D_1}{2} \tag{3}$$

and

$$a = \frac{D_1}{2 \cos a} \tag{4}$$

It is known, and shown by the methods of calculus, that the minimum curvature of an ellipse, that is the curvature at E or F, equals $\dfrac{b}{a^2}$. Taking the values of a and b found in (3) and (4), we have as the curvature at E:

$$\text{Curvature} = \frac{b}{a^2} = \frac{\dfrac{D_1}{2}}{\dfrac{D_1^2}{4 \cos^2 a}} = \frac{4 D_1 \cos^2 a}{2 D_1^2} = \frac{2 \cos^2 a}{D_1} \tag{5}$$

It is also shown in calculus that the *curvature* is equal to $\dfrac{1}{R}$, where R is the *radius of curvature* at the point E. Therefore from (5) we have:

$$\frac{1}{R} = \frac{2 \cos^2 a}{D_1}, \text{ whence } R = \frac{D_1}{2 \cos^2 a} \tag{6}$$

[Formula (6) could have been arrived at directly, without reference to the minimum curvature of the ellipse, by introducing the formula for the radius of curvature in the first place. The curvature is simply the reciprocal value of the radius of curvature, and is only a comparative means of measurement. The radius of curvature of an ellipse at the end of its short axis is $\dfrac{a^2}{b}$, from which formula (6) may be derived directly by introducing the values of a and b from equations (3) and (4).—EDITOR.]

Having now found the radius of curvature of the ellipse at E, we proceed to find the number of teeth which a spur gear of that radius would have. From the figure we have:

$$AB = \frac{P_n}{\cos a} \tag{7}$$

Now, if AB be multiplied by the number of teeth of the spiral gear, we shall obtain a quantity equal to the circumference of the gear; that is:

$$AB \times N = \pi D_1, \text{ and, since } AB = \frac{P_n}{\cos a} \text{ from (7),}$$

$$\frac{P_n}{\cos a} \times N = \pi D_1 \tag{8}$$

Since N_c is the number of teeth which a spur gear of radius R would have, then,

$$N_c = \frac{2 \pi R}{P_n} \tag{9}$$

In equation (9) the numerator of the fraction is the circumference of the spur gear whose radius is R, and the denominator is the circular pitch corresponding to the cutter.

From equation (6) we have:

$$R = \frac{D_1}{2 \cos^2 a}$$

Substituting this value of R in (9), we have:

$$N_c = \frac{2 \pi D_1}{P_n \times 2 \cos^2 a} \tag{10}$$

From equation (8) we have:

$$D_1 = \frac{N P_n}{\pi \cos a} \tag{11}$$

Substitute this value of D_1 in equation (10) and we have:

$$N_c = \frac{2 \pi N P_n}{2 P_n \pi \cos^3 a}$$

or

$$N_c = \frac{N}{\cos^3 a} \tag{12}$$

* * *

The use of wind-mills for electric power generation for agricultural and industrial purposes has greatly increased in Denmark during the past years. The Danish Government conducts experiments to ascertain the best forms of installments, and since 1897 has spent about $28,000 for such experiments, and has lately erected an experimental station for determining the best means for generation of electricity by means of wind-mills. Wind-mills with four wings, have been found to be the most economical, because of giving the most power. The results have shown that out of a wing surface of about 65 square feet one horse-power is developed at a wind velocity of 20 feet per second. At a velocity of 26 feet, one horse-power is developed from about one-half of this wing surface. It is stated that 30 larger and smaller wind-power electrical installations are now in operation in Denmark.

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: A Method of Procedure in the Design of Helical Gears, May, 1906; Cutting Spiral Gears, October, 1905; Spiral Gears, September, 1903; Spiral Gearing Helps, November, 1901.

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RACK-CUTTING MACHINES IN THE SHOPS OF THE R. K. LE BLOND MACHINE TOOL CO.

One of the lines of manufacture of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, is the cutting of racks for the trade. Though the machines for this work have been built at home, they do not display any of the usual crudities of home-made tools, being first-class examples of machine design, presenting a number of points of novelty and interest in their construction. Through the kindness of Mr. Wm. F. Groene, the chief draftsman of the firm, we are enabled to show photographs and details of the latest of these machines, which have recently been completed and put in operation.

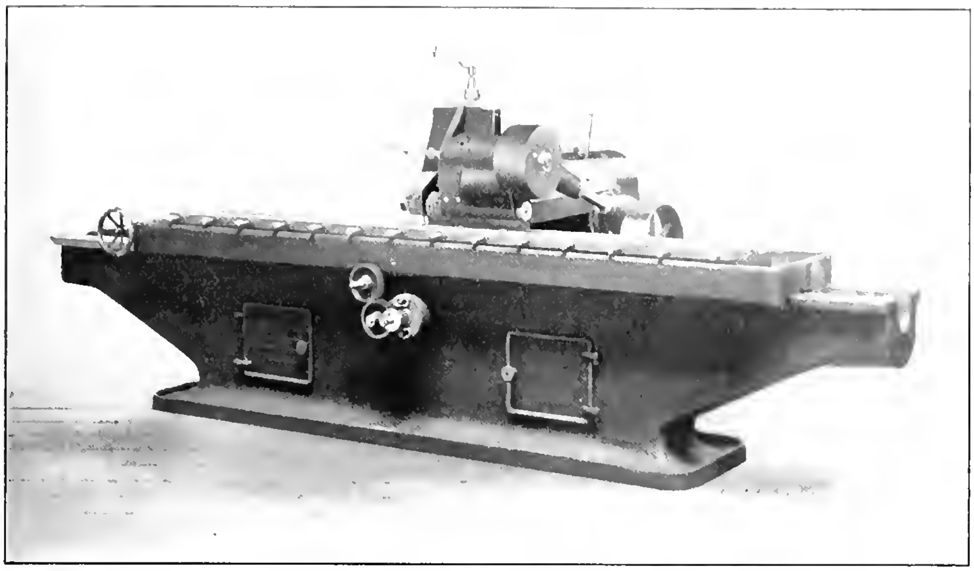


Fig. 1. Rack-cutting Machine built in the Shops of the R. K. Le Blond Machine Tool Co.

General Construction.

As may be seen in Figs. 1 and 2, the machine is of the type derived from the shaper, so far as its structural features are concerned. The cutter spindle and driving gears are carried in a head which is vertically adjustable on the front of a horizontal ram. This vertical adjustment is used for setting the cutters to depth. The horizontal ram is fed slowly forward for the cut, and is then rapidly returned while the work is indexed to a new position. The work is held in a long vise attached to the top of a work table, sliding on dove-tail ways on the long base of the machine. This base, as may be best seen in Fig. 2, is of T-form, having a rearward extension to support the ram, and it is cast solid in one piece. The machine is fully automatic in all its actions.

A 5-horse-power motor, mounted on the ceiling, drives the machine through a single speed pulley, shown best in Fig. 2. The single speed shaft, through change gearing in the case at the right of the ram in Fig. 2, drives a second shaft, connected by bevel gears with the splined shaft shown, running diagonally upward to the cutter slide, where the motion is transmitted to the cutter spindle through bevel and twisted tooth gears. This arrangement of splined shaft and bevel gears transmits the power without interfering with the movements of the cutter ram. The automatic slow forward feed and quick return of the ram is effected by mechanism in the casing at the rear of the column, as shown in Fig. 2, controlled by the handle projecting through the back end of the ram. The indexing is controlled by change gears at the front of the bed.

The work table is indexed by change gears mounted at the front of the bed. The movement of the table for indexing is effected by a stationary lead-screw carried by the table, and a revolving nut operated by the indexing mechanism. The machine will cut racks 10 feet long at one setting. Racks longer than this can be cut by resetting in the chuck, the table being provided with a fine micrometer adjustment by means of the hand-wheel shown at the left in Fig. 1, whereby it can be moved independently by the indexing mechanism, for matching the teeth. The return of the table for the next setting of the rack, and all other movements of the machine, are power operated, relieving the operator of all physical effort. These provisions make it possible for one man to run four machines.

To insure the maximum of productiveness from the machine, provision has been made in its design to furnish an abundant supply of oil to the cutters, so that the work and the cutters are flooded with a stream of lard oil. The inside of the column forms a reservoir from which the oil is pumped to the work. The machine has the necessary arrangements for straining and returning the oil to the reservoir.

Spindle Driving Mechanism.

Details of the spindle drive are shown in Fig. 3. The driving bevel pinion, mounted on the end of the splined driving shaft shown in Figs. 1 and 2, drives a bevel gear keyed with a taper fit to the driving pinion shaft. This shaft has teeth formed integrally with it, meshing with the intermediate gear shown, which, in turn, meshes with the pinion teeth formed integrally with the cutter spindle. This gearing has helical teeth, to give a smooth, even drive to the cutter spindle. The difficulty of driving the spindle of the rack-cutter is well known. The difficulty arises from the fact that the driving pinion of the cutter spindle must be smaller in diameter than the cutters which it drives, so that it must necessarily have very few teeth and be subjected to great strain. This makes it difficult to make it strong enough, and at the same time give a smooth, steady drive. In this case the teeth are made strong enough

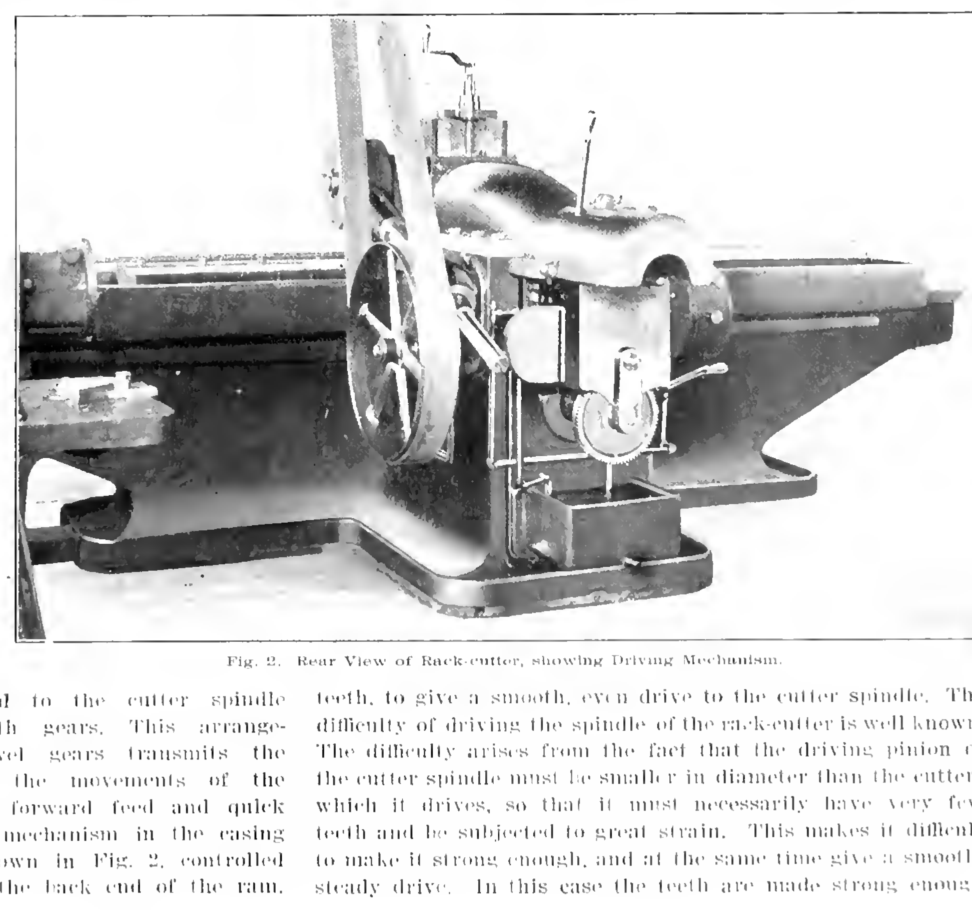


Fig. 2. Rear View of Rack-cutter, showing Driving Mechanism.

by being given a very wide face (5 inches), and the required smoothness of drive with the large pitch used is effected by making the gears with twisted teeth, the helix angle being 14 degrees. The end pressure produced by these twisted teeth is taken care of by suitable thrust washers, the direction of pressure being toward the left for the driving pinion and the cutter spindle, and toward the right for the intermediate gear stud.

The bearings for the cutter spindle on each side of the pinion are tapered, as shown. The one at the left, which takes the thrust, is held in the cutter slide by taper dowel pins. The one at the right may be screwed in or out of the cutter slide cup to take up end play. At the extreme left, the spindle is supported by a removable outboard bearing, which

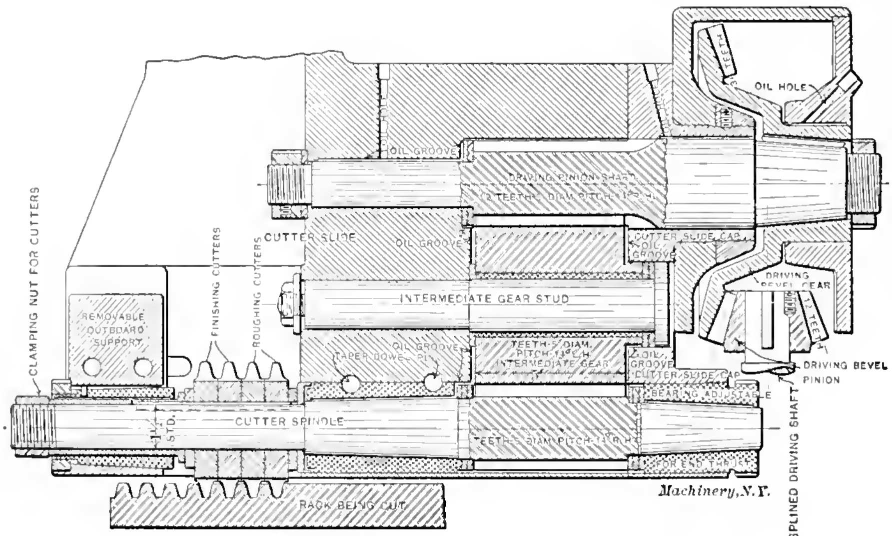


Fig. 3. Vertical Section through Cutter Spindle and Driving Gears.

slides off endwise, and may be adjusted longitudinally to accommodate the width of cutter space required for the cutters used. In the drawing, four cutters are shown in place, two of which rough the tooth spaces while the other two finish them, thus completing two teeth complete at each feeding stroke of the ram. These cutters are keyed to the spindle and are clamped by the nut at the outer end of the spindle, through the journal bushing shown. This bushing has a bearing in the outboard support. The box for this bearing is tapered and split so that it may be adjusted for wear.

Accuracy of Product.

Special attention has been paid to the accuracy of the product. The automatic indexing of the table gives more accurate and uniform results than hand indexing, and this accuracy is still further assured by the mechanism provided for locking the table in position after it is indexed. The great weight (about six tons) and stiffness of the machine also tend in the same direction.

Tests of the accuracy of the indexing were made by placing a 10-foot length of stock in the machine and milling teeth in it for its full length. The cutter used, to facilitate testing, was an ordinary half-inch slotting mill, cutting square teeth. The machine was set to index three diametral pitch, which is about 1.0472 inch circular pitch. The rack was then measured for every 6 inches throughout its length with a Brown & Sharpe 24-inch vernier caliper, set to cover 22½ teeth; that is, 22 teeth plus the thickness of a tooth. The space being 0.5000 inch thick, and the tooth 0.5472 inch thick, this gave a calculated distance of 23.5856 inches for the calculated setting of the vernier. In the 16 measurements made throughout the length of the 10-foot rack, the actual settings obtained varied from the theoretical by from 0.007 inch above to 0.0025 inch below, these amounts being the error in about 2 feet. It is believed that these tests show accuracy meeting every commercial requirement.

One source of error ordinarily met with in rack-cutting machines has been avoided in this tool. Ordinarily, the lead-screw is of some even number of threads or turns per inch. This makes it possible to figure out the gearing for circumferential pitches very easily. For diametral pitch racks, however (which constitute by far the greater part of the product of any such machine), translating gears have to be used to take care of the factor π, which must be used in obtaining diametral pitch from circular pitch measurements. The usual ratio used is 22 : 7, which, carried out, gives a value for π of 3.1429, considerably larger than the true value. From this it follows that racks cut with this gearing are uniformly longer for a given number of teeth than they should be, the error amounting to about 0.0046 inch per foot in length—not enough to create any serious difficulty, of course.

In the present machine this error has been avoided by making the screw with a special lead of $\pi/3 = 1.0472$ inch. The gearing for cutting this special lead was very carefully calculated, the actual calculated pitch for the gearing used being 1.04724 inch lead. This makes the screw nearly correct for diametral pitch gears, while the translating error involved in using the 22/7 ratio will come in cutting circular pitch gears, which form but a small part of the machine's output. The fact that the pitch in the test showed average measurements slightly greater than the standard, is perhaps due to heating, or some other similar cause.

The cold rolled stock ordinarily used for racks comes from the rack-cutting machine somewhat bowed, owing to the removal of the skin tension on the outer surface by the cutting operation. These racks are straightened by passing them several times through a machine which rolls them back to their proper shape. This machine has been specially designed for the purpose, and the straightening is accomplished without impairing the accuracy of the teeth in any way. This straightening machine was illustrated and described in the December, 1906, issue of MACHINERY.

* * *

CONCRETE FOUNDATIONS FOR DROP HAMMERS.

At a recent visit to the Pratt & Whitney Co.'s shops at Hartford, Conn., the writer had an opportunity to see some very interesting drop hammer foundations, made from solid concrete. The blacksmith shop is located on what one might say is the second floor of the building, there being a basement about 11 feet high under the blacksmith shop, which is used as a stock-room and where the case-hardening furnaces are located. The foundations for the drop hammers in the blacksmith shop must therefore be carried down clear through the basement, and then down approximately another 11 feet to hard pan. The construction of these concrete foundations is shown in Fig. 1. At *A* is shown a cast iron base-plate, into which the base of the drop hammer sets. This plate is bolted to the concrete column by four 1¼-inch anchor bolts. Between the cast iron plate and the top of the column a double layer of wood and also a thick layer of tar paper are interposed, the purpose of which will be referred to later. The column, as shown, reaches nearly up to the ceiling of the basement, *C* being the floor line of the blacksmith shop. At *D* is shown a line representing the floor of the basement. As will be seen, reinforcements have been placed around the concrete column in the form of heavy planks *B*, having one-inch bolts through the concrete to clamp them up against the concrete surface. It has been found later, however, that this reinforcement was not necessary, and that the foundations would have served their purpose fully as well had the column been left plain all the way down.

The installation of these concrete foundations, as compared with the wooden foundations previously used, has proved to be a very economical move. While previously, with hammers working on wooden foundations, it was not possible to make the drop forgings shown in Fig. 2 on anything but a 200-pound

hammer, since these foundations were put in, it has proved possible to make them on a 100-pound hammer, and, at the same time, the rapidity of completing the drop forgings has been increased, so that a saving in time of 20 per cent has resulted in the making of these forgings. Other elements of saving in comparing the making of these forgings on a 200- or a 100-pound hammer are that the tools cost more for a larger machine, and it consumes a great deal more power. The reason why there is a saving in the making of these forgings, even in regard to the time consumed, is because the strokes, even on a smaller hammer, can now be made shorter, so that a greater number can be struck in the same time, the blows, however, having an equally good, or better, effect, on account of the solid foundations under the base of the hammer. In the case of drop hammers, where the hammer was previously raised three feet, it is now not necessary to raise it more than two feet, in order to accomplish the same results.

When the foundations were first put in, the cast iron plate *A*, already mentioned, was laid directly on a surface of cement, three inches thick, placed on the top of the concrete foundations. The cast iron base-plate, of course, was not finished on the bottom, but was more or less rough. The cement itself did not have a perfectly plane surface, and it was found that, after the hammer had been used for some time, the top layer of the cement would be ground to powder, on account of the rough surfaces coming in contact, constantly cutting and grinding the surface of the cement. In

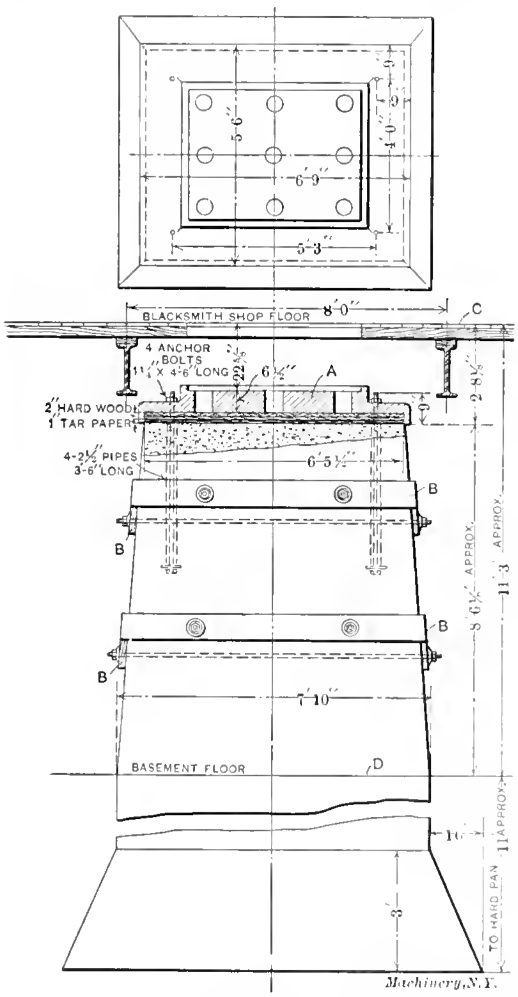


Fig. 1. Concrete Foundations for Drop Hammers in the Pratt & Whitney Co.'s Blacksmith Shop

order to prevent this, a layer of tar paper, one inch thick, was first placed on the top of the concrete foundation, and on top of this, two layers of hard wood, each one inch thick, were laid diagonally, the cast iron base-plate being placed directly on the hard wood, after which the anchor bolts were tightened down, clamping tho base-plate tightly against the wood and the tar paper, and consequently pressing the latter firmly against the top of the concrete. The tar paper would fill in all crevices and rough places on the top of the concrete, and the impact of the hammer blows would be distributed equally over the whole surface. After this improvement had been made, no more troubles were experienced with the top of the concrete being pulverized by the blows of the hammer.

At first it was feared that these solid foundations, having practically no springing action whatever, would cause trouble in regard to the dies, so that a greater cost would be incurred in regard to the replacing of broken dies, but this apprehen-

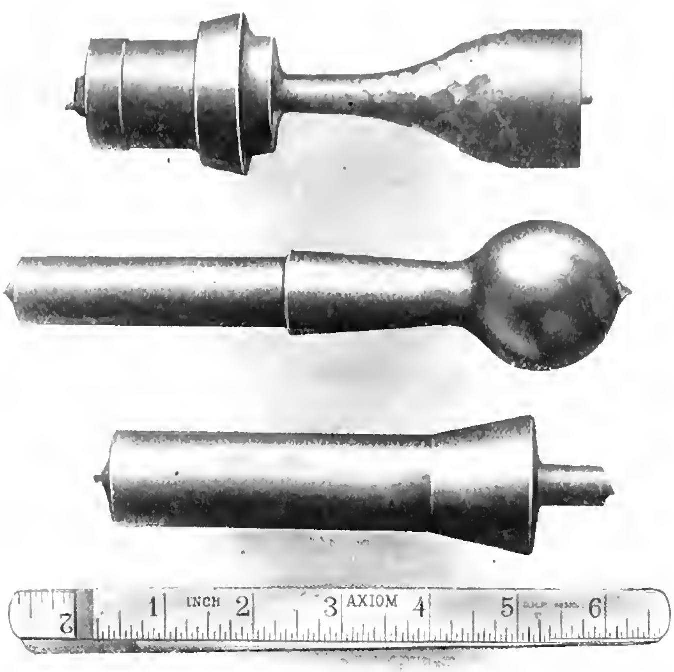


Fig. 2. Examples of Work formerly done on a 200-pound Hammer, but with Concrete Foundations completed on a 100-pound Hammer.

sion proved to have no foundation; the dies seemed to stand up fully as well now as with the old wooden foundations.

The concrete used for these foundations is what is known as 1—3—5 mixture. This mixture consists of one bag of cement, one barrel of heaped sand, and two barrels of stone.

In conclusion, it may be well to remark that the examples of drop forging shown in Fig. 2 do not, by any means, represent the limit of what could be made under the 100-pound hammer since the concrete foundations were put in, but the dimensions of these pieces are now limited by the size of the dies that can be placed on the hammer. As far as the power of the hammer is concerned, it would be possible to forge pieces probably 25 per cent larger than those shown.

The type of foundation used before these concrete columns were put in is shown in Fig. 3. On these foundations the base-plate was first laid on a few layers of plank, each layer being placed crosswise in relation to the next layer above, and this, in turn, was carried by timber, standing on end, to reach through the basement of the building. This timber, in its turn, was placed on foundations in the basement floor. Iron bands reinforced and held the timber together. This built-up foundation, however, acted as a buffer, and the timber standing on end was actually compressed several inches yearly, due to the force of the blows of the hammers.

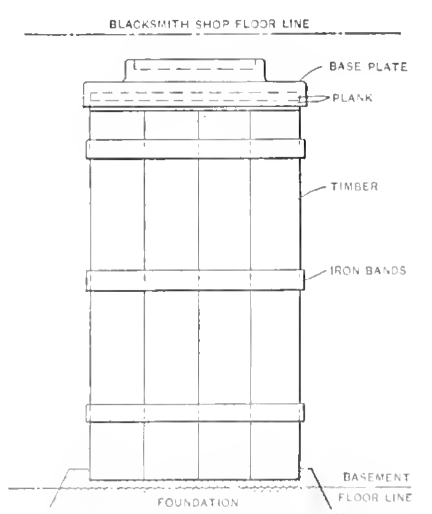
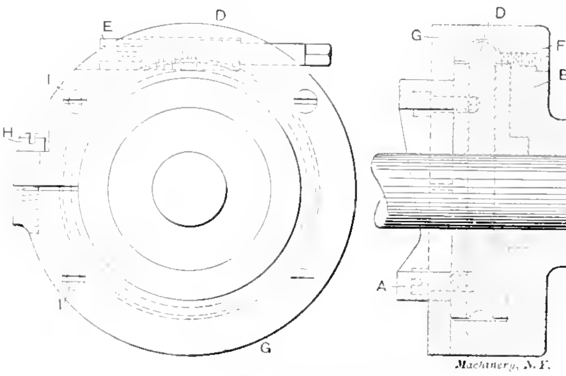


Fig. 3. Old-style Wooden Foundations which have been replaced by the Concrete Column shown in Fig. 1.

LETTERS UPON PRACTICAL SUBJECTS.

CAM ADJUSTING DEVICE.

Some time ago we had a great deal of trouble with the setting of the cams on our automatic roughers. Sometimes it was but a matter of a few minutes to get them just right, and again it would take over an hour of hard work and strong language. To remedy this state of affairs, we installed a series of cams such as shown in the accompanying cut. The cam proper is shown at *A*, enclosed by the circular housing *B*, which is secured to the shaft by the set-screw *C*. The housing *B* is provided with bearings for the worm *D* which engages with the worm threads cut on the cam member *A*, as shown. The worm *D* butts against a shoulder in the housing *B*, and is held in place by a plug bushing *E* driven in at the other end as shown. This plug is held tightly in place by the screw *F*. At *G*, finally, is a split steel ring fastened to the housing *B*, thus holding cam *A* firmly in place.



Cam Adjusting Device.

After the cam has been approximately set in place and secured by tightening the screw *C*, the next step is to loosen the binder *H* and the two screws *I*. These two screws work in slightly elongated slots, and when loosened allow the ring *G* to spring open a trifle. This leaves cam *A* free to revolve, and it is then adjusted accurately by means of a socket wrench fitting on the squared end of the worm shaft *D*. When the adjustment has been satisfactorily made, the binder *H* is tightened, thus drawing the ring *G* around *A* and clamping it. Screws *I* are then screwed down, and this serves as a further lock against the ring loosening. The cam is then in condition for service. With this arrangement it was possible to adjust the cams to the finest required degree of accuracy, and since placing them on the machines we have had no further trouble along this line. F. B.

MILLING ATTACHMENT FOR THE LATHE.

The accompanying half-tones, Figs. 1 to 3, show a simple but efficient milling attachment for the lathe. This device

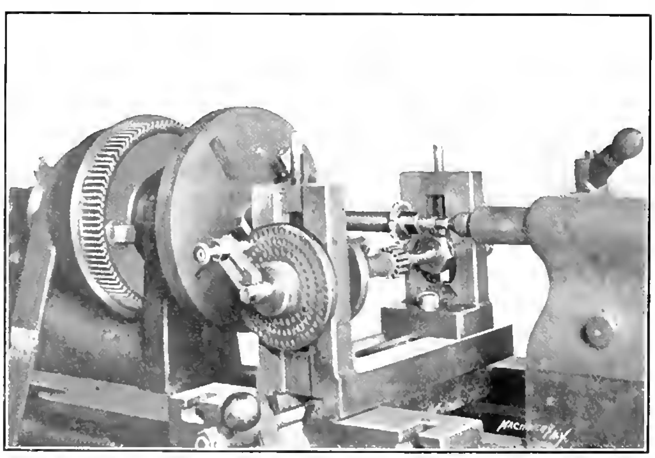


Fig. 1 Front View of the Milling Attachment.

is in use on a foot-power lathe in the private little workshop of Anton Schuermann, of Decatur, Ill., fitted up in the garret of his home.

Fig. 1 shows the front view of the milling attachment, and Fig. 2 shows a rear view of the device, both when in place in the lathe. The gear shown on the arbor between the centers of the device has actually been milled in the foot-power lathe with this device. As will be seen from the cuts, the attachment is placed on the cross slide, in place of the tool carriage. The general design of the device is most plainly

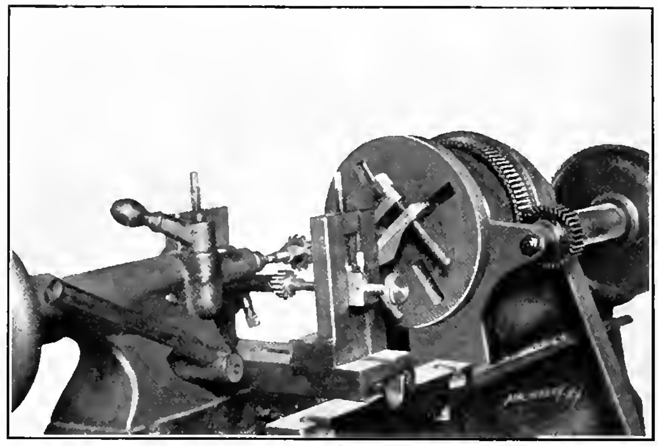


Fig. 2. Rear View of the Milling Attachment.

shown in Fig. 3. The screws *A* are adjusting screws, used for raising and lowering the head- and tail-centers, working on the same principle as does the Lincoln milling machine. The nuts *B* are lock nuts, which are loosened before the screws *A* are turned for adjusting the heads. The tail-center *F* simply slides back and forth in its bearing in the tail-stock, and is held in place by a set-screw *G*. The whole tail-stock may be moved in and out by loosening the screw *K*. The index dial is shown at *D*, three different dials being used

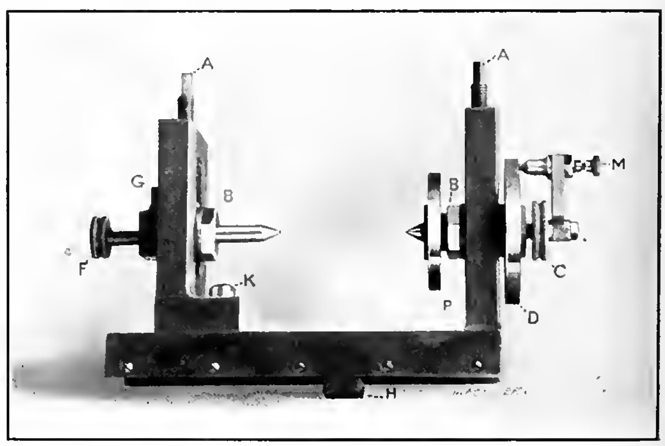


Fig. 3. View showing the Simplicity of the Design.

with the device. The spacing arm *M* is securely locked wherever set by the knurled thumb-nut *C*. The nut by which this fixture engages the cross-slide screw, is shown at *H*. In order to prevent play when an arbor is held between the centers, the tail of the dog used is made tapered where it enters the slot of the driving plate *P*, so that it will fit snugly.

The writer has seen a number of milling attachments adapted to lathes, but this one has several features which are superior to any that he has seen so far. ETHAN VIALL.

Decatur, Ill.

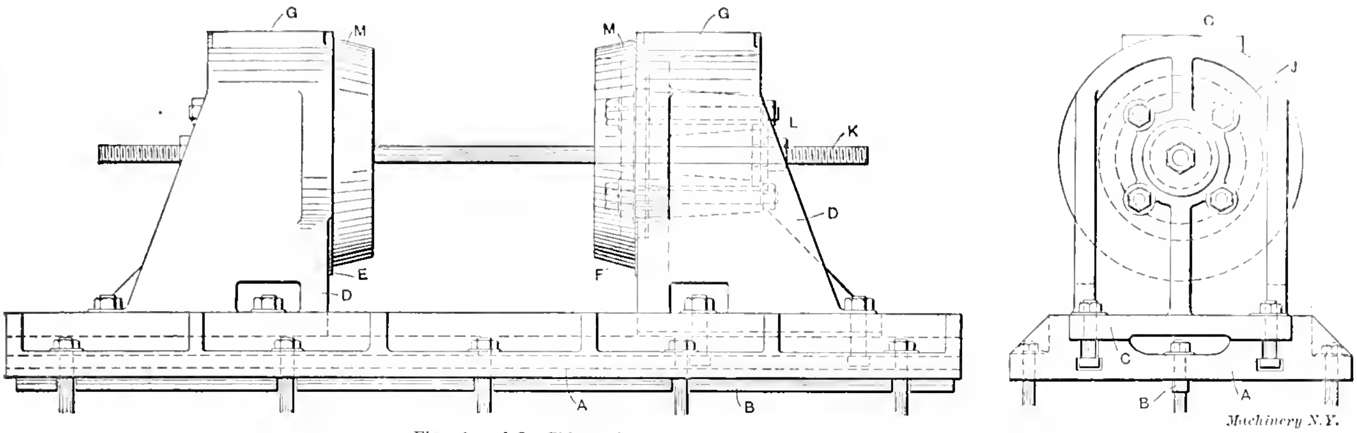
PLANER CHUCK.

Some time ago it became necessary to do some very accurate planer work on a number of cylinders, insuring that the seats outside be true with the center of the bore, and therefore an improvement was necessary on the chuck originally used for that purpose. The outcome of the redesigning was the chuck shown in the accompanying cuts.

The original form of chuck for this class of work consisted of two standards which were bolted to the table of the planer and provided with a series of interchangeable cones, each held by a central bolt to its own standard. This form of chuck rendered it very difficult to get the axes of the two cones

in the same straight line. The chuck, as shown in the cuts herewith, was found upon trial to entirely obviate this difficulty.

The first point at which it was found necessary to change the construction was that a false table had to be constructed to fit upon the planer table. This table is indicated by the letter *A*, Figs. 1 and 2. The rough casting for this table was first of all planed true on the bottom surface. The table of the planer to be used was planed off and the center slot of the table cut out parallel throughout its length by a tool held directly in the tool-post. The false bed was provided with a rib *B*, Figs. 1 and 2, which was accurately finished to fit the slot in the planer table. The false bed was then securely bolted in its permanent position on the table, and a way planed as shown at *C*. This way was carefully finished both on the bottom surface and on the two sides, so as to be of even width throughout.



Figs. 1 and 2. Side and End Elevations of the Planer Chuck.

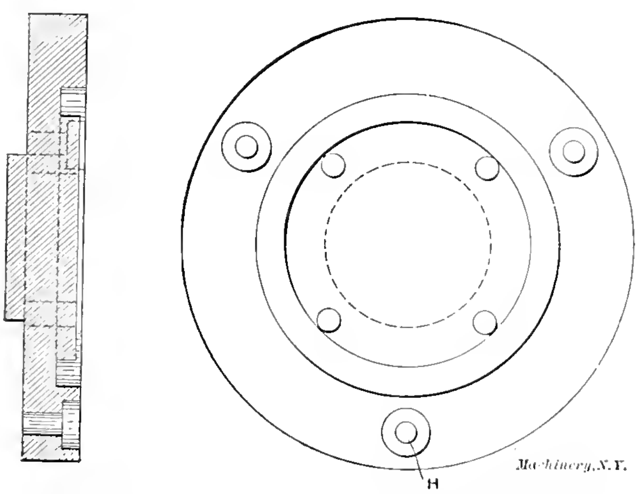


Fig. 3. False Face-plate used for Turning Cones of Various Sizes.

The standards *D* had their feet finished accurately to fit this way, both standards and way being scraped to a sliding fit. When the standards were placed on the way, the centers for the cones were very carefully laid out and tested to insure the two centers being exactly in line. The standards were then removed, chucked in a lathe so that the center was truly central with the spindle of the lathe, faced, and the annular groove *F*, Fig. 1 and 4, accurately turned. The standards were then replaced on the planer and a spot planed at *G*, Figs. 1 and 2, on each one, this spot being an even number of inches above the center line of the cones and center of the annular groove *F*.

Since the cylinders which were to be faced in this chuck were of varying sizes, it was essential that a number of different sized cones should be used to accommodate the various bores. For this purpose the face-plate on a heavy lathe was bored out to receive the boss of the false plate shown in Fig. 3. This false plate was provided with three tapped holes *H* to agree with holes near the rim of the regular face-plate. The false face-plate was made by chucking it with the boss outward in the lathe, and facing off the back, and forming the boss. The face-plate was then turned over and the annular recess shown was cut in it to agree accurately with the recesses *F* formed in the standards. The holes *H* which are countersunk for tapped bolts to enter tapped holes in the regular face-plate should not be spaced evenly, as it is essential that the false plate should have the same position on the regular face-plate every time it is used.

The cones *M*, Fig. 1, were prepared from the rough casting by having an annular rib accurately turned on the back and the back faced off while the casting was held in an ordinary chuck, the rib being made to templet so as to fit either the false face-plate, or the standard. The cone was then bolted to the false face-plate in position on the lathe, and the conical surface carefully turned. It will be seen that an exact center was thus obtained with the center of the false face-plate, which in turn was truly central with the lathe centers, and it was thus possible to get out any number of various sized cones, the centers of all of which when applied to the standards would lie in the same line.

It will be noted in Fig. 4 showing a horizontal section through one of the standards and its cone, that clearance is allowed between the annular rib and the recess receiving it, and that clearance is also allowed between the face of the standard and that part of the back of the cone lying inside of the annular rib. The purpose of this was to obviate the necessity of finishing the back of these portions, as the surfaces obtained by the sides of the rib and the back of the cone outside of that rib are amply sufficient to carry all the stress arising from the weight of the cylinder when in position.

By reference to Fig. 4, it will be seen that the central part of the standard is cast with a large opening clear through;

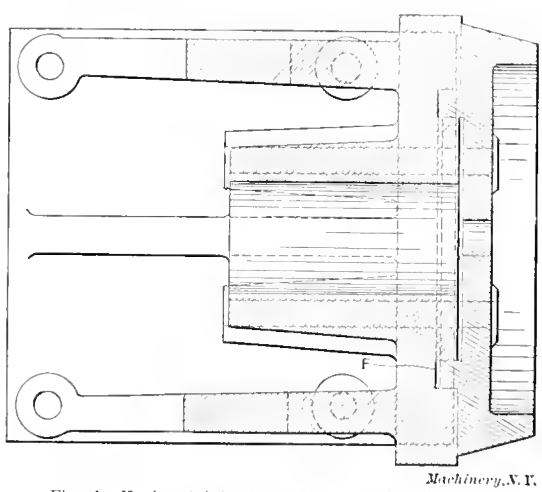


Fig. 4. Horizontal Section of Standard and Cone.

this is merely for lightness, and because in this particular case the cylinders to be carried were very heavy, these standards, if cast solid, would be very difficult to move. The cone is held to the standards by four bolts *J*, Fig. 2, and when in position on the false face-plate for turning, four tapped holes are provided in that face-plate to receive bolts to hold the cone securely. Adjustment for length is made by means of the threaded bar *K*, provided with necessary nuts, and having washers *L* fitting the openings above referred to in the standard.

After having tried this fixture, it was decided to provide means whereby two cylinders could be planed at the same time. A standard having two faces and with two cones was placed between the other two standards, and the bar *K* lengthened. As the construction of this standard, however, is so nearly the same as the ones described, it is not deemed necessary to go into the detail of it.

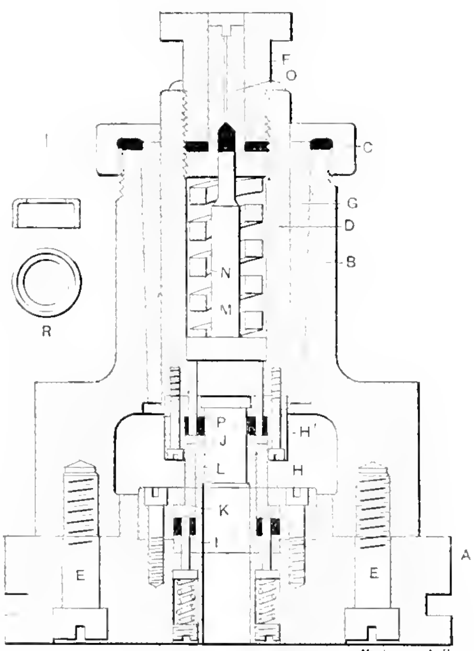
The face *G* is used for leveling up the cylinder cross ways, only the longitudinal leveling being accomplished by the cones. This, of course, is easily done by means of a surface gage, since the face *G* is horizontal both transversely and longitudinally, and is also parallel to the center line of the cone. It is, of course, obvious that the bolts may be changed to suit the planer on which this device is to be used and it is also plain that if a center slot is not obtainable in the planer table, two side slots may be used and two ribs like *B* provided.

Richmond, Va. L. N. GILLIS.

PUNCH AND DIE FOR BLANKING AND FORMING COPPER CUPS.

The subject of punches and dies has been gone over so thoroughly, and is so well understood, that it may seem a bit superfluous to add anything to it; nevertheless the accompanying illustration may be of interest to those who come in contact with such tools.

This die is designed to blank and form up a copper cup or capsule used in the manufacture of balance wheels for watches. The copper strip is fed into the press, which then blanks out and draws the metal into the shape shown at *R*, at the same time punching the center hole. Referring to the



Punch and Die for Blanking, Piercing, and Forming the Copper Capsule shown at R.

illustration, *A* is the base of the sub-press, *B* the body, *C* the cap, and *D* the plunger; all these being of cast iron machined to size. The body and base are held together by two screws *E* after the usual well-known manner. *F* is the buffer plug which receives the thrust of the press piston, and *G* is the babbitt lining of the body *B*. *H* is the outside diameter die, held in place by four screws and two dowel pins. *H'* is the outside diameter punch, also held in place by four screws and two dowels. *I* is the die for cutting out the center hole, and *J* is the punch for this hole. *H'* and *I* also serve as forming dies in bringing the metal to the proper shape. *K* and *L* are shedders, supported by four push-pins, those of the former resting upon springs whose tension is controlled by short threaded plugs, as shown, and those for the latter abutting against the piston *M*, which is in turn pressed down by the large spring *N*, the tension of which is controlled by the plug *O*. The block *P* is used merely to hold the punch *J* firmly in place.

The operation of the die is as follows: The press ram being at top stroke, the copper strip is fed in across the top of *H*, and as the ram descends, the blank is cut from the strip by the punch *H'* and drawn to a cup shape between the inside edge of *H'* and the outside edge of *I*. Simultaneously, the center hole is punched by *J* and *I*. As will be seen by referring to the illustrations, *J* is made a trifle short so that the drawing operation will have begun before this hole is punched. This prevents any distortion of the piece by the punch *J*. Some little trouble was experienced at the start on account of the air in the hollow plunger *D* forming a cushion when it was compressed by the rising of the piston *M*, thus preventing the proper working of the die. This was finally obviated by making a small groove at the side of the piston where it worked in the plug *O*, and drilling a vent hole through *O* as shown. This allowed free communication to the atmosphere, and from then on the die gave complete satisfaction. The variation in size among the cups, or capsules, as they are called, is never more than 0.001 of an inch either in diameter or in length. B. W. F.

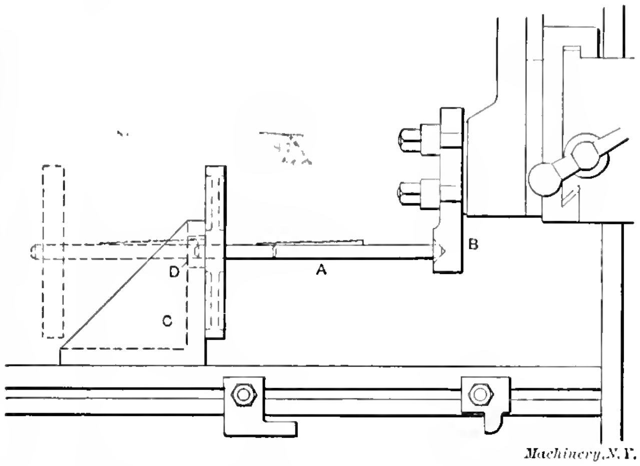
MACHINING CHANGE GEARS.

A subject which is of importance to all lathe builders, whether they be manufacturers who turn out two or three machines a day, or the smaller concerns who may finish the same quantity in a week, is the machining of the change gears. In England this is more important than in America, because the man who first supplied England with screw-cutting lathes decided that twenty-two change gears were necessary, and so twenty-two change gears have become the standard complement, while the ordinary American lathe, as far as my experience goes, has only about fifteen or sixteen. I have not been able to put all the following ideas into practice, but where circumstances permit I shall try all those that are most suitable. I should also like to know from some of the firms who have a lot of this kind of work, how they do it, and the time taken, as this is not so much a record of actual work as a few suggestions as to how the work might be done.

The first item is the castings; start with good workable castings. It will pay to give a bit extra for decent castings. Pickling will improve their workability, and annealing is still better, though perhaps too expensive. The machining of the blanks is the most expensive point of the whole job, with the possible exception of the cost of the castings, therefore it seems that this is the place where we ought to make the biggest saving. One method is first to bore and ream the hole, then drive onto an arbor, and turn down the faces of the rim and boss, using a tool at each side. After this has been done, the blanks are mounted on an arbor, five or six at a time, and the outside diameter turned. I don't care much for this method of turning the sides, because I think there is a tendency for the blank to slip on the arbor when the cut is on, so that the size and speed of the cut will have to be adapted to the gripping power of the arbor, and though two tools are in operation and balancing each other as far as the spring sideways is concerned, there will require to be twice as much power transmitted through the arbor. The method I should adopt for this work would be as follows: There would be a turret mounted in place of the tail-stock, carrying four tools, that is, a chucking drill, a single point boring tool, a roughing reamer, and a finishing reamer. This turret would be fed forward by hand by means of a large pilot wheel, and would revolve automatically on the back stroke. The reason why I should have a hand feed is because the operations would be so quickly performed (especially if the tools were high speed steel) that an automatic feed which would have to be engaged every time would not appreciably diminish the time, though a full automatic turret would no doubt be beneficial. To turn the sides, there would be a long tool-holder mounted on the carriage cross slide, and hinged thereto, so that it could be lifted up to clear the turret when the turret was in operation. Two tools would be used, one for the rim and one for the boss; they would be set in the same plane, so that the boss would be the same length through it as the width of face of the teeth when machined. The reason for this will be explained later. It will be seen now that there are two tools in operation at once, just as

in the other method, and the gear, being gripped in the chuck and thus supported at four points of the rim, is in a better position for being machined than when mounted on a comparatively small arbor. After one side has been machined, the gear is turned around and without any particular care in setting true, other than getting it flat against the faces of the jaws, the other side is machined in a similar manner. The outside diameters are turned as in the first method.

I might say for the benefit of American readers that in England an 8-inch center (16-inch swing) lathe would be supplied with twenty-two change gears, having from twenty to



The Way in which the Gears are key-seated on the Planer.

one hundred and twenty teeth, with an extra 40-, 50-, or 60-tooth gear. They would be 8 diametral pitch and 1¼ inch bore, so that it will be seen that turning up the 120-tooth gear, which is 15¼ inches diameter, on a 1¼-inch arbor is not by any means a rigid job. Another method of machining the blanks, which I think would make about the best time of any, is by grinding. A powerful grinder would soon grind the comparatively narrow faces of a change gear, and leave a better finish than could be obtained by turning and polishing. I should think the Landis Tool Company ought to be able to give us some interesting information on this subject.

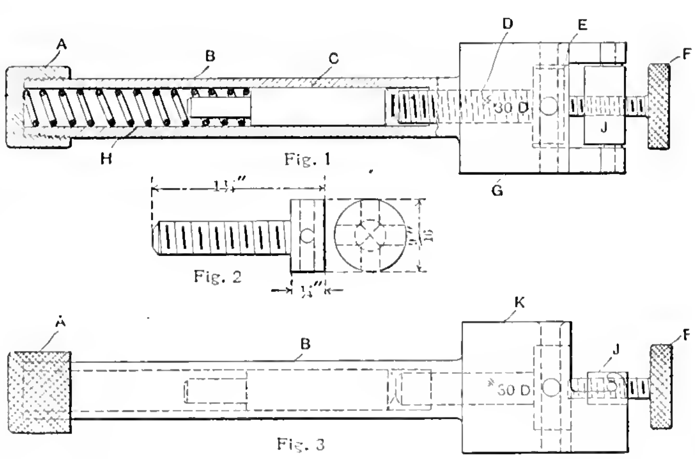
The next question is the cutting of the gears, and I can speak definitely on this point. It is possible to cut 8-pitch teeth in cast iron at a feed of ten inches per minute, and by this I don't mean for five minutes, but day after day, week in and week out. I have done this myself. The machine used was a Brown & Sharpe No. 6; the speed, fifty revolutions per minute; the cutter, a Cammell Laird 0172 high speed steel, 4 inches diameter, and the feed 0.2 inch per revolution. The blanks are cut six at once, and it is for this reason that the rim and boss are made level, the blanks thus staying each other. The indexing motion is geared up, not to cut consecutive teeth, as usual, but to pass two or more teeth, according to the number being cut. For a 120-tooth gear, we arrange to cut every seventh space because 2, 3, 4, 5, and 6, being factors of 120, would simply divide the gear into 60, 40, 30, 24, and 20 respectively; whereas, when we cut every seventh tooth, the cutting goes on until the gear is finished, the blank going around seven times. It is really wonderful how this simple proceeding dissipates the heat generated by the cutter, both cutter and blanks being comparatively cool after a two hours' run, the time usually worked with one sharpening of the cutter.

To finish the gears, they require to be key-seated, and for this a planer can be used, which, with very little outlay, will make as good time as the best key-seater. The first thing to be considered is the cutter bar or broach, which consists of a piece of tool steel *A* about twenty-four inches long, and a sliding fit in the bore of the gears. This bar is grooved to a depth of about three-eighths of its diameter, starting in at one end and finishing about three inches from the other end. Into this groove are fixed, by screws from the under side, two or three pieces of tool steel which have teeth cut therein, the teeth tapering from nothing at the front end to the depth of the key-seat at the other end, the last few teeth being all the same height so that they will keep the size longer. The first tooth is about two inches from the front end of the bar. The width of the teeth is of course equal to the width of the key-seat to be cut. To the planer tool-post is fastened a suitable cup-shaped thrust piece *B*, and an angle plate *C* is securely bolted to the platen. In the angle plate is a hole which receives bushing *D* bored the same size as the cutter bar or broach. In operation, the planer platen should not run above 15 feet a minute on the cut, the stroke being adjusted so that it is from 6 to 12 inches more than the length of the cutter bar. The front end of the cutter bar is then placed in the angle plate bushing, and run through two or three times, the bar being revolved the width of the key-seat at every stroke, so that there is no fear of the teeth having to cut into the bushing when operating on the gears. After this has been done, the stroke is altered so that when the table reverses at the end of the cutting stroke there is room for the gear between the thrust piece and the angle plate. It isn't necessary to stop the machine every time a gear has been key-seated. As soon as the end of the bar comes through the angle plate, another gear is put on, as indicated by the dotted line, and when the table reverses, the gear that has been key-seated is removed, and the bar with the gear which has been previously placed in position is withdrawn and put on the other side of the angle plate to be again pushed through. It is necessary always to keep the teeth of the cutter-bar approximately in the same position as the slot in the bushing. With this arrangement it is an easy job to key-seat one hundred and twenty gears an hour, the biggest job being the carrying of the gears to and from the machine.

RACQUET.

DRILL JIG.

Figs. 1 and 3 represent a drill jig for drilling ⅛-inch holes in the adjustment screw shown in Fig. 2. This screw is made from cold rolled stock, and the holes do not need to be very accurate, as they are only used to turn the screw by putting a pin in the holes. Referring to Fig. 1, handle *B* and the body of the jig *G* is made from a piece of square machine steel and case-hardened. The piece of work to be drilled as shown



Figs. 1, 2 and 3, showing the Jig and a Sample of the Work.

in Fig. 2, is placed into the jig and held there with the thumb and the left hand, pushing back plunger *C* against spring *H*, while cross-head *J* with screw *F* is taken in the right hand. The cross-head is placed in position as shown in Fig. 3, hooks on the jig body being provided for the pin through the cross-head, and screw *F* is then tightened. Then the screw shown in Fig. 2 is ready to be drilled. It is only necessary to drill from two sides of the jig. The size of the drill is marked on these two sides.

A very important feature is that after the piece of work is drilled, and the cross-head *J* is removed, spring *H* pushes out the piece of work, and all that is necessary to do is to insert another screw, and drill in same manner as before. Cap *A* is merely to keep spring *H* and plunger *C* from coming out.

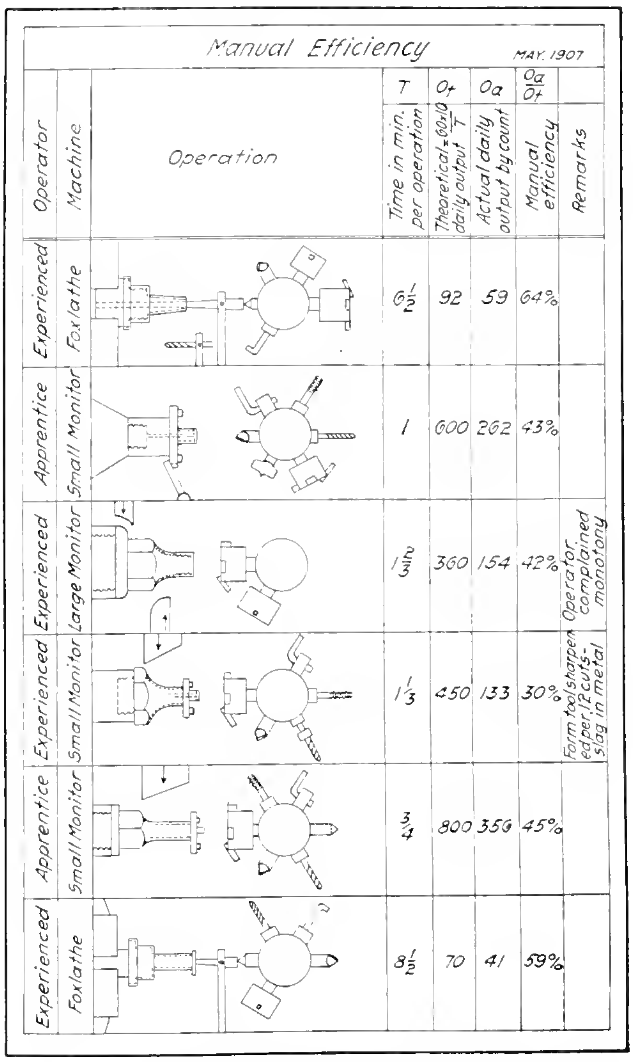
This jig was first tried with a small cam lever, instead of using the cross-head *J* and screw *F*, but owing to the variation in width of the heads of the screw (Fig. 2), it made it impossible to stop the cam lever in same position every time, which caused the lever to project past surface *K*, which of

couse, interfered in laying the jig on the table of the drill press. It may not seem practicable to make a jig and not bush the holes, but as we did not have a great many screws to drill and as the work was not very particular, it was cheaper and good enough for the job to leave out the bushings. The jig has proved very satisfactory, and has been in use at different times for more than three years, and it is still in good condition. B. M. WELLER.

Franklin, Pa.

EFFICIENCY CARD.

The accompanying cut shows a page from a data book used in one of the machine tool building shops. This card is intended for recording the time used for performing certain operations, and for recording the efficiency, expressed in per cent, of the men. In the two first columns are given the class of operator and the machine on which the operation was performed. The middle column, headed "operation," under which are shown crude sketches of the tools used, is intended to give an idea of the class of tools and the way of setting up used in the individual case for which the record was taken.



Manual Efficiency MAY. 1907

Operator	Machine	Operation	T Time in min. per operation	O_t Theoretical $= \frac{60 \times 10}{T}$ daily output	O_a Actual daily output by count	$\frac{O_a}{O_t}$ Manual efficiency	Remarks
Experienced	Fox lathe		$6\frac{1}{2}$	92	59	64%	
Apprentice	Small Monitor		1	600	262	43%	
Experienced	Large Monitor		$1\frac{2}{3}$	360	154	42%	Operator complained monotony
Experienced	Small Monitor		$1\frac{1}{3}$	450	133	30%	Form tool sharpened per 12 cuts - slag in metal
Apprentice	Small Monitor		$\frac{3}{4}$	800	356	45%	
Experienced	Fox lathe		$8\frac{1}{2}$	70	41	59%	

Sample Page from Data Book in which is recorded the Time for Performing Work, and the Efficiency of the Men

Each man is permitted to set up his work and his tools in an individual manner, using, of course, such special tools as he receives on request from the tool-room. The time given in the column T is the time in minutes used for completing one piece, the operator, unknown to himself, having been timed through one complete cycle of operation. For the sake of comparison, the number of pieces made during the day was counted after the men had left the shop. The column O_t gives the theoretical daily output, that is, the output which would result if all the pieces could be made at the same rate as the one timed in the first column. The column O_a gives the actual daily output ascertained by counting, as stated heretofore. The next column gives the efficiency in per cent, being arrived at by comparing the theoretical daily output with the actual daily output. The last column is reserved for remarks. Probably others have on hand records of a similar character, showing the comparative efficiency of workmen, subjected to a more rigid system than ours. The results of such investigations would probably be interesting to the readers of MACHINERY. H. D. Y.

PIRATING.

In a recent issue of MACHINERY an editorial appeared on "Pirating Special Machine Tools" which calls to mind another form of piracy which is possibly more common. This is the taking of ideas from other concerns in designing a machine for the market. How many times do we hear the words, "Why, that new machine of the Jones Machine Co. was designed by Smith who used to be with Jones' competitors. You can see the other fellow's ear-marks on Jones' new machine." This is probably the least objectionable form, for a man who designs a machine for one firm will probably follow more or less the same lines in designing for another concern a machine of similar nature. The next step in these forms of pirating is for one designer to take his ideas deliberately from a competing concern.

Here is the story which was told me by the draftsman who did the "designing." A concern manufacturing pumps decided to bring out a new type, and gave the draftsman general instructions as to what special features the design should include, leaving the details to be worked out by him. The draftsman happened to recall having seen a pamphlet of a competing pump manufacturer showing a pump somewhat on the lines proposed. He hunted up the pamphlet, which, by the way, announced that the pump shown was a strictly new departure. The draftsman, not letting it be known that he had the circular, followed out the design to a large extent. Things progressed, and the first pump was made according to the design and about ready to be tested, when, one day, into the drafting-room walked the manager. "There's a leak in this factory somewhere," said he to the draftsman. "Here the ———, ——— & Co. have gotten out a pump exactly on the line of our new pump. Somebody in this shop must have given it away to them." He had come across the circular the draftsman had used. A. A. ANDREWS.

THE GAGING OF HEATS FOR HARDENING.

In a recent issue of a technical magazine, I read an article on a very important subject: The heat treatment of carbon steels. This is a subject that is uppermost in the minds of a great many mechanics at the present time, and each one has his own ideas as to how it should be done to get the best results. They read everything published bearing on the subject, and use their own judgment as to the best methods of obtaining the right heat for hardening.

It takes an experienced man to gage the heat for hardening with the eye, at all times, and under all conditions, without heating some tools just a little hotter than they should be to get the best results, and that means sometimes spoiling an expensive tool, or, hardening the tool in such a way that it will not stand up to the work expected of it. Again, some of the tools on test will be found soft, and that means reheating, which is unnecessary when it is done right the first time, and in the case of taps, and such tools, that cannot be ground or lapped without a lot of trouble and expense, it means sometimes a loss of that particular tool.

There are various reasons why heats are not always gaged correctly. In the first place, the man has no gage to go by, and again, the light conditions, prevailing at the time, may interfere. This can be overcome by having shades at the windows, that can be adjusted. Sometimes the eye gets "off-color" and needs rest for a few minutes. The use of the "magnetic influence" in gaging the heats for hardening is practically new; in fact, a great many experienced mechanics, versed in the handling of carbon steels, have never heard of it, but the fact remains just the same. We all know that the proper heat for hardening steel to get the best and most lasting results, is the lowest heat that the steel will harden at. How are we to find this out? By the use of the magnetic needle,

no matter what the make, or brand of steel. Following these lines, the writer has experimented for two years, and, at the present time, can harden a tool or piece of carbon steel at the first heat, without knowing the brand or temper of steel, and with such results that tools hardened by this method outlast similar tools hardened in the old way, sometimes as high as 4 to 1. In every case, the tool lasts much longer, showing very plainly that this method is the best, or at least worth testing.

The gaging of heats by the magnetic needle, is done in such a way that you can test every piece, or you can test every second, or third or fifth piece, or only the first piece, and then, noting the color very carefully, harden several pieces and make no mistake. If the color seems to be off a little, test

Testing a Milling Cutter, when Hardening, by Swinging it Back and Forth past a Magnetic Needle.

again; this can be done right along, provided the steel is of the same "carbon temper," but in all cases where the carbon temper changes, the test must be made again. Some months ago I had a pair of rolls to harden, about 27 inches long by 6½ inches diameter. After sizing them up, I made inquiries as to what they were made of; one said they were crucible machinery steel; another, that they were tool steel, and the superintendent said that he did not know—it was up to me to harden them. Well, I did harden them, and without any experimenting or second heating. I heated them in a Brown & Sharpe furnace, and tested them with the magnet and with plenty of water, and did a good job. I had experimented with the magnet before, so I knew what to do. At another time I had to harden 1,000 horseshoe magnets for telephones, one-half of which were imported steel, the other half, domestic. I hardened them without any trouble, and the telephone company was pleased with the work. I found out afterward that the company had tried to harden them and could not get a uniform hardness. In this case I tested one in about every forty.

In starting my experiments, I bought a small pocket compass with a jeweled pivot and needle stop, about 2 inch diameter, and costing a dollar and a half. I got a wooden stool to rest it on close to furnace, as shown in the illustration. The stool and compass should be set in such a position that the natural swing of the work back and forth when testing, will be in a plane parallel with the needle; in other words, the piece being hardened should be swung north and south. By passing the tool being hardened (in this case a milling cutter) forward and backward close to the compass, the magnetism of the tool will cause the needle to be deflected one way, then the other, and the tool will still continue to deflect the needle until the right degree of heat has been obtained, that is, the proper heat for dipping in the bath. In other words, the right heat is when the tool loses its magnetism. It does not follow, that if the needle remains stationary, the first time you test, that the heat is right, because, after the tool has reached a certain degree of heat the magnetism leaves the steel, so there is no influence on the needle, showing plainly that the steel is too hot. The different carbon tempers and different grades of steel, require different degrees of heat, and the magnetism leaves the steel at a certain degree of heat to correspond to the different points of carbon in the steel, and in every case this is the proper heat for dipping. After testing until the right degree of heat is obtained, I put the tool back in the furnace for about twenty seconds, just to even up the heat. I then dip the tool in a water bath to set the hardness, then from the water bath to a lard oil bath until cold. In the case of the rolls previously spoken of, I had to rig up a tackle to the roof, and in place of a rivet in the tongs, I made a hook with thread and two nuts, one hook on each side of tongs, to hook into the tackle, so as to handle the work quickly.

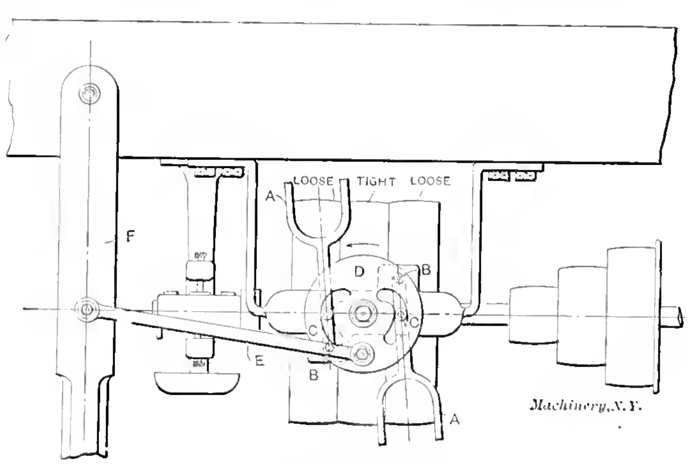
This method applies only to tools that can be heated all over, as it is obvious that heating a tool, say a tap, on the end to be hardened, would have a disturbing effect on the needle simply because only part of the tap would be hot, leaving magnetism in the shank; I am referring now to taps with long shanks. In using the magnetic needle, if it points due north and south, a large body of metal would deflect the needle, to a certain extent, from its natural position, but no matter what the position of the needle, the moment a tool is held close to it, it answers to the magnetism of the tool, and will move until the right degree of heat is reached; when this point is reached, the needle become inactive.

I make it a point to keep my furnace at 1,300 degrees F. all the time, or as near as possible to this degree of heat, and with this heat I find it is not necessary to test every piece. I have never given much thought to improving this method, but undoubtedly, there is a large field for somebody to experiment in. GEO. T. COLES.

Decatur, Ill.

A BELT SHIFTER.

The belt shifter which is shown in the cut is so simple in design and operation that little explanation is needed. The belts are guided by the forked levers *A*, which are pivoted at *B*. The rollers *C* are fixed to the forked levers, and work in the slots as shown. When the disk *D* is rotated—say in the direction of the arrow—by the levers *E* and *F*, the left roller is forced toward the center of the plate *D*, thus moving the forked lever to the right and shifting the belt on the tight pulley. The belt on the right side is not moved during this



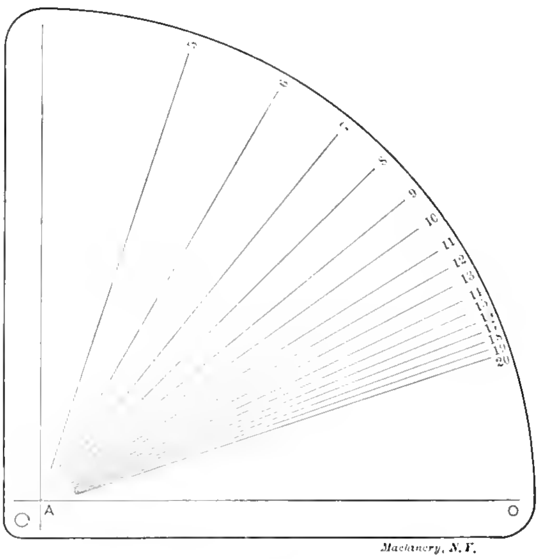
A Belt Shifter of Simple Design.

operation, as the right roller moves in a part of the slot which is concentric with the plate *D*. If the disk *D* had been rotated in a direction opposite to that indicated by the arrow, the movements would, of course, have been reversed, the right belt being shifted, and the left one remaining stationary. This shifting device has, in many cases, given better satisfaction than the friction clutch, as it does not get out of order as easily, and it is not so likely to run warm. CHARLES ROEYS.

Antwerp, Belgium.

TOOL FOR SPACING BOLT HOLES.

In drawing flanges, cylinder heads, etc., where a number of holes are shown on a given pitch circle, it is usually desirable to have them located correctly on the drawing, for the sake of appearance at least, even if not really important otherwise, and for this purpose the tool shown in the accompanying cut was designed. It is a very convenient instrument, made from transparent sheet celluloid, about 1/64 inch thick. The method of procedure when using this tool is to draw the pitch circle, and then place the instrument over it, with the point *A* on the center. One point of the dividers is placed on the line *A O*, at the point where it intersects the pitch circle, and the other point of the dividers is set at the inter-



Tool for Spacing Bolt Holes.

section of the pitch circle and the radial line marked with a number corresponding to the required number of holes in the whole pitch circle. This gives the correct spacing for the number of holes required. If reasonable care is used in the construction of this tool, it will be found to give very close results. The design, of course, can be varied to suit special requirements. The one shown in the cut was made by laying off the correct angles on the circle having 18 inches radius, and scratching the radial lines with a needle point on the celluloid, after which drawing ink was rubbed into the scratches so as to make them show plainly. F. W. C.

BALL-BEARING CONE CENTERS.

The subject of cone centers is one that has received much attention and thought from designers and mechanics for many years, and the story of the many unsuccessful attempts to design a ball bearing cone center would prove interesting reading if such an article could be written. In presenting

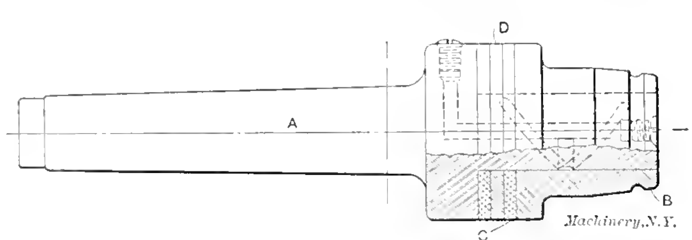


Fig 1 Cone Center of Ordinary Design.

this article, I wish to call attention to the gradual design or evolution of a most satisfactory center of this description, where a failure was turned into a complete success.

Fig. 1 shows the ordinary and most widely used cone center, also the simplest one, and the one most easily made, consisting as it does of the center proper *A*, the cone *B*, the two fiber washers *C*, and the hardened steel washer *D*. While this center will give "good enough" service in many cases, for durability and accuracy, the design is bad. The center bearing of cone *B* wears, and the cone very soon runs out of true, and this error is produced many times in the finished work. The worst feature of this design is that there is no way to prevent the small particles of steel, dirt, etc., from getting into the wearing surfaces and causing trouble. The washers *C* also wear very fast, and although many different forms and materials have been tried, the fact remains that they soon wear out, drop off, and get lost, or are mislaid. This last fact gives us the first essential of a successful cone center.

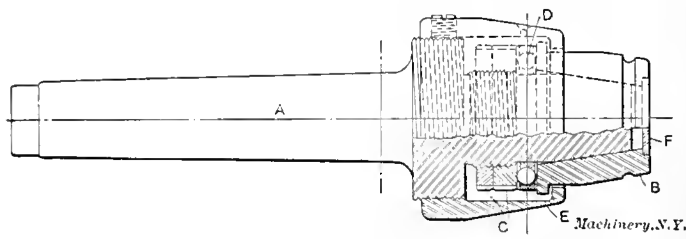


Fig. 2. Ball-bearing Cone Center which proved Unsatisfactory.

It should be self contained, and made in such a manner that the component parts are held in such a way as to prevent their being lost. The design shown in Fig. 2 was not expected to entirely overcome the wear on the cone bearing. The ball bearing *D*, was introduced and adjusting nuts *C* to provide adjustment for the cone *B* as fast as the cone bearing on spindle *A* should wear. This center also proved a failure owing to the variation in the diameter of the balls, the change in the alignment of the adjusting nuts, and the fine adjustments necessary to keep the cone true, all of which led to a combination that was too expensive to maintain, and caused the final abandonment of the design. In this design it will be noticed that the retaining guard *E*, and dirt guard *F* have been added. The final and successful center is clearly shown in Fig. 3, in which *A* is the shank having two grooves or ball races at *D* to receive 24 and 48, 1/4-inch balls, respectively. The cone *B* is hardened and ground inside and out, and has a flange a little smaller in diameter than the shoulder on *A*, allowing retaining guard *E* to slip over the cone. This guard is held in position on the shoulder of *A* by the set-screw, as shown, and prevents too much freedom of movement of the cone *B*. In order to provide for the grinding operations, and provide a dust guard, a recess is cut in the

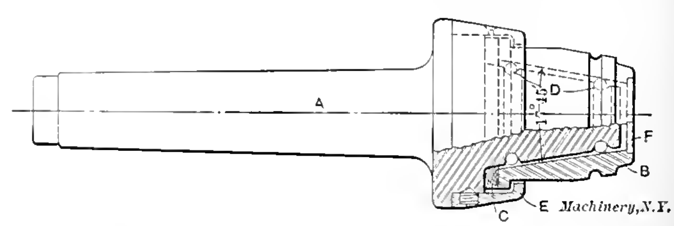


Fig. 3. Ball-bearing Cone Center of Improved Design.

small end of *B*, and, after the center is assembled and adjusted, the cone *B* is removed and a disk *F* forced into place, leaving the end flush, thus preventing any dirt or chips getting into the ball races. A felt washer *C* acts as a filter between the shank *A* and the cone *B*, and, while allowing the water to fill the cone, prevents all foreign matter getting near the balls, and at the same time allows the balls to revolve in a water bath, keeping them cool. After 500 valves had been ground, the cone and shank showed no perceptible wear, and after the first 1,000 had been turned out, the center was declared to be "just getting into good shape." One of the important points in this design is that the bearing point of the work is in direct line with the ball bearing, thus preventing the leverage which would result if the point of contact were at the extreme outside point of the cone.

There are many points to be considered in the production of this center. I have in mind a tool-maker (?) who, after the cone had been carefully ground and the center assembled for inspection, before disk *F* had been put into place, instead of removing cone *B*, carefully placed disk *F* in position and then applied pressure against the disk, cone, and balls. Naturally upon trial the center developed a bad case of "wobbles," and this tool-maker then declared that, "that cone was the worst job of grinding that he had ever seen."

Easton, Pa. F. R. PEIRCE.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

398. LUBRICANT FOR ALUMINUM CUTTING.

The following mixture makes the best lubricant for turning, or any other machining operation on aluminum, that I have ever tried: Mix 1 part good lard oil with 4 parts of kerosene oil. It beats anything yet published in this department.

A. A. STEVENSON.

399. TO MAKE LIQUID GLUE.

Take one quart soft water and 2 pounds of pale glue; dissolve in a covered vessel by the heat of a water bath, cool, and add gradually 7 ounces of nitric acid (specific gravity 1.335). This glue is very strong and will not gelatinize.

C. S.

400. LUBRICANT FOR FITTING ALUMINUM THREADS.

When screwing an aluminum article on to an iron or steel part, much trouble is often experienced by the breaking and tearing of the threads of the softer metal. This can be prevented by lubricating the screw well with a mixture of oil and graphite.

SREGOR.

401. MATT DIP FOR BRASS.

To make a matt dip for brass, mix 1 part sulphuric acid in 1 to 2 parts of nitric acid and 1 part sulphate of zinc. Let the mixture stand 24 hours, and use hot. More or less nitric acid gives a fine or coarse effect, as may be preferred.

Bridgeport, Conn. J. L. LUCAS.

402. TO PREVENT SCREWS FROM GETTING RUSTY.

To prevent screws from getting rusty and sticking tight, instead of using ordinary oil only, add some graphite. After years you will be able to unscrew them with ease, and find them as bright as new, even if they were exposed to very damp air.

J. M. MENEGUS.

Los Angeles, Cal.

403. TO DISSOLVE GLASS.

A hole may be cut or etched through glass readily by using hydrofluoric acid. The acid should be applied in the same way as etching acid, using wax to surround the portion of the glass which is to be penetrated. Hydrofluoric acid is sold in wax bottles, as it cannot be kept in glass. It may be handled with a hard rubber dropper similar in construction to the ordinary glass medicine droppers.

S. W. GREEN.

404. TO ANNEAL HIGH-SPEED AND AIR-HARDENING STEELS.

To anneal "Novo" or "Blue Chip" high-speed steel or any of the air-hardening steels, pack the steel in a piece of gas pipe with powdered charcoal, and seal the ends with clay or caps screwed on. Heat to a cherry red, giving time for the contents of the pipe to reach this temperature, and then set in a dry, sheltered place to cool. The steel will be found annealed so that can be readily drilled, turned, planed or worked as required.

A. A. STEVENSON.

405. TO MAKE A WATER-TIGHT JOINT.

Take ordinary white lead, and mix enough powdered red lead with it to make a paste the consistency of putty. Spread this mixture on the joint, and when it hardens, the joint will bo perfectly water-tight. We used this mixture on flanges on a standpipe, after we had tried all kinds of rubber gaskets without success. The mixture hardened and made a tight joint, never leaking afterward.

J. D. PAGE.

Youngstown, Ohio.

406. TO TEST WHITE LEAD.

This simple test to determine the purity of white lead may be found useful where much painting is being done. It is as follows: Select a piece of charcoal of firm structure, and hollow out a cavity in one side about 1/2 inch in diameter and of the same depth. Put a sample of white lead in the hollow about the size of a pea, and subject it for a few moments to a blow-pipe flame. If the sample is pure, it will quickly reduce to metallic lead. Adulterated white lead will generally contain a residue that cannot be reduced.

M. E. CANEK.

407. ALUMINUM SOLDER.

The following is a receipt for aluminum solder which we are using with success in the Elwell-Parker Electric Co.'s shop, Cleveland, Ohio. It is the result of experiments made by several of our foremen: Pig tin, 12 ounces; sheet zinc, 3 ounces; mercury, 1 ounce. Melt the zinc first and then add the tin. When the tin is melted remove from the fire and add the mercury while still in the molten state. Be careful to stir the mixture thoroughly before pouring into the mold. Use stearic acid for a flux.

L. MILLER.

Cleveland, Ohio.

408. PARTIAL CASE-HARDENING.

The entire surface of the work, or that part which is to be hardened, should be coated with a moderately heavy coat of Japan enamel, and then a medium heavy coat of copper should be applied to the remaining portion of the work. In applying the copper, care should be taken not to disturb the Japan. After the copper is applied, the piece is ready to be carbonized. It should be packed, and heated to a bright red, and held at this heat long enough for the requirements of the work. Then the box or case, containing the pieces to be case-hardened, are taken out of the fire and the work is permitted to cool in the box. When cool, the work is taken out and reheated in the open fire, and dipped in oil or water. The copper prevents the absorption of the carbon, while the Japan enamel burns off and allows the carbon to take effect.

E. S. WHEELER.

409. HARDENING CAST IRON.

The following process can be used for hardening cast iron whether rough or after machining. The casting is first heated to a cherry-red heat; it is then dipped in a bath which consists of a practically anhydrous acid of high heat-conducting power, preferably sulphuric acid of a specific gravity of from 1.8 to 1.9, to which is added a suitable quantity of one or more of the heavy metals or their compounds—such, for example, as arsenic or the like. The preferable ingredients of the bath are sulphuric acid of a specific gravity of approximately 1.84 and red arsenic in the proportions of 3/4 pound of red arsenic crystals to 1 gallon of sulphuric acid. The castings may be either suddenly dipped in the aforementioned mixture, and then taken out and cooled in water, or they may be left in the bath until cool. In preparing the bath, when sulphuric acid and red arsenic are used, better results are obtained when the crystals are added to the sulphuric acid and the bath is allowed to stand for about a week before using.

O. G.

410. A TEMPERING SOLUTION.

A tempering solution used for high heats may be composed of two parts Chili saltpeter and one part nitrate of soda. This tempering solution is used only at high temperatures, as it becomes solid at about 500 degrees F. It is used in place of tempering oils, as they often thicken after short use, and will flash or ignite at about 600 degrees F., and often at a lower temperature. It should be used in connection with a tempering furnace, the heat being gaged by a thermometer. The thermometer should be removed when the day's work is over. At night, two iron plugs, with a fairly liberal taper per foot, and long enough to reach from the inside bottom of the tank containing the bath, to about four inches above the top of the solution, should be placed vertically with the small end of the taper down, and some little distance apart. These should be permitted to stay in the solution when it solidifies. On the following morning, these iron plugs should be unscrewed and removed. The holes left in the solidified solution by these plugs afford an escape for gases that form in reheating the bath.

E. S. WHEELER.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

WIDTHS OF TOOLS FOR CUTTING SQUARE THREADS.

C. H. H.—Please give, in your "How and Why" columns, the dimensions for tools used for cutting square threads. As is well known, in order to procure clearance between threads in the screw and the nut, when provided with square threads, the threads in the screw and the nut must be cut somewhat different from what would be the actual theoretical standard width for square threads. What I wish to know is the width of the point of the tool for cutting screws and nuts having square thread.

A.—When cutting square threads it is customary to make the screws exactly according to the theoretical standard of the square thread. The width of the point of the tool for cutting *screws* with square threads is therefore exactly one-half of the pitch, but the width of the point of the tool for cutting taps, which afterwards are used for tapping nuts, is slightly less than one-half the pitch, so that the groove in the tap becomes narrower, and the land or cutting point wider than the theoretical square thread, thereby cutting a groove in the nut which will be slightly wider than the thread in the screw, so as to provide for clearance. An inside threading tool for threading nuts evidently must be of the same width as the land on the tap would be, or in other words, slightly wider than one-half the pitch. This provides, then, the required clearance. The accompanying table gives the width

TABLE OF WIDTHS OF TOOLS FOR CUTTING SQUARE THREADS.

Number of Threads per inch.	Width of Point of Tool for Taps.	Width of Point of Tool for Screws.	For Inside Thread Tools for Nuts.
1	0.4965	0.5000	0.5035
1 1/3	0.3715	0.3750	0.3785
1½	0.3303	0.3333	0.3363
1¾	0.2827	0.2857	0.2887
2	0.2475	0.2500	0.2525
2½	0.1975	0.2000	0.2025
3	0.1641	0.1666	0.1691
3½	0.1408	0.1428	0.1448
4	0.1235	0.1250	0.1265
4½	0.1096	0.1111	0.1126
5	0.0985	0.1000	0.1015
5½	0.0894	0.0909	0.0924
6	0.0818	0.0833	0.0848
7	0.0699	0.0714	0.0729
8	0.0615	0.0625	0.0635
9	0.0545	0.0555	0.0565
10	0.0490	0.0500	0.0510
11	0.0444	0.0454	0.0464
12	0.0407	0.0417	0.0427
13	0.0375	0.0385	0.0395
14	0.0352	0.0357	0.0362
15	0.0328	0.0333	0.0338
16	0.0307	0.0312	0.0317
18	0.0272	0.0277	0.0282
20	0.0245	0.0250	0.0255
22	0.0222	0.0227	0.0232
24	0.0203	0.0208	0.0213

of the point of the tool for all ordinary pitches from one to twenty-four threads per inch. The second column gives the width of the point for cutting taps to be used for producing square thread nuts. The third column gives the width of the point of the tool for cutting screws which, as we have said, equals one-half the pitch, and the fourth column gives the width of the point for inside threading tools for nuts. While the table has been carried to as fine pitches as those having twenty-four threads per inch, square threaded screws having so fine a pitch are very seldom used. Some manufacturers of square threading tools, however, make square threading tools for pitches as fine as these, and for this reason they have been included.

TRUCK EQUALIZER.

H. E. R.—How should fiber stress and thickness be determined for a truck equalizer such as shown in Fig. 1? The total load on the truck is 43,000 pounds, supported by two springs, each spring hung between two equalizers.

A.—This equalizer is a beam supported at the ends and loaded symmetrically at two points between the supports, and should be so considered in figuring the fiber stress for a given load, except as the calculations are modified by the curved shape. The maximum bending moment and fiber stress will occur at the points where the springs are attached, and at all sections between these two points.

Fig. 2 shows the method of finding the bending moment at section $x\ y$ through the point of spring suspension, or at any other point $x_1\ y_1$ between the spring and the support. The sections must be taken at right angles to the neutral axis,

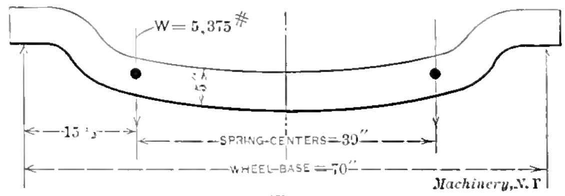


Fig.

and the distance l is measured from the neutral point of the section perpendicularly to the line of reaction. The bending moment at all points between B and the corresponding point on the opposite side of the center line is the same as at B

Between B and the point of support when the sections are at a different angle from the reaction, as in Fig. 2, there is a direct tensile stress to be added to the maximum tensile stress due to bending. The greater the angle, the greater this stress. It is found as given by the formulas in Fig. 2. Between point B and the corresponding one the other side of the center line, the angularity of the section makes no difference, and does not enter into the calculation at all. In this calculation we will consider that the hole for the spring sup-

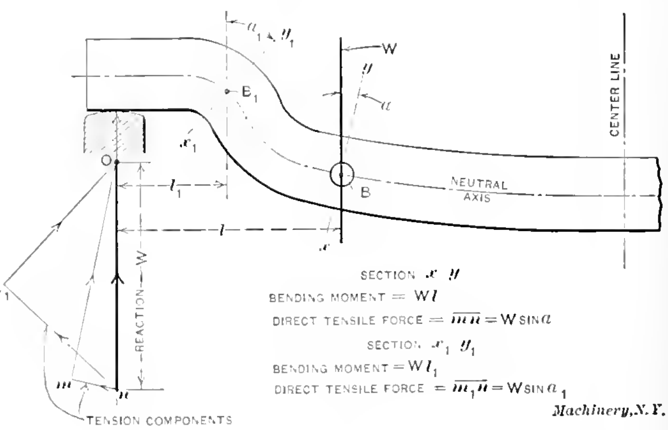


Fig. 2.

porting pin is located on the neutral axis. The section will be the strongest if this is the case, and there seems to be no good reason why it should not be so located.

In the formulas and calculations these reference letters will be used, in addition to those given in Figs. 2, 3 and 4.

A = area of section.
W = load = reaction.
M = bending moment.
Z = section modulus.
s_b = fiber stress due to bending.
s_t = stress due to direct tension.
s = total tensile stress.

The maximum tensile stress at any section between B and the point of support is found by the following formulas:

$$s_b = \frac{M}{Z} \tag{1}$$

$$s_t = \frac{W \sin a}{A} \tag{2}$$

$$s = s_b + s_t \tag{3}$$

To find M, see Fig. 2; to find Z, see Figs. 3 and 4.

The section at $x\ y$, which is the weakest, sustains the maximum fiber stress. Assuming that $b = 1\frac{1}{2}$ inch and $d = 1\ 1/8$ inch (Fig. 4), the maximum stress is found by the following calculations:

$M = 5{,}375 \times 15.5 = 83{,}312.5$ inch-pounds See Fig. 2.

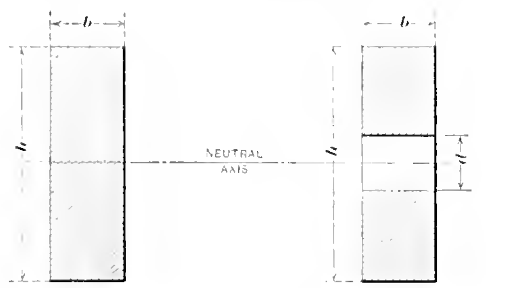
$$Z = \frac{1.5}{6 \times 5}(5^3 - 1.125^3) = \frac{123.577}{20} = 6.1788 \quad \text{See Fig. 4.}$$

$$s_b = \frac{83,312.5}{6.1788} = 13,500 \text{ pounds per square inch—about.} \quad \text{See (1)}$$

The section seems to have an inclination of about 12 degrees, of which the sine is about 0.208.

$$s_t = \frac{5,375 \times 0.208}{3.875 \times 1.5} = 192 \text{ pounds per square inch—about.} \quad \text{See (2)}$$

$$s = 13,500 + 192 = 13,692 \text{ pounds per square inch.} \quad (4)$$



$Z = \frac{bh^2}{6}$ $\qquad Z = \frac{b}{6h}(h^3 - d^3)$

Figs. 3 and 4.

If we take any other section to the left of B, such as $x_1 y_1$, we will find the maximum fiber stress considerably less than at $x y$. This section has an inclination of about 43 degrees.

$$M = 5,375 \times 7.5 = 40,312.5 \text{ inch-pounds.}$$

$$Z = \frac{1.5 \times 5^2}{6} = \frac{25}{4} = 6.25. \quad \text{See Fig 3.}$$

$$s_b = \frac{40,312.5}{6.25} = 6,450 \text{ pounds per square inch.}$$

$$s_t = \frac{5,375 \times 0.682}{5 \times 1.5} = 490 \text{ pounds per square inch.}$$

$$s = 6,450 + 490 = 6,940 \text{ pounds per square inch.} \quad (5)$$

In these calculations, we have assumed a thickness b of $1\frac{1}{2}$ inches. This gives, see (4), a maximum fiber stress of 13,692 pounds. This is a reasonable value for wrought iron. The thickness is greater than usual, and it would be better, perhaps, to make the bar somewhat wider and so reduce its thickness.

* * *

CALCULATING THE SIDE OF AN INSCRIBED POLYGON.

FRED WALSLEBEN.

In the February issue of MACHINERY a method is suggested for determining the sides of regular inscribed polygons when the number of sides increases in geometrical proportion in the ratio 2. The method suggested must seem rather vague to those not acquainted with its proof. It is only applicable to polygons whose radius is unity, and its application involves a confusing alternation of minus and plus signs. A more satisfactory way is as follows:

Given the side a and the radius R of a regular inscribed polygon, to find the side D of a regular inscribed polygon of double the number of sides and the same radius:

$$D = \sqrt{R\left(2R - \sqrt{4R^2 - a^2}\right)}$$

This formula is general. Its derivation and proof can be found in any treatise on plane geometry.

* * *

A report from Consul-General Richard Guenther, of Frankfort, Germany, states that in 1907 the production of denatured alcohol in that country was 27,720,000 gallons, an increase of about 2,900,000 gallons over the previous year. The price for alcohol was high, having been considerably advanced at different times, but in the report, the actual price per gallon is not stated. It is stated that the alcohol production in Germany is controlled by a trust or combination, which fixes both the amount of production and the price. German alcohol is made principally from potatoes.

SOME EXAMPLES OF ELECTRIC WELDING.

Although the electric welding process passed out of the experimental into the practical stage some years ago, to most mechanics electric welding is still a rather vague subject. Electric welding, however, plays an important part nowadays in the manufacture of a great many articles, and several companies have been formed which devote their entire attention to the manufacture of articles in which electric welding is an integral part of the manufacturing process. Without the process of electric welding, many of these products would have to be manufactured in an entirely different way, and in many cases at a greatly increased cost.

It may be well to state at the outset that there are at least four distinct processes of electric welding in use at the present time. These processes are commonly named the Zerener, the La Grange-Hoho, the Benardos, and the Thomson processes. In the process first mentioned above, the Zerener process, perhaps more commonly known as the electric blow-pipe method, an electric arc is drawn between two carbon electrodes. This arc is then caused to impinge upon the metal surfaces to be welded, by means of an electro-magnet.

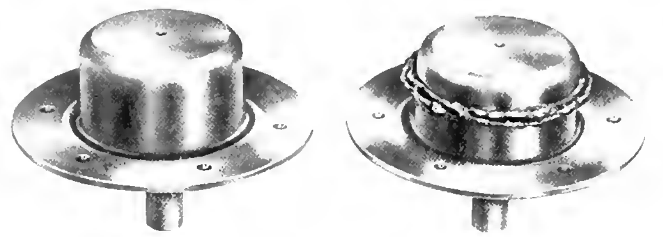


Fig 1. Automobile Hub Completed by Electric Welding.

The second process mentioned, the La Grange-Hoho, commonly known as the "water-pail forge," is distinctly different from all the other processes in principle, as well as in its practical application. A wooden tank is filled with a suitable fluid, and in this the positive electrode of the electric circuit is placed. The negative electrode is connected to the metal to be forged or welded, which is then immersed in the fluid in the tank. The metal is permitted to remain in the fluid until it has reached a welding temperature. The object to be welded is then removed, and the actual forging or welding process is carried out in the usual manner under a hammer. Strictly speaking, this is not an electric welding process, but merely an electric heating process to bring the metal to a welding heat.

Fig 2. Electric Weld on Automobile Pinion Casing

The characteristic principle of the Benardos process is, that an electric arc is drawn directly between the metal to be welded, which itself forms one electrode for the electric circuit, and the carbon electrode, which forms the other terminal for the circuit. In this process the pieces of metal to be welded are melted on their faces, together with a small rod of iron which acts as a kind of solder, and flows in between the two surfaces to be joined together by the welding process.

Finally, in the fourth, or the Thomson process, often known as the incandescent process, the metals to be welded are brought into intimate contact, being usually held closely together by metal clamps actuated by springs so as to permit

a permanent pressure on the parts even when the metal at the welding surfaces commences to melt. By this contact, the parts to be welded complete an electric circuit, and the resistance at the points of contact between the metals produces a welding temperature in a very few seconds, at the same time as the two metals are, by the spring-actuated clamps, forced together automatically, and welded. A distinct feature of this electric welding process is that the interior is raised to a welding temperature before the surface reaches that heat. When heated in the forge for welding, the opposite conditions take place. In the process of electric welding, if the exterior surfaces weld, the operator is sure that the interior is also welded, since it must, by necessity, be of a somewhat higher heat. With ordinary forge welding the surfaces may present a perfect weld and still cover an imperfect joint inside. The accompanying photographs show a number of applications of electric welding, as carried out in the shops of the Standard Welding Co., Cleveland, Ohio, by the use of the Thomson process, which will illustrate its possibilities.

Fig. 3. Stem of Carbon Steel Welded to a Soft Steel Disk.

A few years ago it was thought that electric welding would be practical only for very small objects, on account of the high amperage required, but since that time the process has been developed so that it is now possible to electrically weld parts of considerable size. The process is particularly suited for the manufacture of automobile and bicycle parts, carriage hardware, and mechanics' tools of various descriptions. While the process is employed to a considerable extent among manufacturers, it is probable that in the shops of the company mentioned above there is a greater variety of work welded by the electric process than in any other.

When, as mentioned above, the two parts to be welded have been placed against each other, in the electric circuit, which heats the metal at the juncture to a molten state, the separate parts will be united into one piece in such a manner that the joint is practically imperceptible, but at first a burr or upset is produced around the welded surface, composed of the expelled oxidized and otherwise inferior metal. This oxidation, examples of which are shown in all of the accompanying cuts, is, of course, removed, and then a perfect joint is the result. In the cut, Fig. 1, an automobile hub is shown, on which an electric welding process has been performed. The dome or cover and the spindle of the hub are drop forged as an integral part, the flange being produced under a power press. The parts are then roughly machined, so as to be fairly uniform in the dimensions where the joint is to take place, and are then subjected to the electric welding process. At the right, in the cut, the hub is shown with the burr or upset resulting from the welding process still left in place, while at the left is shown the finished hub after this burr has been removed. The turning and grinding operations complete the work, producing practically a solid hub.

The cut, Fig. 2, illustrates an automobile pinion casing. The parts for making up this casing are of stamped steel. The burr incidental to the welding process is shown, in order to indicate where the joint is located. While the welding process is being carried out, the parts are held in alignment so that after being roughed and finished, and after having been cupped at the ends, the ball races will be in correct alignment.

In the cut, Fig. 3, is illustrated a soft steel disk, welded to a stem or spindle, containing from 0.12 to 0.60 per cent carbon. The detail shown is used largely in the manufacture of cream separator bowls, but, of course, similar applications are found in a great many other machines. It is possible to join soft steel disks to stems or spindles of even higher carbon content than that mentioned.

In Fig. 4 is shown a double lever or arm welded to the steering knuckle on an automobile. This illustration presents a case where it would not be possible, without greatly increased expense, to produce the part without electric welding.

The illustrations shown are, of course, only general examples of what can be accomplished by means of the electric welding process, but they are suggestive to the mechanical mind which may be unfamiliar with the wide field of application for electric welding, indicating as well, that the future of electric welding is one of great possibilities. For a more complete description of the shops, methods and products of the Standard Welding Co., see MACHINERY, April, 1903.

One very important question in regard to electric welding, and for that matter any other process for joining metallic parts, is whether the joint is sound. Experiments and tests, as well as use of electrically welded joints, have unquestionably demonstrated its reliability. In the case of electric welding, the great variety of parts so joined has shown, beyond doubt, that the joint is practically as sound as the solid sections in the parts so joined. Very commonly the parts which are welded by the electric process are subjected to abuse and rough handling, or to heavy stresses. Especially is this so in automobile work. The results obtained have been so satisfactory as to place the art among the most useful of the applications of electricity.

In this connection, it may be well to mention that the Thomson process, while originally an American invention, has also received considerable attention in England. A writer in the *London Times* some time ago, called attention to the fact that the system has caused a complete revolution in existing methods of manufacture in many industries, and that electric welding had created some entirely new manufactures. As to the reliability of these joints, this writer also mentioned that tests had been carried on regarding the comparative strength of electric and ordinary forged welds, and that these tests

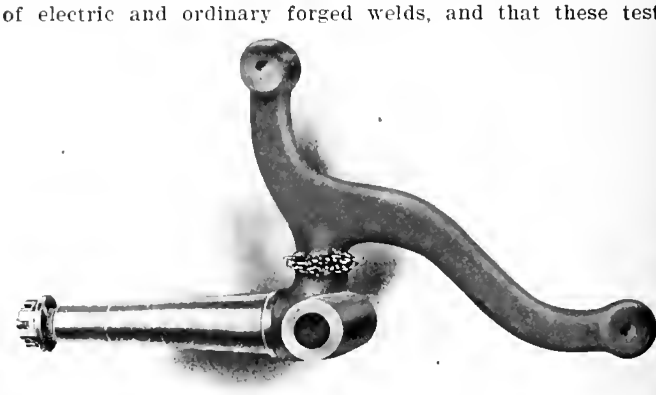


Fig. 4. Welding Operation on Automobile Steering Knuckle and Lever.

show that while the ordinary forge weld of iron bars shows an average strength of 89.3 per cent, as compared with the strength of the solid, electrically welded joints show a strength of 91.9 per cent.

In giving a summary of the advantages which can, with propriety, be claimed for the electric welding process, the following may be stated as being the most important: Finished or nearly finished work may be welded and repaired without damage; the welding operation can be closely watched as it proceeds, and faulty welds prevented; the process is carried out with great rapidity, occupying only a few seconds, and in small work it is performed almost instantaneously; and, finally, impurities are expelled from the joint, and a perfectly homogeneous weld is obtained. The cost for the generation of heat, generally speaking, is probably the same for forge and electric welding, but with the electric process the cost of labor is greatly reduced.

THE SETTING UP AND OPERATION OF THE POTTER & JOHNSTON AUTOMATIC CHUCKING MACHINE.—I.

The invasion by the automatic turret machine of the field so long held by the lathe, in its work of machining castings, has been one of the important developments of the past decade in the machine tool business. Beginning with the original automatic screw machine, which first came into use a quarter of a century ago, the automatically operated turret machine has steadily found wider and wider fields of usefulness, being applied first to small turned parts made from bar stock, later to small castings, and more recently to the machining of castings and forgings of considerable size.

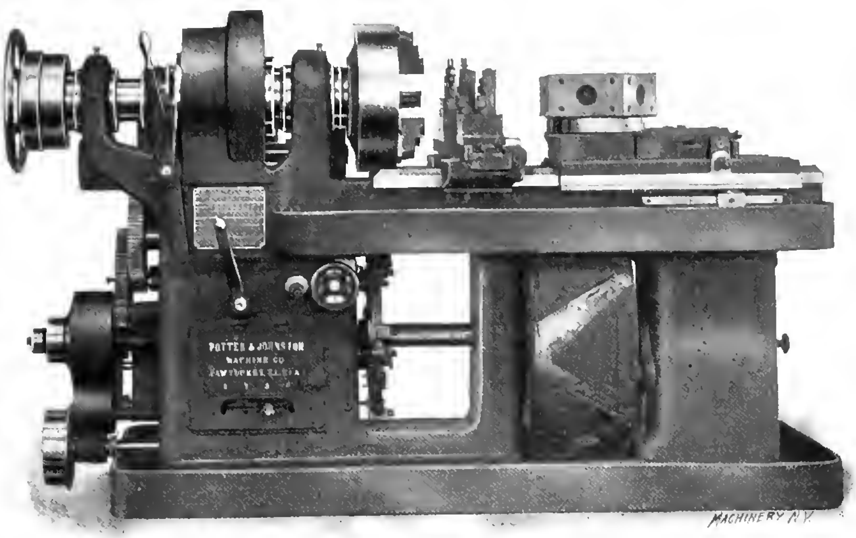


Fig. 1. Potter & Johnston Automatic Chucking and Turning Machine, with Two-speed Geared Spindle Drive.

The automatic chucking machine shown in Fig. 1, built by Potter & Johnston, Pawtucket, R. I., is the logical result of this extension of the automatic screw machine idea to the handling of large work. There are so many of them in use, that it was believed that a description of the operation of this machine, particularly as relates to setting it up for simple work, would be valuable and interesting to our readers. This article was prepared with this in view, the information and illustrative matter it contains being gathered during a special visit to the shops of the builders, who freely provided every facility that could be asked for.

Description of the Machine.

A clear understanding of the action of the machine is essential for the operator, if he expects to set it up and work it intelligently. We will describe its construction as simply and in as few words as possible.

In Fig. 1 is shown a machine of the type from which the observations were taken. Various styles of machines are made by the builders, there being two sizes and several arrangements of the driving mechanism. Some of the machines have spindles driven directly from pulleys on the spindle. Some have one spindle speed only; some have two speeds of fixed ratio for any given piece of work; while others (as in this case, which is the form most suited for heavy chucking work in iron or steel) have two speeds available for the same piece of work, which speeds may be selected without reference to each other, from a wide range.

The principle of operation of the machine is simple. Mechanism has to be provided to stop, start and change the spindle feed; to operate the cross slide; and to feed the turret slide forward, return it quickly, rotate the turret to a new position, and feed it forward quickly for taking a new cut. The cross slide and turret slide movements are effected by cams mounted on the large drum seen beneath the turret in Fig. 1, while the various feed and speed changes are effected by dogs and pins carried on a disk keyed to the same shaft on which the cam drum is mounted. This shaft, with the cam drum and the governing disk, makes one revolution for each piece of work completed.

The periphery of the drum carries the cams for operating the turret slide, which is moved positively in both directions, without the use of springs. The cam roll is carried by an intermediate slide, lying in a groove in the upper surface of the bed. This slide has rack teeth cut on it, engaging a pinion on the squared shaft, seen projecting from the side of the turret slide. By turning this shaft with a crank, the position of the turret slide with relation to the cam may be altered, so that it may be adjusted for long or short work and long or short tools, as may be required.

The cross-slide cams, and the means for transmitting the movement obtained from them to the cross slide, are best seen in Figs. 3 and 5. These cams are mounted on the rear face of drum *W*, and act on a roll, carried at the front of yoke *A*, which extends diagonally upward toward the rear of the machine. The rear end of this yoke has rack teeth formed on it, meshing with teeth of a segmental pinion, which is fast to a stout rock shaft *B*, extending lengthwise of the machine at the rear. At the head-stock end, this rock shaft carries another segmental pinion, meshing with rack teeth formed on the cross slide. The movement imparted to the yoke by the cams, is thus transmitted through the pinions and the rock shaft to the cross slide.

The cam drum is driven by a pinion meshing with a gear (seen in Fig. 1) which is fast to its front periphery. This pinion is driven through a train of gearing from pulley *L* (see Fig. 6), which is belted to the spindle. The feeds are thus always dependent on the spindle speeds, as should always be the case in any machine of the lathe type. By means of epicyclic gearing and suitable clutches, the motion thus derived from the spindle may be made either very rapid, for returning the turret to be indexed and then advancing to the cutting position again, or very slow for the forward feed. These changes from slow to rapid movement or *vice versa* are effected by mechanism operated from a cam on a shaft whose outer end terminates in a star-wheel, shown just at the right of the small hand-wheel beneath the main head-stock bearing in Fig. 1. Whenever the motion is to be changed, this star-wheel is operated by pins carried by the governing disk, seen best in Fig. 6. The first

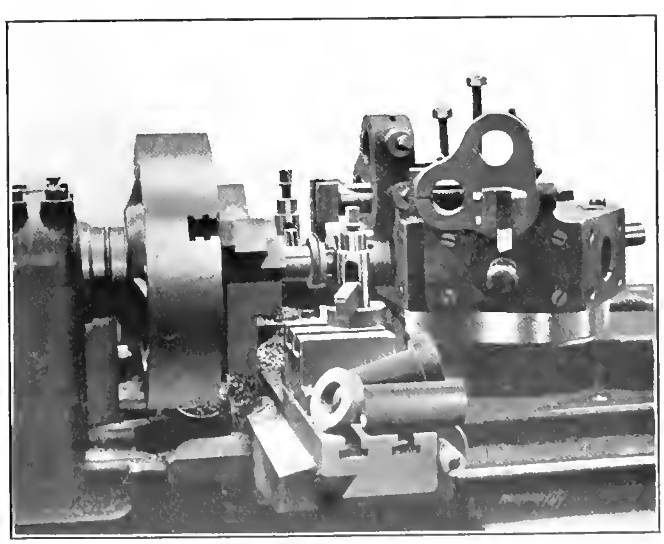


Fig. 2. Front View of Machine set up for the Finishing Operation on the Recessed Bushing and Collar shown in the Foreground and in Fig. 4.

pin *M* that strikes it advances it one-sixth of a rotation, changing the feed from fast to slow. The next pin that strikes it will change it another sixth of a rotation, from slow to fast feeding—and so on. Hand wheel *E* is geared with the cam-shaft on which the star-wheel is mounted, so that the feeds may be changed manually from slow to fast, or *vice versa*.

A unique constructional feature of disk *D* is best seen in Fig. 6. The slot in which pins *M* are located is a continuous one,

extending clear around the disk, so that the rim is entirely separate from the inner portion, which is supported by the arms. The two parts of the disk are always held together, however, by the various pins carried in the slot, which are never all unclamped simultaneously. This makes the two parts practically solid, without disturbing the continuity of the slot. Besides these feed changing pins, there is also carried in this slot, a dog which operates a lever by which the feed movement is stopped, when the work has been completed.

Four rates of feed are provided for by quick change gearing of the sliding gear type, operated by handle *K* shown projecting through the door in the cabinet leg beneath the head-stock. When this handle is set in the central position, the feed is disengaged. The ability to change the feed quickly tends toward running the machine at its highest efficiency. The operator is more likely to speed the machine up, if he sees that the tools are all working too easily, than he would be if he had to stop the machine to alter the setting of change gears of the ordinary type.

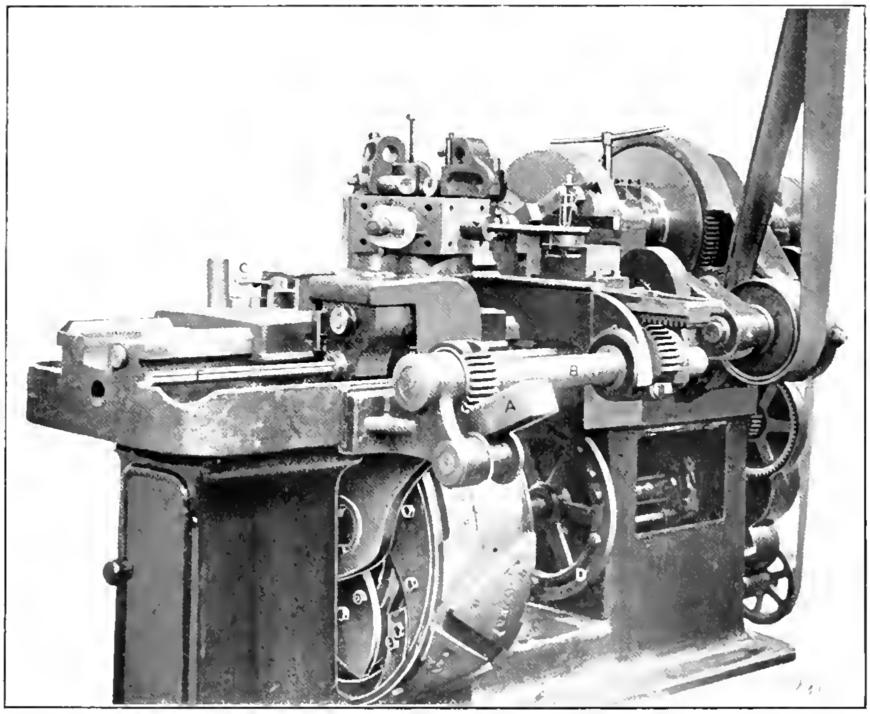


Fig. 3. Rear View of Machine set up for Work as in Fig 2; shows the Cross-slide Mechanism, Driving Gearing, etc.

On the periphery of the governing disk are also clamped dogs or cams *N*, which operate a horizontal swinging lever *P*, connected by a link with vertical lever *J*, which controls the two spindle speeds with which the machine is provided, either one of which may thus be thrown into action at any time. The spindle driving connections are best seen in Fig. 3. As may be seen, a single speed pulley is used. The shaft on which it is mounted is connected to two sets of change gearing, enclosed in suitable guards, one on each side of the driving pulley, and each connected with its own loose driving gear on the spindle. Either of these driving gears may be connected with the spindle by clutch lever *J*, operated by the dogs *N* on the disk *D*. These driving gears are connected with the driving pulley in different ratios, and with the change gears used, ten different speeds may be obtained from each, 20 speeds being available in all, of which the two most suitable are available for any given piece. Lever *H* connects or disconnects the driving pulley with the shaft on which it is mounted, thus stopping and starting the machine.

Vertical lever *H* in the cabinet base, stops and starts the automatic feed. The shaft with the squared end, projecting from the base just at the left of hand-wheel *E*, is used with the crank to operate the drums by hand.

The rotation of the turret, which takes place at the rear of its travel of course, is effected by power. In Fig. 3 will be seen a shaft *F* extending from the head-stock through the gear casing at the rear of the turret slide. This shaft is driven from the constant speed drive pulley of the machine, and operates the turret revolving mechanism at constant speed. A dog shown in Fig. 1 at the side of the bed, is set to trip the turret revolving mechanism at the proper point in the travel to avoid interference between the tools and the work. The turret is provided with an automatic clamping device. The mechanism first withdraws the locking pin and unclamps the turret, revolves it, then throws in the locking pin and clamps the turret again. The horizontal lever at the right of the turret in Fig. 1 may be used to release the locking pin for turning the turret by hand, the clamping mechanism having been released by lever *C*, Fig. 3.

The Work and the Operations to be Performed.

The piece we have selected for illustrating the setting up and operation of the machine is shown in Fig. 4. It is a very simple piece, and will thus best serve for illustrating the principles involved. Although it is simple, it is of special interest in one or two particulars. For instance, the operation we are to perform is a second operation. In the first operation, the hole was drilled, bored and reamed, the small end of the bushing was faced, and the outside diameter finished. The enlarged diameter at the end was used for holding the work in the chuck, so, of course, it was left rough. This brings the part to the condition shown at the right in Fig. 4, where it is ready for our second operation. In this second operation we have to cut off the enlarged end, whose original purpose was that of furnishing a chucking piece to hold the work by. In order, however, not to waste any stock, this piece which we cut off is made to serve as a collar on another part of the machine for which the bushing is intended. For this purpose, we turn its outside diameter, and face the outside end of it before cutting it off. Besides this, we have to recess the bushing, as shown, and face its outer end.

In order to have the second operation dead true with the first one, we place a set of soft false jaws in the chuck (see Figs. 2 and 3) and clamp them down on a short piece of stock, slightly smaller in diameter than the diameter to be held. Then the jaws are carefully bored out to exactly the diameter of the work to be held. We can now be sure that the work will be held truly, within reasonable limits, provided the chuck is always tightened up in the same way as when it was tightened for boring.

The first thing to do is to decide on the order of operations. These are performed in the following order: On the first turret face we will turn the outside diameter of the collar, and face the outer end. On the second turret face we will finish turn the outside diameter of the collar, and finish the outer face. The third face of the turret will not be used, this portion of the cycle being taken up in cutting off the collar with the cut-off tool on the rear cross slide. For the fourth operation we will recess the bushing, as shown in Fig. 4, and for the fifth operation we will face the end of the bushing, to remove the rough surface left by the cutting-off tool.

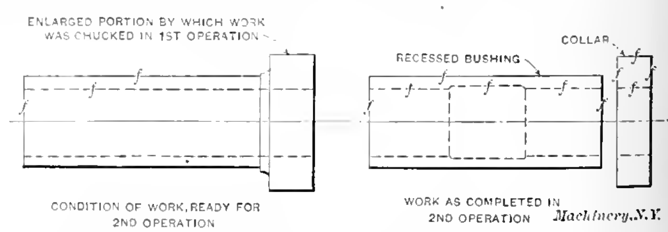


Fig. 4. The Work to be Operated on; this Second Operation recesses the Bushing, and finishes the Chucking Portion for Use on the Collar.

The tools used are shown in place in Figs. 2 and 3. For the first operation, standard turning tools are used, consisting of brackets bolted to the face of the turrets, with upward projections, provided with three holes each for carrying turn-

ing tool holders. As will be shown later, this arrangement provides for turning a number of diameters at different lengths simultaneously; but for our purpose a single turning tool for each holder will be used, located, as shown, in the lowest of the possible positions. A special device is used for recessing, as will be described later, while the facing of the end of the bushing is effected by tools so simple as to be self explanatory.

Setting the Tools.

We have first to determine the change gears to be used to get suitable spindle speeds to agree with the diameter of

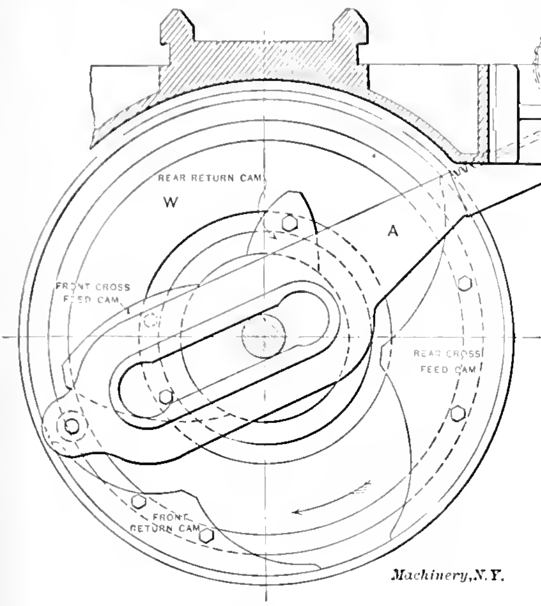


Fig. 5. Diagram of Cross-slide Cams and Mechanism.

the work. Referring to the speed and feed plate on the head-stock of the machine (see Fig. 7) we are permitted to use one speed from the list given for the fast train and one from the list for the slow train, so long as the same gears are not used in each case. The diameter of the collar for our piece of work in Fig. 4 is 2½ inches, while the diameter of the body is 2 inches. We should use a surface speed of about 40 feet per minute. A little calculation shows that the 66 revolutions per minute given by the fast train, gives 43 feet

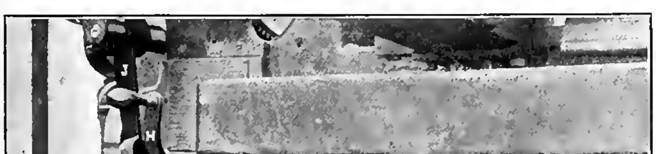


Fig. 6. The Controlling Mechanism for Feeds and Speeds.

per minute on 2½ inches diameter; and the 78 revolutions per minute obtained from the slow train of gearing, gives about 41 feet per minute on 2 inches diameter. The spindle gearing indicated for these speeds is therefore placed in position on the proper studs at the back of the machine.

Next, we have to determine on which faces of the turret to place the different tools. Each turret face is numbered to agree with the corresponding feed cam on the drum. The brass plate at the head-stock end of the machine gives the various feeds obtainable per revolution of the spindle. As will be seen, the different cams give different feeds. Cam No. 1 has a coarse feed suitable for roughing; cam No. 2 a finer feed, adapted to finishing cuts; and so on. Since our first operation consists in rough turning, it seems reasonable to give this operation to cam No. 1. Cam No. 2 will then have a finer feed for the finish turning; No. 3 is devoted to cutting off the collar; No. 4, which is ordinarily used for reaming, would, in our case, be devoted to recessing. Since this recess is for clearance only, and may be done with a coarse feed, this cam is entirely suitable.

The final operation, which is a facing one, could be done on any cam, so No. 5 will do. It will be understood, of course, that for facing operations, the feeds given do not apply. As the roll is going over the point of the feed cam at the extreme of the movement, the feed of the turret slide is gradually slowed down to zero. Since the facing takes place in the last eighth or sixteenth-inch of this movement, it is done at a feed which is gradually tapered off to zero. This is, of course, just as it should be, and we need pay no attention to tabulated feeds in facing operations.

The next adjustment to make on the machine, is that of setting the turret slide in proper position. In making this setting, the turret is set in relation to the work so that the tools will require but a small amount of over-hang, the cam-shaft having been revolved by hand until the cam-roll is on the extreme top of the forward feeding cam, so that the turret slide is at the extreme of its forward motion. When

8½ x 16. NO. 11 AUTOMATIC $3\frac{9}{16}$ SPIN

SPINDLE REVOLUTIONS PER MINUTE

SPINDLE SPEED FAST TRAIN OF GEARS	150	120	98	80	66	55	45	37	30	24
UPPER CHANGE GEAR	18	21	24	27	30	33	36	39	42	45
LOWER CHANGE GEAR	45	42	39	36	33	30	27	24	21	18
SPINDLE SPEED SLOW TRAIN OF GEARS	78	62	51	42	34	28	23	19	16	12

TURRET FEEDS PER REVOLUTION OF SPINDLE

CAM NUMBER		1	2	3	4	5
HANDLE POSITION	1	.006	.003	.004	.009	.005
	2	.013	.007	.008	.018	.010
	3	.024	.012	.015	.034	.018
	4	.047	.025	.029	.068	.036

DRIVING PULLEY 330 REVOLUTIONS PER MINUTE
FOR SPECIAL CAMS SEE DIAGRAMS IN CATALOGUE
POTTER & JOHNSTON MACHINE CO.,
PAWTUCKET R.I. U.S.A.

Machinery,N.Y.

Fig. 7. Plate on the Head-stock, giving the Feeds and Speeds for the Machine.

this adjustment has been made by the means provided, set the turret index tripping dog so as to revolve the turret at the proper point.

We have, then, a standard turning tool holder on face No. 1. In the lowest hole of this is placed a turning tool stem with a cutter in place. With cam No. 1 in action, we revolve the cam by hand until the roll is on the point of the cam and the turret at the forward extreme of its motion. At this point we set the turning tool stem, so that when the cutter is in place it will have completely passed over the surface to be turned. Clamping the stem in this position we turn the feed cam backwards, returning the turret slide toward the rear again, and clamping the cutter in the stem at about the proper diameter for the desired roughing cut. By manipulating the crank on shaft A, the turret slide is fed forward and back while this cutter is adjusted for diameter, until it is properly set. We then turn this diameter, feeding the cam drum by hand.

A facing tool, shown in action in Fig. 2, is placed at this station of the turret, being held in the turret hole. This consists, as may be seen, of a pilot bar clamped in the turret hole, carrying a circular body holding a facing blade. Feeding by hand, as before, this is adjusted lengthwise to rough face the work for the dimension desired. In a similar way, the finish turning and facing tools in the second face are set, the cam-shaft being revolved by hand to bring this second face and second cam into operation. The finishing facing tool is not shown in place in Fig. 3.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

HEALD INTERNAL GRINDING MACHINE.

One of the many important developments of the automobile industry has been the new importance given to the operation of internal grinding. This operation has been proved to be a most practicable one for finishing holes accurately to size, in all sorts of work which at one time was thought to be best finished by the reamer. The reaming operation is a costly one, owing to the large expense involved in keeping the tools to size, requiring the purchase of new reamers if the solid type was used; if the adjustable variety is employed, there is always a slight variation in size due to the change in diameter

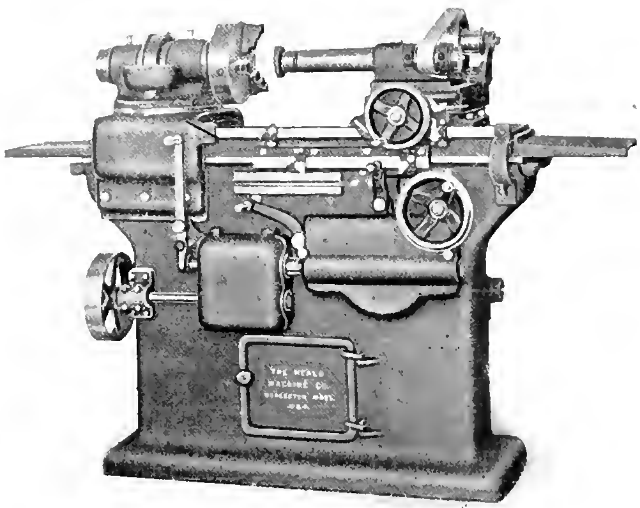


Fig. 1. The Heald Internal Grinding Machine.

that takes place before the necessary readjusting and regrinding is undertaken. Besides this, there is much work that is difficult to hold for reaming without distortion, because of thin walls which give under the pressure of the of the chuck jaws by which the work is held. The comparatively light clamping necessary for the grinding operation, and the light contact between the wheel and the work, permit the obtaining of holes much more nearly true and accurate to dimensions than is possible in any other way.

A good internal grinding machine will finish holes day after day, rapidly and true to size within 0.00025 inch (or closer if desired) directly from a rough bored cut, and without any expense for reamers for the various diameters, and without expense for keeping such reamers sharp. Besides this, it will finish to size, rapidly, holes in hardened steel parts, which cannot be reamed under any circumstances, and at a fraction of the time required for lapping them out.

Internal grinding has not always been done with all the rapidity and economy which the operation is capable of showing. This is owing to the fact that practically all internal grinding has been done on machines in which the wheel was supported by a structure in the nature of an attachment of the machine, instead of being an integral part of it. This usual construction (by which the wheel is supported on an over-hanging arm reaching forward from the wheel stand at the back of the machine) was so light and flexible as to encourage the vibrations which are one of the most serious troubles met with in grinding. The vibration of a spindle thus poorly supported breaks down the texture of the wheel, and makes it impossible for it to cut either rapidly or smoothly. Rigidity is the fundamental requirement in a successful internal grinding machine. The Heald Machine Co. of Worcester, Mass., believes that it has fulfilled this requirement in the internal grinding machiue which we herewith describe and illustrate.

As may be seen, this tool is not an external cylindrical grinder modified for internal grinding, but is radically designed for the operation it is to perform. The bed is of simple and rigid form, provided with ways on its upper surface, on which slides a table carrying the wheel spindle. The work spindle head-stock is mounted on a frame which straddles the work table, and is fastened to the base on either side. A more direct and rigid construction it would be difficult to imagine.

The saddle or bridge on which the head-stock is mounted is of heavy design, as may be seen in Fig. 3. The head-stock *B* may be swiveled on it to any angle for grinding tapered holes, graduations being provided which read in degrees and in tapers per foot. Hardened bushing *C* is driven into *A*, and fitted carefully to *B*, furnishing a pivot about which the adjustment is made. The spindle is made of a special grade of high carbon steel, ground and lapped, and, as may be seen, is of generous diameter. It runs in tapered phosphor bronze bushings, adjustable for wear, and provided for suitable means for excluding dust and grit.

This spindle is driven by a belt from a 5-speed quick change gear box, which forms a part of the counter-shaft; by this mechanism correct work speeds for holes of different diameters are easily obtained, the changes being made much more quickly and easily than is possible with the cone pulleys ordinarily used. This encourages the operator to change the speed to suit the diameter of the work being ground, instead of (as is more often the case) using the same speed day after day on work of different kinds. It also permits him to instantly speed up the work during the finishing cut, to get the mirror-like finish possible with increased peripheral speed.

The cutter spindle is mounted on a cross slide for adjusting the wheel for the desired diameter. This cross slide, in turn, may be adjusted lengthwise of the table to bring the wheel in proper position for the length of work being ground. The cross slide carries a double idler pulley, of which the small diameter is driven from the counter-shaft, while the large diameter is belted to the driving pulley on the wheel spindle.

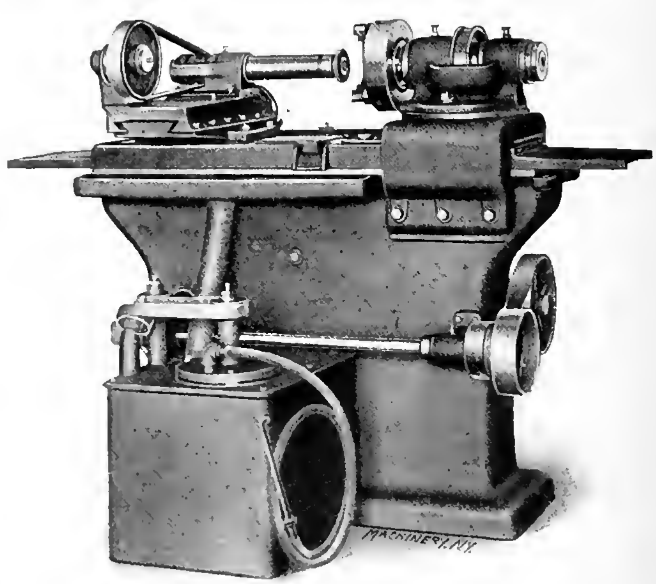


Fig. 2. Rear View of Machine showing Drive of Wheel Spindle and Provision for Wet Grinding.

The construction of the wheel spindle is shown in Fig. 4. The head *D* is held by a gibbed bearing to the cross slide. It supports the wheel spindle at three points—by two ball bearings on either side of spindle pulley *E*, and by a bronze bushing *F*, next to the wheel. This bronze bushing, which is tapered on its outside diameter, is adjusted in or out for wear by nut *G*; screws *H*, with tapered points, are used for expanding it to tightly fill the bore of the hole in which it is placed, thus giving a solid bearing without vibration, and fitting closely both the spindle and the head casting. The two ball bearings *J*, on either side of the driving pulley *E*, are suitably protected from dust and grit. The outer bearing is supported in such a way that an endless belt may be used,

connecting pulley E with the idler pulley. The stand on which the idler pulley is mounted is adjustable to maintain the tension on this belt.

Various sizes of heads D are provided for holes of different diameters. The regular line of heads is made in seven sizes, of which the smallest is suitable for a minimum hole of 7/8 inch diameter, while the minimum diameter for the largest size is 3 inches. These will grind holes varying in depth from

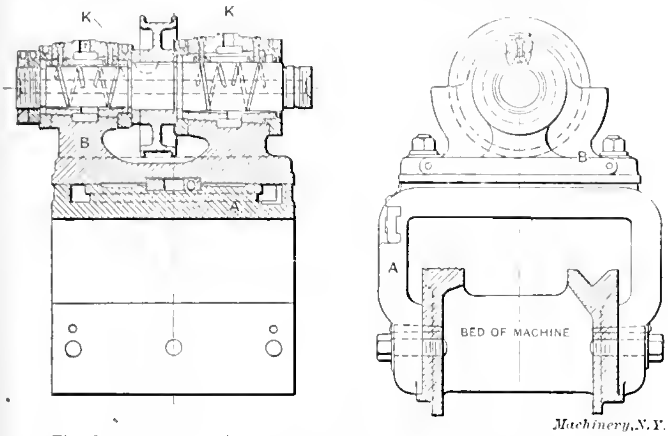


Fig. 3. Work Spindle Head and Method of Supporting it on Bed.

a maximum of 4 inches long for the smallest, up to 11 inches long for the largest. The heads are self-contained and interchangeable, so that different sizes can be instantly substituted when changing from the grinding of large holes to small holes or *vice versa.* In shops equipped with several machines, the same head may be used on different ones, so that the expense of purchasing extra spindles is avoided. The diameter of the driving pulley on the different wheel spindles of these heads is made proportional to the diameter of the grinding wheels used, so that the correct speed for any given wheel is obtained automatically, without requiring any attention on the part of the operator.

The cross feed of the wheel, as may be seen in Fig. 1, is arranged to be operated either by hand or automatically, at either one or both ends of the table travel. Provision is made also for automatically throwing out this feed when the work has been brought down to size. The rate of feed may be varied from 0.00025 inches to 0.003 inch at each reversal of the table.

On the front of the base is mounted the automatic reversing gear box, and at the left the three-speed quick change gear box for giving the table three different rates of travel for each work speed. The feed is driven from the same shaft on the overhead works which drives the work table, so that the feed and work speed are always proportional—the proper arrange-

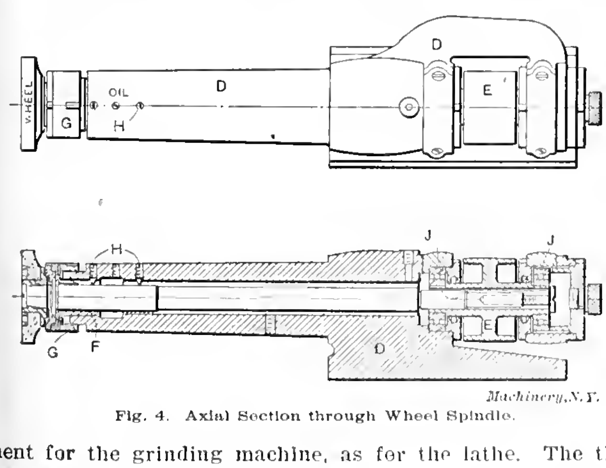


Fig. 4. Axial Section through Wheel Spindle.

ment for the grinding machine, as for the lathe. The three different feeds provided and the easy means of changing them, encourage the operator to use the fast travel for roughing out the stock, and the slower rates for truing and finishing the holes. They are controlled by the vertical handle at the left end of the gear box. All changes of feeds and speeds are made from the front of the machine without stopping either the table, work, or wheel.

The provision made for the use of the water in this machine is carefully worked out, the table being provided with water channels leading to a water pan on the back. This tank is made unusually large, with an ample settling chamber, so that only clear water passes to the pump chamber and back to the wheel again. The pump is of the centrifugal type, so constructed that all the bearings are above the water, no packing or attention being required.

The builders consider that they have obtained in this machine the following essentials for rapid and accurate work: First, a massive and rigid design which will resist vibration, and give the wheel the ability to cut freely and smoothly. Second, suitable range of speeds of rotation for the work, covering the different sizes of holes, and materials to be ground, with means for changing these speeds instantly and easily. Third, a suitable range of table feeds for each of the spindle speeds, covering the requirements for roughing and finishing in different materials; these feed changes are also easily obtained. The design of the machine is, it must be admitted, a very attractive one.

BROWN & SHARPE GEAR-CUTTER GRINDING MACHINE.

We have previously called attention in MACHINERY to the necessity for grinding the faces of gear-cutter teeth radially, if the correct form of the cutter is to be preserved. With the common "rough and ready" method of grinding, in which the cutter is laid on a rest in front of a dish wheel, and ground by hand on the faces of its teeth, these faces may or

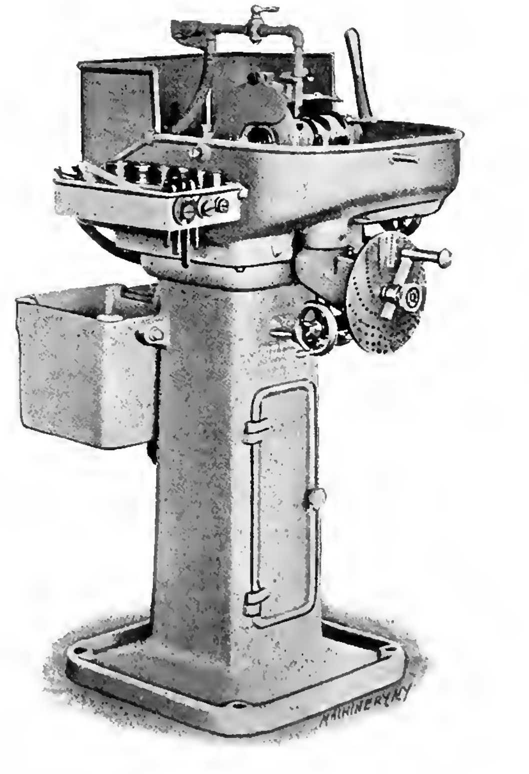


Fig. 1. Brown & Sharpe Wet Grinder for Formed Gear-cutters.

may not be radial. Usually they are far from it, and the tooth space produced is consequently too flaring if the cutter teeth are ground too far back at the tops, or the tooth spaces are as badly off in the other direction if the teeth of the cutter are "hooked." To provide means for grinding the cutter exactly radial, and doing it quickly, cheaply and conveniently, the Brown & Sharpe Mfg. Co., Providence, R. I., is building the grinding machine which we herewith describe and illustrate. As well as providing for grinding the cutter radially, it also spaces the grinding of the faces accurately, so that the teeth are always of the same height, thus allowing each one to do its share of the work, and permitting the maximum output from the cutter.

Fig. 1 shows the front view of the machine as a whole, and gives a very good idea of the design, which, it will be seen, gives great rigidity and freedom from vibration, in combination with a very moderate weight. Fig. 2 shows the right-hand side, and illustrates the compactness and convenient ar-

rangement of the operating mechanism. This mechanism is best understood by referring to the line drawings, Figs. 3, 4 and 5.

The cutter to be ground is dropped onto the hollow work spindle *A*, the open side clamping washer *B* being slipped from beneath the head of clamping bolt *C* for that purpose. A spring bearing against a shoulder in *A* keeps the clamping bolt forced upward, except when it is drawn down onto the

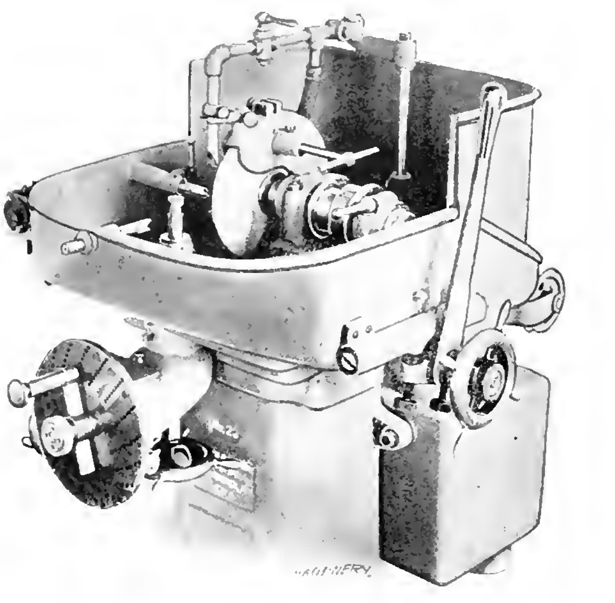


Fig. 2. Details of the Wheel Feed and Work-holding Arrangements.

work by revolving the work clamping hand-wheel *D*. Various bushings are provided for the work spindle, to suit various diameters of holes in the cutters; and various washers are provided to bring the center of the cutter in the horizontal plane of the axis of the wheel. The centering of the cutter is tested by the work centering gage *E*, which is pushed in until the V-groove in its end rests on the point of the cutter tooth. The centering need be only approximate.

Index crank-shaft *F* is connected with the work spindle by bevel gears, as shown, and carries an index crank and pin similar to that used on the index centers of the milling machines. The index crank can be moved from one row of holes to another in the usual fashion, being tightened by the clamp nut shown on the end of the crank-shaft. Index plate *G* is provided with 9 rows of holes, for obtaining any number of settings up to 18. It is keyed to the hub of a worm-wheel, and is operated by a worm connected with the work spindle adjusting wheel *H*. Wheel *H* is used to rotate the work into posi-

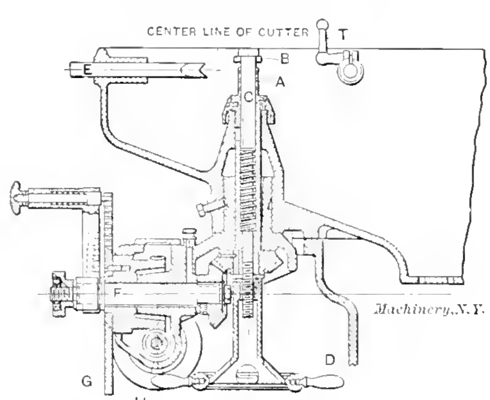


Fig. 3. The Work Spindle and its Clamping and Indexing Mechanism.

tion for the wheel to grind the faces of the teeth, and to feed the wheel for successively deeper cuts, as the teeth are ground. The feeding is not continuous, taking place only at the end of each complete revolution of the work.

The emery wheel, which is of the dished variety, is mounted, as may be seen in Fig. 4, on a spindle driven by a two-step cone pulley. The wheel spindle head-stock is adjustable in the direction of the center line of the spindle, as will be explained later, for centering the wheel so that it will grind the faces of the teeth radially. The base on which the headstock is mounted slides in and out, toward and away from the work, being actuated by a rack, and a segmental gear *M*, keyed to a rock-shaft on which is mounted hand lever *N*. This hand lever is not directly connected with the rock-shaft, but has clutch teeth formed on its hub, which engage similar teeth in the hub of the wheel slide adjusting hand-wheel *O*, which is keyed to the shaft. The clutch teeth are kept in contact by the spring shown. By pulling the hand-wheel out, turning it in relation to the lever, and re-engaging it, the lever may be brought into any desired relation with the position of the wheel slide, to make the operation of the machine convenient. As is best seen in Fig. 2, the hub of the hand lever is provided with lugs carrying adjustable stop-screws *P* (Fig. 4) which are set to limit the movement of the slide when in operation, so that the wheel grinds to the proper depth in the cutter, and is allowed to come far enough out of the cutter to permit it to be indexed for the next tooth. Spring plunger *Q* keeps the wheel slide normally in its backward position.

Provision is made for thoroughly flooding the work with water while it is being ground. A centrifugal pump of simple construction is provided with all its bearings above the water line. Convenient piping, settling tanks and reservoir are included with the machine, so that water is kept off the floor and from all those parts of the machine where it does not belong. The water is strained and returned to the reservoir ready to be used over again. A number of other conveniences are provided. In the side of the water pan is cast a boss with a clamp handle *T* for holding a diamond tool in truing the wheel. This diamond tool is adjusted to the proper position while the wheel is fed back and forth across it by lever *N*, as when grinding cutters.

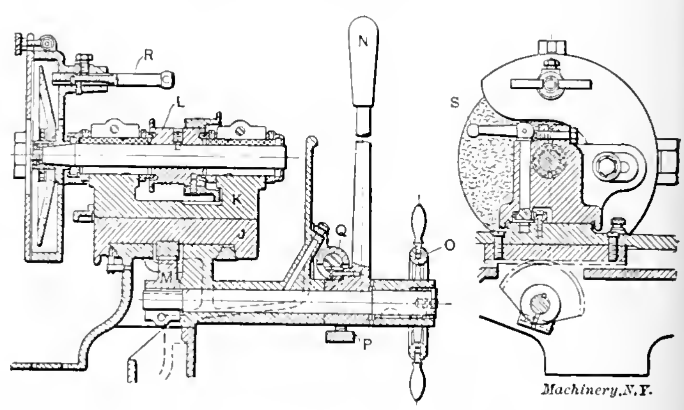


Fig. 4, Side View, and Fig. 5, Cross-section of Wheel Head-stock, Slide, etc., showing the Movements and Adjustments.

Two-step cone pulley *L* is only used for speeding up the wheel, when it is worn to so small a diameter that the peripheral speed is below the normal rate. When this takes place, the belt is shifted to the smaller pulley. To make sure that the belt will not be shifted before the wheel has been worn down sufficiently, the device shown at *R* is used. This consists of a stud with a cross handle, which prevents shifting the belt to the small step. It can be pushed in out of the way only when the wheel, as shown in Fig. 4, has been worn down small enough to allow it to clear. When it has been worn down this amount, the time has arrived for shifting the belt. This prevents the possibility of running the wheel at a dangerous rate. The wheel is provided with a guard, as shown, to prevent accidental breakage of the wheel or injury to the operator.

The centering of the wheel is simply effected by the method indicated in Fig. 6. The center gage is laid against the trued side of the wheel, and the slide is adjusted (by means of lever *S* in Fig. 5) in or out until the surface of the gage just touches the body diameter of the work clamp bolt. When the gage just touches this point as it rests on the face of the wheel, the wheel is exactly centered with the work spindle.

The stand is of box form, rigidly braced internally to resist vibration, and its interior is fitted up as a closet to hold small tools. A finished pad is provided at the back of the stand for attaching a motor when desired. The water pan is a separate casting securely bolted to this stand, amply large

enough to take care of all water used. The back is cut away and a removable sheet iron guard, heavily japanned, is provided to facilitate cleaning.

This machine will grind cutters up to 8 inches in diameter, 1½ inch pitch and 2¼ inches thick, using an 8-inch emery wheel with 1¼-inch hole. The work spindle and the bushings provided are arranged to fit holes ⅞, 1 1-16, 1¼, 1½, and 1¾ inch in diameter, respectively. The counter-shaft is provided

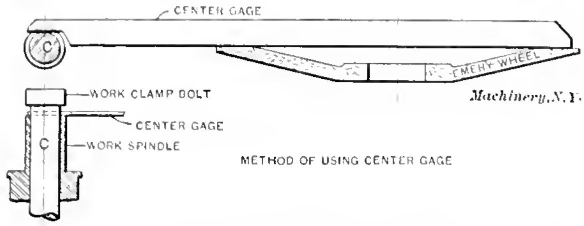


Fig. 6. Use of the Centering Gage in aligning Face of the Wheel with the Center Line of the Work.

with tight and loose pulleys 6 inches in diameter for 2-inch belt, and should run at 600 revolutions per minute. The net weight of the grinder is 760 pounds. It occupies a floor space 33 inches wide, parallel to the wheel spindle, and 39 inches long, perpendicular to the spindle.

REVOLVING OILSTONE SCRAPER SHARPENER.

The revolving oilstone grinding machine, made by Mummert, Wolf & Dixon, of Hanover, Pa., which we have previously described (see New Machinery and Tools in the June, 1907, issue of MACHINERY), has been adapted by the builders to the sharpening of scraping tools.

Figs. 1 and 2 show it so arranged. It is claimed by the builders that scrapers sharpened on this machine are much superior to those sharpened by the usual hand method on a bench oilstone. It is said that the scraper will not only be sharpened quicker and better, but in such a way that it will cut better and longer without resharpening, and in such a way as to enable an inexperienced man to get the greatest efficiency out of the tool.

In the first place, the device may be used for concaving the faces of the scraper in much the same way that a razor is concaved, to prevent the cutting edges from displaying their tendency to become so obtuse that the tool will not work unless held at a considerable angle with the surface being scraped. By concaving the scraper in the way shown in Fig. 3, a much freer cutting edge is obtained.

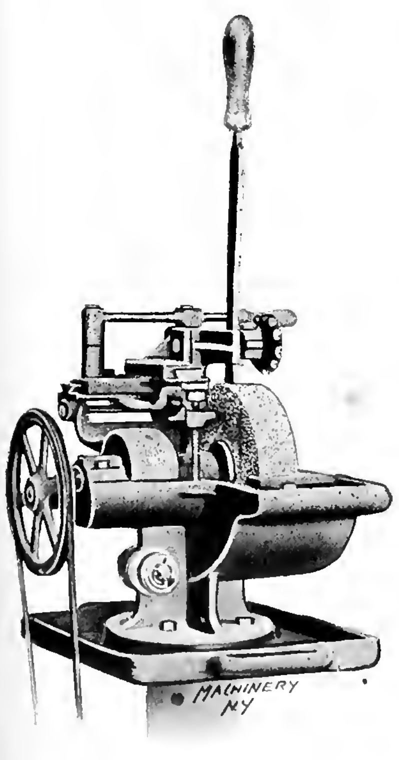


Fig. 1. Revolving Oilstone sharpening a Machine Scraper.

For grinding the edge, as shown in Fig. 1, the scraper is held in a vise supported by suitable slides. By the use of the hand lever, the scraper is moved back and forth as well as laterally across the face of the stone. By these two motions the tool is ground all over the cutting edge, and the stone is kept straight as well. For gripping the scraper quickly and accurately in the vise, a small reference surface is provided which is always in line with the face of the wheel, and parallel with the lines of the motion of the two slides. To use this, the scraper is first pushed over this reference surface; the scraper is set to it, and then gripped by turning the small hand-wheel shown, after which the vise is pushed laterally forward until the scraper comes over the stone. The feed is regulated by the adjusting screw shown at the front of the machine.

This revolving oilstone may be used for other purposes besides sharpening scrapers—such as touching up and putting a keen, smooth edge on thread cutting or other tools on which a fine edge is required. In doing work like this, the scraper holding attachment is thrown back out of the way, as shown in Fig. 2. The wheel is run in a bath of kerosene, which prevents heating the tool and keeps the surface of the wheel keen and sharp, without allowing it to glaze. In the design shown, the wheel is driven by a motor, connected by a belt with the driving pulley, which transmits the power to the wheel through two-to-one gearing. The motor, which is of ¼ horse-power capacity, is furnished for either direct or alternating current.

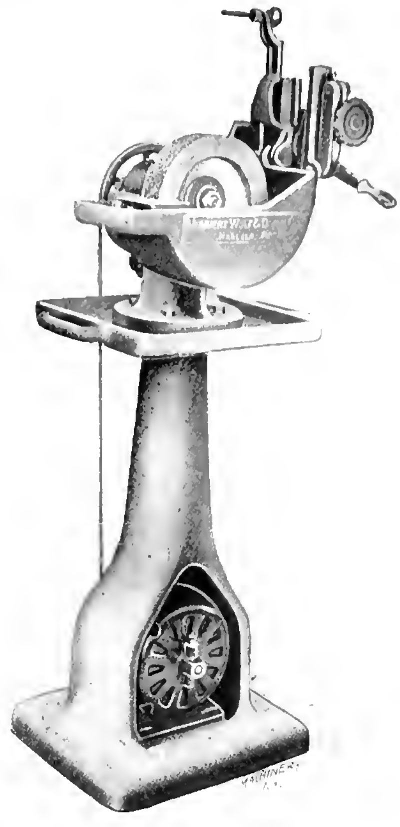


Fig. 2. Scraper Holding Device thrown Back, leaving Wheel Free for General Use.

When electrically driven, the tool is especially adapted to the work of grinding scrapers, as it is provided with two

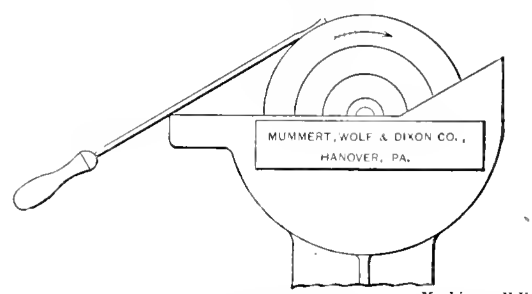


Fig. 3. Recommended Method of Concaving Scrapers to give Free Cutting Action.

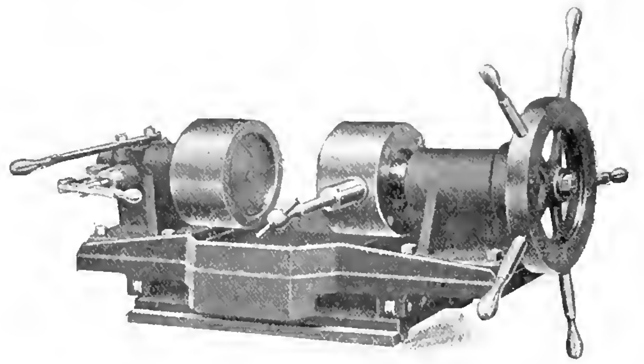
handles by which it may be easily carried by two persons and placed close to the work on which the scraping men are engaged. When desired, it will be furnished with a countershaft and belt drive, instead of a motor as shown.

MURCHEY REVOLVING CHUCK FOR DRILLING AND TAPPING.

The accompanying half-tone illustrates an improved revolving chuck, designed for holding steam, gas, or water fittings, and valves, and adapted for use on a vertical drill press or tapping machine. This chuck is made by the Murchey Machine & Tool Co., 1th and Porter Sts., Detroit, Mich. The following description will make clear the points of improvement claimed for this chuck over former designs:

The work is held between the two cylindrical clamping heads shown at the center of the machine, the final clamping action being accomplished by means of the pilot wheel to the right. When the work is removed, this pilot wheel is first given a slight turn, enough to release the pressure on the work and on the indexing pin attached to the lower lever shown at the left-hand end in the cut. The indexing pin, which serves the purpose of taking the end thrust as well as preventing the clamping heads from rotating while the work

is operated upon, is now withdrawn, and finally, the left-hand clamping head is moved back by the upper lever at the left end, which quickly opens the chuck and permits the work to be removed. This improvement considerably lessens the time required for removing and inserting work as compared with the old style chucks having right-hand and left-hand screws.



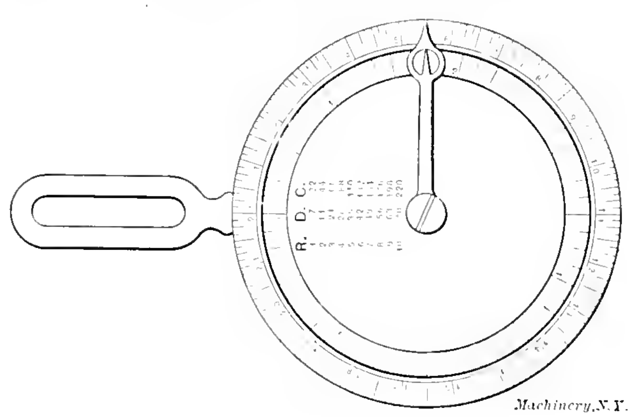
Murchey Revolving Chuck for Drilling and Tapping Valves, Pipe Fittings, etc.

The several faces of the fitting are drilled and tapped at one setting of the work, the indexing mechanism permitting the work to be turned to any required angle.

The rollers shown at both ends of the device under the bed plate of the chuck, between it and the base, are intended to permit the work to adjust itself easily to the position of the drill, and also permit the operator to pull the chuck easily from under the drill press spindle for removing the work.

JONES DIAL MEASURING WHEEL.

The illustration shows a dial measuring wheel designed for the use of boilermakers, blacksmiths, and plate metal workers. Diameters and circumferences are simultaneously obtained by setting the indicator at zero and running the wheel around the circumference of the piece to be measured. The pointer is made double, and indicates diameters on the inner



Jones Dial Measuring Wheel.

circle and circumferences on the outer one. The wheel is made of brass with raised and polished figures, letters, and graduations. The handle is mounted on the back, thus leaving the face of the wheel free of obstruction. The wheel is 7 inches diameter and 22 inches circumference (nearly). It is made and sold by J. M. Jones, 1560 Cambridge St., Cambridge, Mass.

STURTEVANT STEAM-TURBINE-DRIVEN FOUNDRY BLOWERS.

The Sturtevant steam turbine, which we illustrated and described in the New Machinery and Tools Department of the November, 1907, issue of MACHINERY, has been arranged by its builder, the B. F. Sturtevant Co., of Hyde Park, Mass., in combination with its line of foundry blowers, in a series of self-contained units. These turbine-blower units are especially suitable combinations for foundry use, since the driving of the foundry blowers by either steam engine or motor presents numerous difficulties of operation, all of which are overcome in the steam turbine.

With a blower driven by a reciprocating engine, the connection between the two must, of necessity, be by belt or some other speed increasing mechanism, since the high pressure required for foundry service demands a high rate of speed for the blower. Usually a counter-shaft is employed to give the necessary increase. Another difficulty is the chance of having the engine disabled by water coming over from the boiler in the long pipes which must be used. This danger may, of course, be minimized by the use of separators, but it is always in existence. There is, besides this, the liability to wear and break down, due to the somewhat complicated mechanism of the valve gear, piston, cross-head, etc.

The electric motor is generally used in preference to the engine, where there is a supply of electricity, the motor being usually connected with the blower by belting. Due to the

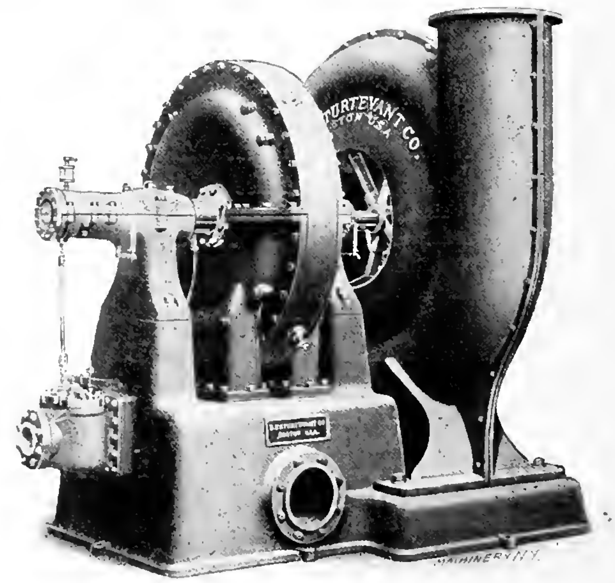


Fig. 1. Sturtevant Steam Turbine and Foundry Blower Set.

varying volume and pressure of air required, it is difficult to fit an electric motor for the conditions under which the blower will have to operate, since it is often impossible to determine these in the beginning. Besides this, the motor will deteriorate rapidly in the heat and dust of the foundry atmosphere, and usually has to be placed in a room of its own, or be removed to a considerable distance from the cupola.

In a steam turbine, such as is shown in Fig. 1, the difficulties of both the reciprocating engine and the motor are believed to have been obviated. It can be continuously operated, without attention, requiring only a weekly filling of the oil cups. The entire absence of mechanism makes the cost of

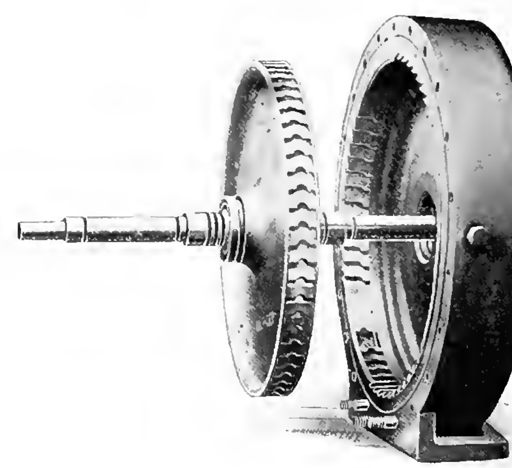


Fig. 2. The Runner of the Turbine withdrawn from the Casing to show the Solid Buckets.

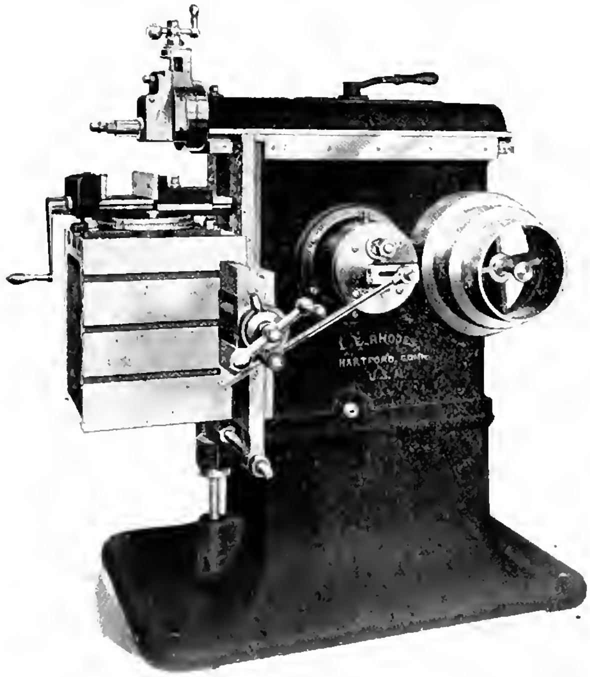
renewals and repairs so small as to scarcely have to be reckoned with. There are no valves to set or eccentrics to adjust. Although the reciprocating engine is as economical, the steam consumption is not the true measure of ultimate economy. When other items, such as repairs, deterioration, etc., are considered, the builders believe that the turbine will prove ultimately more economical than the reciprocating engine.

The wheel, removed from the casing, is shown in Fig. 2. The buckets are cut from the solid forging, not being separate pieces as in many turbines now on the market. A single solid wheel is used, in which the steam is used over again a number of times, so as to reduce the peripheral velocity of the wheel, and at the same time abstract all available energy from the steam before it escapes into the exhaust. For a more detailed description of the action of the steam in this turbine, see the article in MACHINERY previously referred to.

RHODES 12-INCH BACK-GEARED CRANK SHAPER.

The back-geared crank shaper shown herewith is built by L. E. Rhodes, of Hartford, Conn. Its special feature, aside from its small size and convenient arrangement, which fit it for tool-room work, is the fact that it is provided with back-gearing for varying the ratio of the connecting gearing between the cone pulleys and the crank. This is an unusual provision for so small a machine. Six changes of speed are furnished in all, with the three steps provided on the driving cone. The back-gear change is made by pushing the knob shown in the cone pulley either in or out, as may be required. This shifts a double driving pinion on the driving shaft, so that either its large or small diameter engages with gears on the intermediate shaft, by which it is connected to the crank gear.

The machine is provided with a suitable vise, as shown, having tool steel faced jaws 9 inches long and 2 inches deep, opening 6 inches. The finest table feed is 0.005 inch. The table is fastened to the cross rail by a wedge-shaped gib, thus insuring a bearing surface through its whole length.



A Small Back-geared Crank Shaper

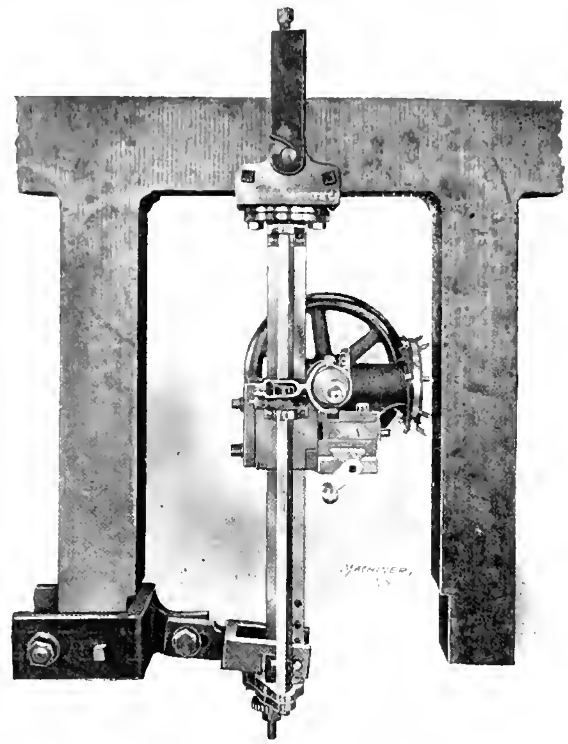
The stroke of the ram is 13 inches, the vertical adjustment of the table 12 inches, and the traverse of the table 18 inches. The working surface of the table is 11 x 13 inches. The machine is driven by a 2½-inch belt. The weight of the machine, complete, is 1,650 pounds.

UNDERWOOD PORTABLE FACING MACHINE FOR LOCOMOTIVE FRAME PEDESTALS.

H. B. Underwood & Co., 1024 Hamilton Street, Philadelphia, Pa., have recently added another tool to their list of portable devices for general railroad and machine shop use. This new tool, as may be seen in the accompanying half-tone, is designed for facing the inner surfaces of the pedestal legs on locomotive engine frames.

The milling head by which the facing is done is carried by a square bar, which is the main supporting member of the mechanism. This bar is provided at the top with a steel swivel connection to the clamping block by which it is fastened to the frame. This steel swivel allows the cutting tool to be swung around for cutting the other side of the opening, and also allows the square bar to be set at an angle for facing on a taper. The clamping block may be easily changed to enable it to enter narrow spaces. At the lower end of the square bar the universal adjustable clamp holds it securely to the frame.

The milling head is fed along the square bar by a bronze half nut, which may be engaged with, or disengaged from the feed-screw. This screw is revolved by a ratchet and dog at the lower end of the device, operated, through the squared shaft shown, by an eccentric on the milling head. The feed is thus automatic, and may be varied to suit the requirements. The milling spindle has adjustments in two directions—to and from the leg, and across the face. Fine or rapid adjustments may be made without difficulty, suitable cranks being provided for obtaining these movements.



A Portable Machine for Facing the Pedestal Jaws of Locomotive Frames.

The milling spindle is threaded to receive the milling cutters, which have blades of square high-speed steel, set in a solid head; they are removable for grinding or adjustment. The power is applied by a telescopic shaft with universal joints, operating through gearing on the spindle, and allowing the source of the power to be in any convenient, out of the way place, making belts, etc., unnecessary. The maker's two-cylinder air or steam motor is a very suitable prime mover for a portable tool of this kind.

In using this machine, a large quantity of metal can be removed in a given time, by taking a succession of light cuts and feeding very rapidly.

GOULD & EBERHARDT RACK-CUTTING MACHINE.

We illustrate in Figs. 1 and 2 a new design of rack-cutter built by Messrs. Gould & Eberhardt, of Newark, N. J. This machine has been improved in a number of particulars over the designs formerly built adapting it to faster and heavier cutting and greater accuracy. It is designed with a view of obtaining to the fullest extent the benefits to be derived from the use of high-speed steel cutters, and at the same time give a product of the highest degree of accuracy required in commercial work.

One important change has been made in the design of the bed of the machine. This was formerly of rectangular form, supported by box legs. The new construction is solid in one piece, resting directly on the floor, thus taking directly all

strains from the action of the cutters on the work. That part of the bed which supports the cutter slide column is also cast solid with the main bed casting, still further adding to the rigidity of the entire machine. Another improvement consists in arranging the thrust bearings of the feed-screw so

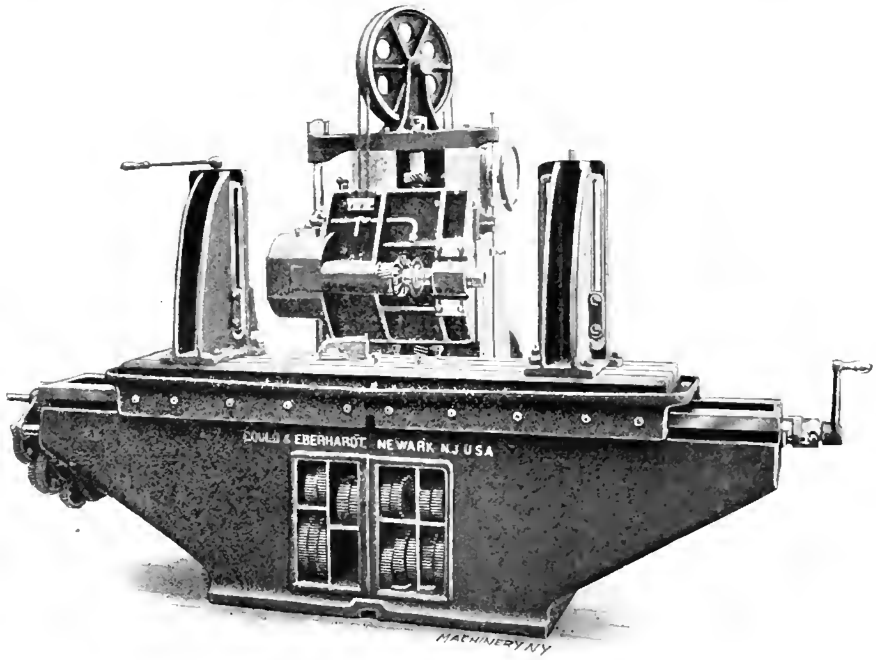


Fig. 1. A New Design of the Gould & Eberhardt Rack-cutting Machine.

that the cutter slide is pulled down, as it feeds through the work, on the draw-cut principle. This, in connection with the style of bed furnished, insures not only increased feeds, but greater accuracy as well.

The cutter slide is counterbalanced, and is so arranged that it cannot possibly feed downward unless the proper indexing for the work and all previous necessary movements have been completed. The cutter spindle is located approximately in the center of the slide, which has a large bearing surface, giving freedom from chatter under heavy work. The cutter spindle is driven by double spiral gears, one pair placed at the outboard end, and the other close up to the cutter, where the full driving effect can be obtained. One of these pairs is cut right- and the other left-hand, thus neutralizing by this herringbone gear effect the end thrust in the cutter spindle. The guard over the inner driving gear has been removed in Fig. 1 to show this drive.

The feeds for the cutter slide range in geometrical progression from ¾-inch to 14½-inch per minute, thus providing a range that will economically take care of all classes of work. The spindle drive, feed motion and the indexing are all derived from the single speed driving pulley at the rear. This makes the matter of changing to individual motor drive a very simple one. The feeds are obtained by quick change gear mechanism, shown next to the driving pulley in Fig. 2. The cutter speeds are varied by the change gears shown at the end of the rear extension of the bed. These cutter speeds vary from 12 to 76 revolutions per minute, in geometrical progression.

The work table is provided with chucks or vises for holding the work. These vises are so designed that they are fastened solidly, metal to metal, to the top of the table, thus avoiding the common fault of springing or warping the latter out of line. The table has a generous bearing surface, and is strongly gibbed to the ways on the main bed casting. The vertical position of the blanks and the vertical travel of the cutter slide, permit chips and oil to drop down out of the way of the cutters, leaving the work free. An opening in the bed of the machine is provided, through which the chips and lubricant are drained, being separated by suitable screens so that the oil is returned to the pump and the cutters, free from chips.

The indexing mechanism for the table is simple and absolutely positive in its action, reducing the chances of error to a minimum. One novel feature is the provision for the insertion of translating gears for changing the setting of the machine from diametral to circular pitch or *vice versa*, or to set it for cutting metric module or circular pitch—all with the same lead or dividing screw. An auxiliary end adjustment for the screw is provided which is useful in resetting work which has to be recut, or for taking a light cut on one side of the tooth. The table is geared to index in either direction, avoiding the necessity for returning the table every time a new blank is set. Adjustable stops are provided which can be set at any predetermined point, to automatically throw out the table indexing movement.

The machine shown, which has a capacity of work up to 6 feet long at one setting, was furnished to a large planer manufacturer for cutting the planer table racks. Duplicate machines from the same lot have been furnished to other manufacturers of machine tools, printing presses, etc. This tool will cut any width of face up to 10 inches, or a series of narrow-faced racks up to the same width. Any pitch as coarse as 1½ diametral in cast iron, or 2 diametral in steel may be cut, using from 1 to 12 cutters, depending on the pitch. It is possible to use a roughing and a finishing cutter at the same time on the largest pitch mentioned above. Gang cutters provided with this machine have their cutting points set spirally, so as to avoid chatter and the consequent rapid dulling of the cutting edges. A bed and table for work up to ten feet in length at a single setting will be furnished if the purchaser requires it.

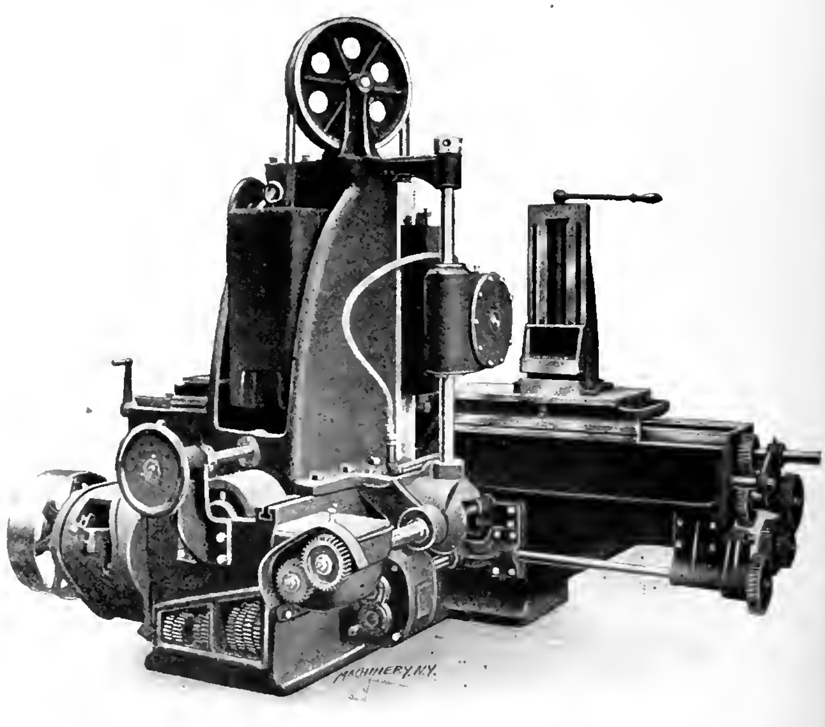


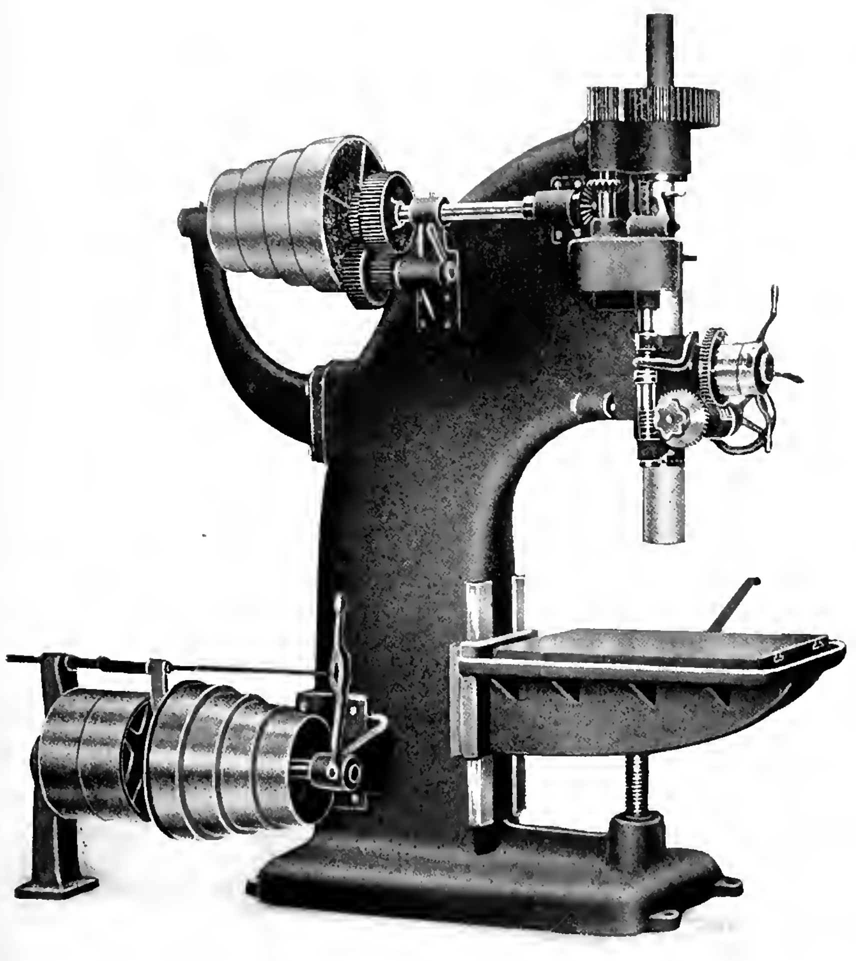
Fig. 2. Rear View of the Machine, showing Single-speed Drive, Quick-change Gear Feed, Indexing Mechanism, etc.

It will be seen that this machine in its structural features belongs with the other Gould & Eberhardt machine and the Reinecker machine, shown in Figs. 69 and 70 of the article on

gear-cutting machinery (on page 509 of the engineering edition of this issue) though it differs considerably in its mechanism from either of them.

FOOTE-BURT HIGH DUTY DRILL PRESS.

It used to be considered that, for drilling tools, all it was necessary to have was a revolving spindle, properly driven, and a table on which the work could be placed, having a surface approximately perpendicular to the axis of the spindle. Carefulness of workmanship, strength and rigidity of frame, and other such features as are looked out for in the design of lathes, planers, milling machines, etc., were once thought to be a waste of time and money when applied to drilling machines. Of recent years, however, this attitude has changed, since it has been found that drills, particularly of the modern high-speed type, can be worked harder, and will remove more material in a given space of time, when driven by a heavy, rigidly built machine, than when used in a tool of the older type; heavier feeds can be taken, and the cutting edge lasts longer. Recognizing this condition, the Foote-Burt Co., of Cleveland, Ohio, has brought out the drill press shown in the accompanying engraving.



A Drill Press for Heavy Duty with High-speed Drill

The spindle is of forged carbon steel, $3\frac{1}{2}$ inches in diameter in the sleeve, with a No. 6 Morse taper hole. The thrust of the cut is taken by a bearing of $\frac{3}{4}$-inch balls which is made in the shops of the builder, and is guaranteed to stand up under the hardest service continuously, without breaking the balls or crushing the collars. The spindle is driven from a four-step cone, through bevel and spur gears and a set of back gears, which, in combination with the cone pulleys, give eight changes of speed to the spindle.

Three changes of gear feed are provided, any one of which is instantly available by simply shifting a lever conveniently located at the front of the machine. The power feed, hand worm-feed, automatic stop and quick return levers are all within easy reach of the operator at all times.

The maximum distance from the end of the spindle to the body of the table is 32 inches, the distance from the center of the spindle to the face of the column is 22 or 30 inches (as may be ordered), and the spindle has 16 inches of power feed. The revolutions per minute vary from 23 to 170. Either a plain or a compound table movement may be furnished. The 44-inch swing size weighs 6,000 pounds, and the 60-inch swing 6,800 pounds. The machine is powerful enough to drive a $3\frac{1}{2}$-inch high speed drill up to its full capacity.

HILBERT TRIPLE-GEARED UPRIGHT DRILLING MACHINE.

As may be seen from the accompanying engravings, the designer of this drill press (which is built by the Hilbert Machine Co., Cincinnati, Ohio) has broken entirely away from the traditions of the standard drill press builder. Everything, from the shape of the frame to the method of driving, has been worked out on original lines. The designer's reasons for these changes will appear in the following description.

The frame consists of a round column of generous dimensions, provided with a large bottom flange, bolted to a heavily ribbed T-slotted base. This column is supported by a second column or back brace, which connects the base and the top housing, making these four members solid.

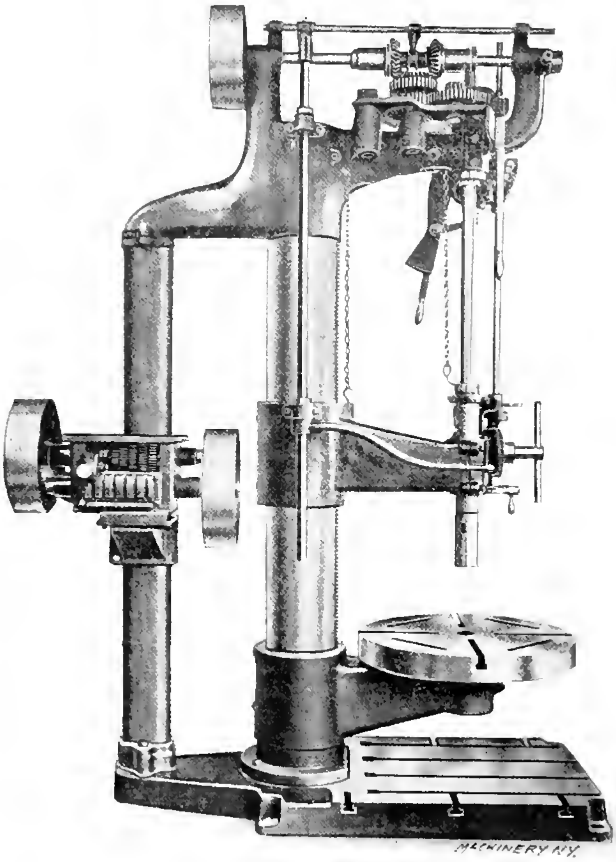
The work table is fixed in height, avoiding the raising and lowering mechanism usually provided. Instead of this, the arm carrying the lower spindle bearing is adjusted up and down on the column. This has a long bearing, and surrounds the column, sliding down on the latter to the top of the table arm, when the nose of the spindle will nearly touch the base. These two arms for supporting the table and the spindle are of box shape, and of nearly the same pattern. Each is clamped securely to the column by means of two strong screws, insuring the rigidity of the structure of which they are a part. This arrangement is believed by the builders to be superior to the usual method of fastening the lower spindle bearing to the frame work by screws and flat bearings, so far as concerns the matter of obtaining the necessary rigidity for heavy duty work.

The machine is connected to the countershaft by a belt to the single speed pulley, shown attached to the speed variator on the rear column. This single pulley allows the machine to be set in any direction under the line shafting, either at right angles with it or parallel to it. The speed variator is of the most simple type, and is operated with one lever only, giving six speeds arranged in geometrical progression. From here, the power is carried by belt to the shaft on top of the machine. This belt serves as a safety device in the otherwise positive power transmission system, preventing the breakage of the drilling or boring tools. The six speeds given by the variator are multiplied by three, by the operation of the handle shown in front, depending from the upper spindle bearing. This lever is conveniently located for the operator, and its position can be changed instantly.

The spindle is driven by either one of two gears, a large one with a coarse pitch for the slowest speeds and a small one with finer pitch for the higher speeds. None of these gears run idle. When the back gear is thrown in, the gears of the medium and high speeds are thrown out, and *vice versa*. Having this change of speed directly on the spindle, allows all the shafts of the machine to rotate slowly when the spindle speed is high, as contrasted with the great rate of rotation necessary for the horizontal shaft in the usual type of upright drill, with its bevel gear drive ratio of one to two or one to three. In such cases the shafts have to rotate two or three times faster than the spindle.

Another feature of this machine is the design and location

of the tapping mechanism provided. Instead of being applied directly to the spindle drive, as usual, where the torque is at the highest point, it is located on the high speed driving shaft. It consists of two miter gears, provided with friction clutches which are adjustable for wear. The clutches are so designed that they tighten in proportion to the load placed on them. Either of these friction clutches may be connected



An Upright Drill of Original Design, made by the Hilbert Machine Co.

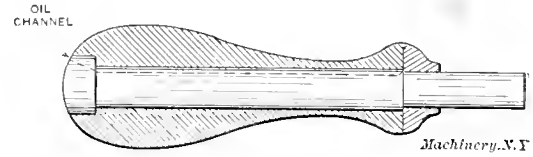
with its miter gear by means of the horizontal handle shown, pivoted to the lower spindle bearing head, and operating the vertical squared shaft, which transmits the movement to the clutch. This lever is directly in front of the operator, and is used by him for stopping, starting and reversing the machine, as well as for tapping. Owing to the use of the friction clutch, the reversing of the spindle may be done at any speed. These clutches have proved to be reliable in actual use, having been in operation for over six years without requiring any adjustment for wear.

The power feed is the positive gear type, having four changes. It is very powerful and constructed in a mechanical manner. It is quickly and easily changed by the handle shown in the engraving, hanging from the upper bearing of the spindle on the further side of the machine. Hand feed and quick return movements are provided for the spindle, as well as an automatic trip, adjustable to work at any point throughout the travel of the spindle.

The machine shown is the standard type furnished by the builders, and is of 36-inch capacity. As shown, it is regularly provided with the tapping attachment. It is built in a workmanlike manner; all the important gears are of steel and all the important bearings are of phosphor-bronze.

CINCINNATI QUICK-ACTION BALL CRANK.

The Cincinnati Ball Crank Co., of Cincinnati, O., has been for some years manufacturing solid crank handles for machine tool builders, for general use on cranks, hand-wheels, etc. It has recently added to this line of solid handles, a "quick action" design of the type shown in the accompanying line engraving. As may be seen, it consists of a central pin which is riveted or otherwise fastened to the crank or balance wheel, and carries a washer, and a loose handle or spool, which is grasped by the hand of the operator. Since this handle revolves freely, the workman is able to use it much more quickly and easily than would be the case if it were solid. It will be found especially adapted to heavy tools, being useful, for instance, for such applications as to the carriage movement of a large lathe. The rotation of the



Machine Crank or Wheel Handle with Revolving Grip.

handle makes it possible to operate such machines with the ease and rapidity of tools of much smaller size. As is shown, an oil channel is provided, by means of which the handle can be lubricated.

CYLINDER GRINDING ATTACHMENT FOR THOMPSON GRINDING MACHINE.

The accompanying Figs. 1 and 2 show a method of holding automobile cylinders and similar work for internal grinding operations, which is much superior to any possible method of clamping it to a face-plate or holding it in a chuck. Fig. 1 shows the device mounted on the table of a grinding machine built by the maker of the attachment, the Thompson Grinder Co., of Springfield, O. Fig. 2 shows the device in action, with the work in place.

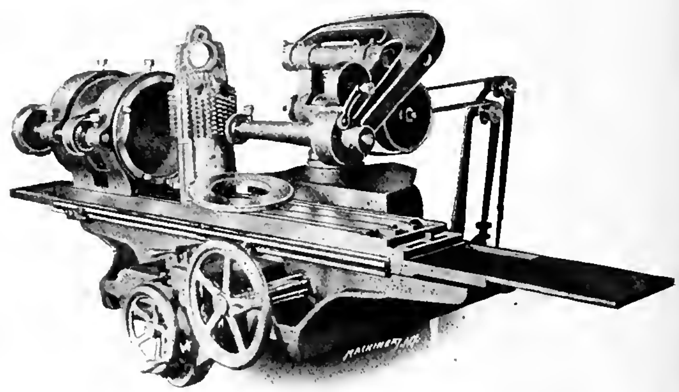


Fig. 1. Hollow Spindle Head-stock for Grinding Automobile Cylinders in Thompson Grinding Machine.

As will be seen in the engravings, the front end of the work is held in a face-plate, bored to the same size as the recess of the crank-case, thereby holding it without any possible chance of springing it in clamping. This face-plate, in turn, is bolted to the face of the hollow spindle, which runs in generous bearings, with suitable provision for adjust-

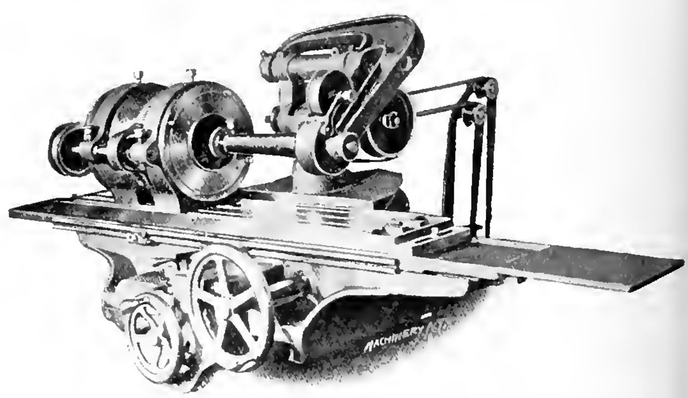


Fig. 2. Cylinders in Place in Hollow Spindle Attachment and Grinding in Progress.

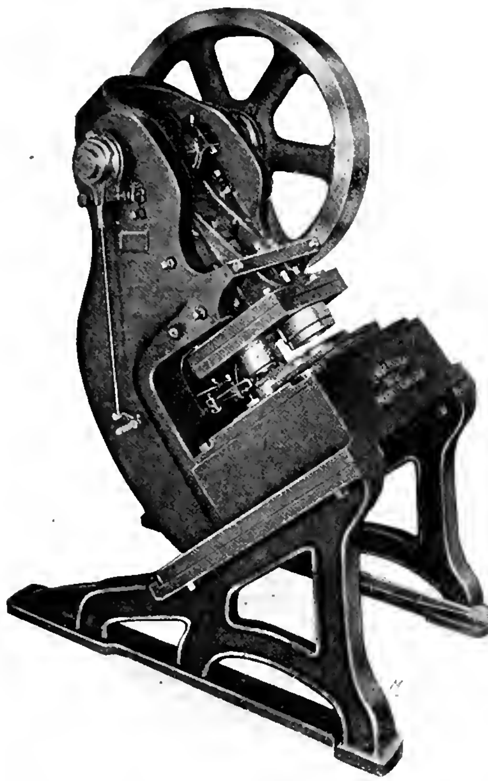
ment for wear. It is driven by gearing from a fast-running shaft. The diameter of the hole in the hollow spindle is 10 inches. At the rear end of the attachment, appropriate means are provided for supporting the closed end of the work.

The cylinder shown on the table of Fig. 1 is of the air-cooled type, and is $5\frac{1}{2}$ inches bore by 11 inches deep. In this machine the internal grinding spindle is of tool steel, hardened and ground, and running in adjustable bearings, by which all lost motion is taken up, except that necessary

for the lubricating oil. It is driven by an endless cotton belt, held at the proper tension by the idler seen in the engraving, thereby securing long life to the belt and bearings. As the machine is regularly provided with pumps, pipes, etc., for wet grinding, provision has also been made for using water with this attachment when desired.

INCLINED BLISS PRESS WITH DOUBLE DIE ATTACHMENT.

The press shown in the accompanying engraving is built by the E. W. Bliss Company, 5 Adams Street, Brooklyn. It is fitted with tools for blanking, drawing and wiring shallow cups or similar shaped work. Double dies are used. The first one is a regular combination die, which cuts, draws and forms the blank. The press being in an inclined position, the work thus blanked slides by gravity down the chute, where it is caught and supported by a finger gage, which holds it in position beneath the second member of the die, which wires the edges on the next downward stroke of the ram. On this same stroke, of course, another blank is being cut and formed



Bliss Press arranged for Performing Two Successive Operations at Each Stroke.

in the first die. On the return of the ram to its upper position, the wired blank is released by the finger feed, and drops into a receptacle placed to receive it, after which the finger quickly returns to center the next blank, which has meantime dropped down from the first die. The feed is operated by the cam shown at the end of the crank-shaft. The ram has a stroke of two inches, and is operated by a crank-shaft made from hammered, high carbon steel. It is fitted with a cross-bar knock-out. The press, arranged as shown, weighs 5,350 pounds.

WILMARTH & MORMAN SURFACE GRINDER.

The builders of the tool shown in Figs. 1 to 4 call their machine a "surface grinder," but that title scarcely gives a proper idea of the range of operations which may be performed on the machine. If desired by the purchaser, it may be furnished for surface grinding pure and simple, but provision is made for using a cutter and reamer grinding attachment, or a drill grinding attachment when desired, so that, when completely fitted out, the machine will cover practically the whole range of tool-room work so far as concerns the sharpening of drills, cutters, reamers, dies, etc. The surface grinding table may be arranged to be operated entirely by hand, or may be supplied with automatic feed as desired. If supplied with automatic feed, this may be for the longitudinal movement only, or both longitudinal and cross movements may be automatic.

The spindle is of crucible steel, ground and lapped to size, and supported close up to the wheel, so as to do away with vibration due to springing and overhang. The spindle cone pulley is carefully turned both inside and out to secure per-

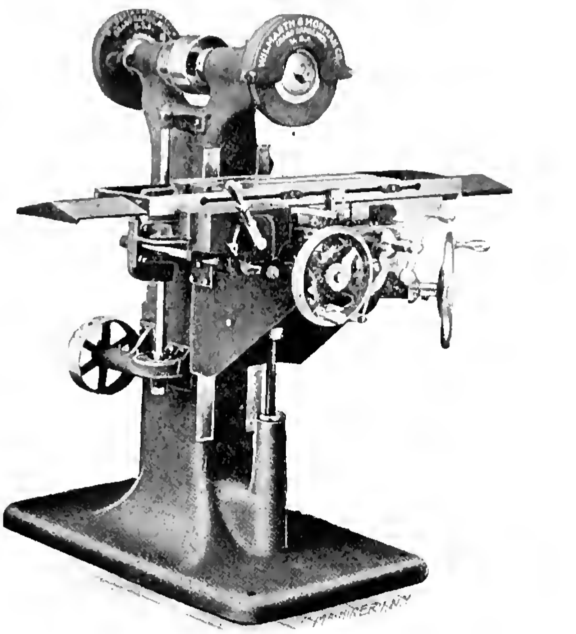


Fig. 1. Front View of the Wilmarth & Morman No. 2 Surface Grinder.

fect balance. The bearings are of phosphor bronze, with liberal dimensions, being 8 inches and 5 inches, respectively, in length, and tapering from 2 inches to 1½ inch in diameter. The bearings in each box may be adjusted independently. The matter of lubrication has been carefully looked out for. The oil chambers are very large, and supply the bearings with oil through felt wicks, by capillary attraction. Surplus oil that may be run out to the front of the bearings is returned to the oil chambers by small channels. The bearings are carefully protected from dust and grit.

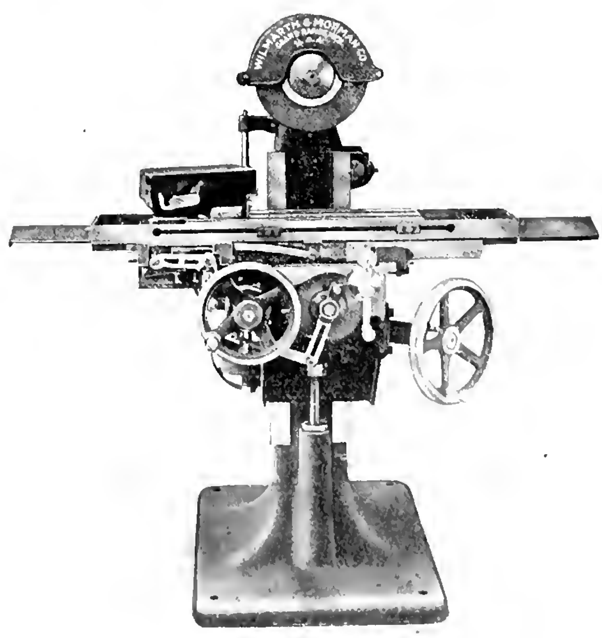


Fig. 2. Surface Grinder with Automatic Feed Box removed to show Mechanism.

The table of this machine is 8 inches wide and 50 inches long, and has a working surface of 8 inches by 20 inches. This 20 inches of length is carried by 36 inches length of saddle, so that the work is always well supported. A gib is attached to the rear of the table which effectually prevents any tipping, even when an excessive load is placed on the overhang end of the table at the extreme limit of its travel

The machine is designed for a 10-inch diameter wheel for ordinary surfacing work, and with a wheel of this size, has a capacity for work up to 11½ inches high. The spindle driving cone has two steps, giving the proper speeds for both 7-inch and 10-inch wheels. The 7-inch wheel is used for cutter and reamer grinding, and may be used for surfacing as well, where circumstances make its use advisable.

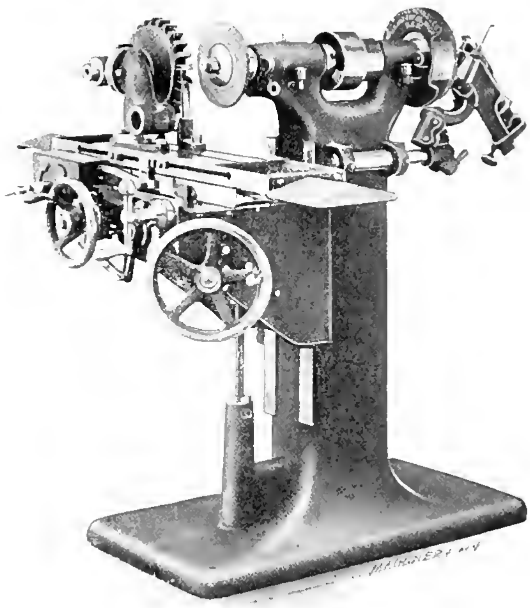


Fig. 3. Cutter Grinding Attachment in Use on Table of Surface Grinder. Note Drill Grinding Attachment on Rear of Column.

Where the machine is furnished for plain hand feed, the longitudinal movement is effected by means of the hand-wheel at the left of the front of the knee, and operates through a plain rack and pinion movement. The cross movement is by ball crank and screw, and may be read on a dial to a thousandth of an inch. The vertical adjustment is effected by a vertical screw running on a ball thrust bearing and working in a bronze nut. This adjustment may be easily read to half a thousandth of an inch.

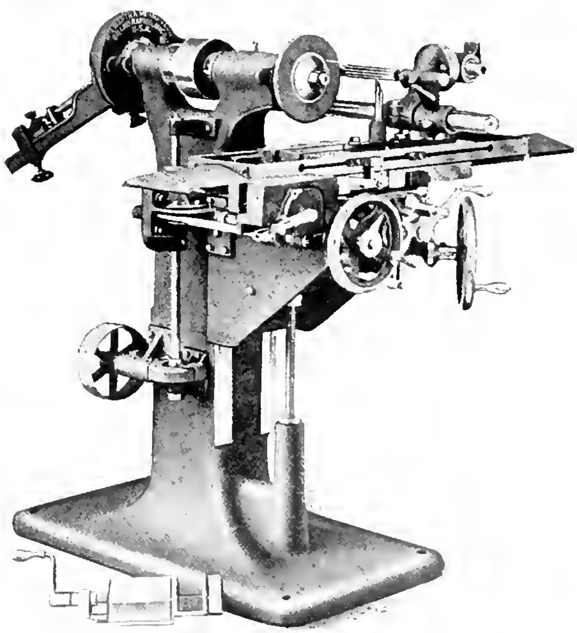


Fig. 4. Centers for Reamer Grinding in Use on Table of Surface Grinder.

When automatic feeds are used, as in the machine shown, the reversing mechanism is contained in a casing on the front left end of the saddle, shown removed in Fig. 2. The reversing lever may be placed in the center so as to hold the clutches in neutral position when desired, thus leaving the machine free for plain hand feeding. When the transverse feed is used, it is arranged to be applied or released by a friction clutch, operated by the knurled knob in the center of the table traverse hand-wheel. This feed may be arranged to act in either direction at the will of the operator, and may be varied in amount to suit the work in hand. All gears are carefully guarded, to protect them from dust, and from injuring the operator. The ways of the various slides are also protected from grit.

The cutter grinding attachment shown in use in Fig. 3, is universal in its application, and has a capacity for handling all kinds of milling cutters, including face and side mills up to 30 inches in diameter. It can be mounted on the table of the surface grinder by simply clamping it in place with two bolts, and can be manipulated as conveniently and quickly as regular cutter grinders made especially for the purpose. In Fig. 4 this cutter grinding attachment is shown in use in conjunction with centers, mounted on a bar and supporting a taper reamer for grinding. The adjustments of the attachment permit the grinding of reamers at any angle. Counterbores, end mills, etc., may be sharpened in the same way.

The "New Yankee" drill grinder shown attached to the rear of the column is a well-known tool. Its use on the same base does not interfere in any way with the use of the surface grinder, as one operator may be using the front side of the machine while another comes up and sharpens his drills, without either being in the slightest degree in the other's way.

NEW TYPES OF DRILLS AND CHUCKS MADE BY WHITMAN & BARNES.

The Whitman & Barnes Mfg. Co., of Akron, Ohio, and Chicago, Ill., has developed a line of drills to cover the requirements of the heaviest service that is asked of these tools in metal working. The first design, shown with the chuck for holding it, is illustrated in Fig. 1. As may be seen, this drill, known as the "Economy," is a modified flat drill. It is so made as to be capable of standing extremely heavy feeds in the very hardest and toughest materials, such as high carbon steels, hard cast iron, armor plate, steel rails, and steel castings. It is not especially adapted to work where unusual accuracy of diameter is required, nor should it be used for very deep drilling, it being best adapted for holes from 1 to 3 inches deep. The drills are made of the very best grade of high speed steel, are ground to size, and are tempered so that practically the whole length can be used. The chuck for holding them, as may be seen in Fig. 1, is so arranged that only as much of the drill as is necessary needs to project beyond the chuck. The back end of the drill fits a plug held in place by a cross bar secured by a retaining sleeve. In the body of the chuck are bored a series of holes in which the cross bar fits. By releasing the cross bar, the plug and drill may be moved out the required distance, the adjustment being fixed by slipping the retaining sleeve over the cross bar again. The use of this chuck reduces the torsional strain on the drill very

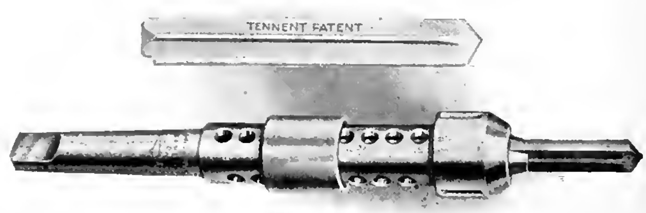


Fig. 1. The "Economy" Flat Drill and the Chuck for Holding it.

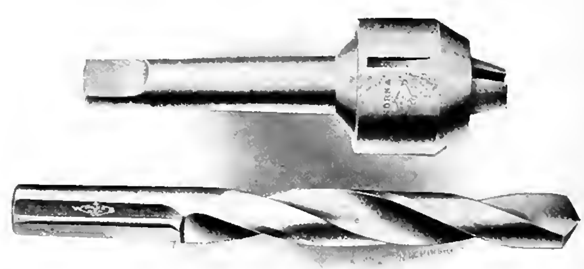


Fig. 2. The "Norka" High Speed Twist Drill and Chuck.

greatly, and increases its efficiency, so it may be run at a higher rate of speed without injury or breakage.

The "Norka" high speed twist drill and the chuck used for holding it are shown in Fig. 2. These drills are made from high speed steel, twisted while hot, so that the grain of the steel is not disturbed at all. This gives them great strength, ability to stand hard and rough service, and adaptability to all kinds of drilling in any class of material in which drilling is possible. They are ground to size, and proper clearance is formed on the flutes. In making the drill, the end of the blank is left flat and straight. This forms the shank, which fits into the chuck, so that there is no possibility of the tangs twisting off, or of the drills turning in the socket. This flat end of the drill is beaded to fit grooves in the jaws of the chuck, so that the drill is held firmly and centered. In the chuck used, the drill is centered by a steel plug, and is securely locked in the jaws with the clamping nut shown. The chuck may be used with taper shank drills by removing the jaws and steel plug, when the drill will fit into the chuck as in an ordinary sleeve or socket.

FRICTION-DRIVEN SENSITIVE DRILL PRESS OF NOVEL DESIGN.

The Washburn Shops of the Polytechnic Institute of Worcester are well known as being the only school or college shops actively engaged in the building of machine tools for the trade. Their drill grinders have been well known for many years. They have recently added to their line a new product, which we illustrate herewith; it is a friction-driven sensitive drill press, presenting novelties of design and construction which make it of unusual interest to the mechanic and designer.

As may be seen in Fig. 1, which shows the single spindle type, the tool has the convenient arrangement in which the head is vertically adjustable through a considerable range, and in which a circular table, vertically adjustable, is provided in addition to the usual swinging rectangular table. This combination is most useful, in that it makes provision for doing all sorts and conditions of work.

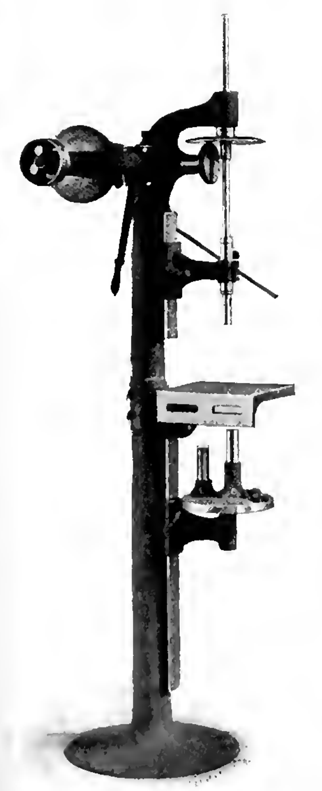


Fig. 1. Friction-driven Sensitive Drill Press, built by the Washburn Shops of the Worcester Polytechnic Institute.

In addition to the adjustments mentioned, the rectangular work table may be swiveled about a horizontal axis to present the work at any desired angle with the drill spindle. It is provided also with a short vertical face, with cored slots, by means of which the work may be clamped to it when it is more convenient to present it to the drill in this way. The round, vertically adjustable table may be removed, and either a V-center or a cone center used in its place. These are convenient for drilling cross holes in round work, or for center drilling round shafts.

The chief novelty of the arrangement, however, lies in the design of the friction drive provided. As may be seen, the machine is driven by a horizontal shaft at the back, carrying a friction disk which bears on the periphery of a fiber roll on a second horizontal shaft at right angles to it. The front end of this shaft carries a second similar fiber roll, bearing on the face of the disk on the vertical spindle of the machine. By means of the handle shown in Fig. 1 at the side of the column, this shaft and its two rolls can be moved toward the rear or toward the front, thus changing their positions on the faces of the disks, and decreasing or increasing the spindle speed in a total ratio of about 4 to 1, for an end-wise movement of only about 2 inches.

The most original feature of this arrangement is the provision made for supplying just enough pressure to the friction drive to transmit the required amount of power. As is best

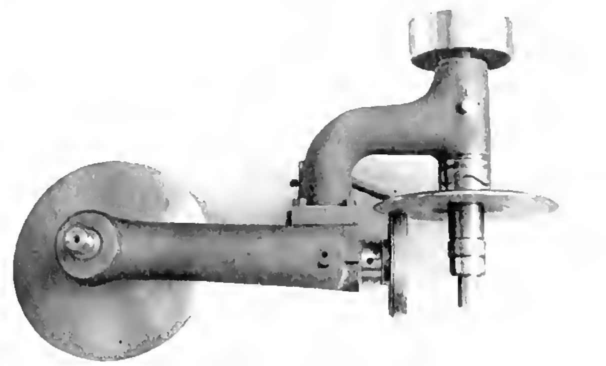


Fig. 2. Top View of Machine, showing Friction Drive.

seen by comparing Fig. 1 and Fig. 2, both of the friction disks are loose on their shafts, being driven from them by cam faces on their hubs, corresponding with and bearing on cam faces on collars fast to the shafts. When no resistance is offered by the drill, very little power is required to rotate the spindle. Under these circumstances the disks are only lightly in contact with the rollers. As soon, however, as the drill reaches the work, the contact between the friction disks and their rolls is not enough to drive the spindle. Under these circumstances the friction disks slip on the shafts, but this slippage involves the climbing of the cam surfaces of the disks and their collars on each other in such a way as to force the friction parts into closer contact. Every bit of slip, therefore, involves an increased pressure on the friction rolls, so that this pressure is always great enough to drive the spindle, but is never any more than is needed.

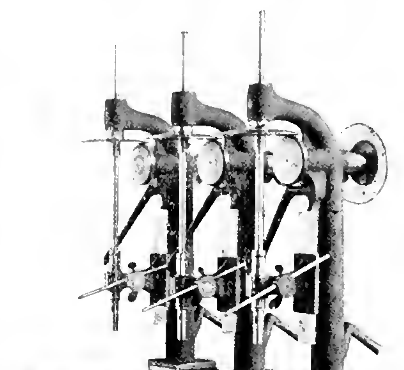


Fig. 3. Multiple Spindle Form of the Machine, with the Columns Adjustable for Center Distance.

This arrangement makes unnecessary the use of cones and quarter-turn belts, and permits an instantaneous change of speed. The thrust of the friction members is taken up by ball bearings, and the journals of the two horizontal shafts are ring-oiled from ample oil reservoirs. No counter-shaft is required. To stop the spindle, the speed lever is thrown to its extreme position. While in this position, the driven roll is out of contact with the driving disk, which is recessed for this purpose to clear the roll.

The elimination of this counter-shaft is especially advantageous in the multiple spindle type of machine, shown in Fig. 3. Note the ease with which the variations of spindle speeds may be obtained without the trouble of shifting belts. This design also presents a much neater appearance than is possible in designs which depend on a quarter-turn belt to transmit the power. Each head of the multiple spindle type is a unit in itself, and the heads may be slipped along the bed to any position required, to drill to within a minimum center distance, between adjacent drills, of 10 inches. Any head may be taken from the base, or extra heads may be

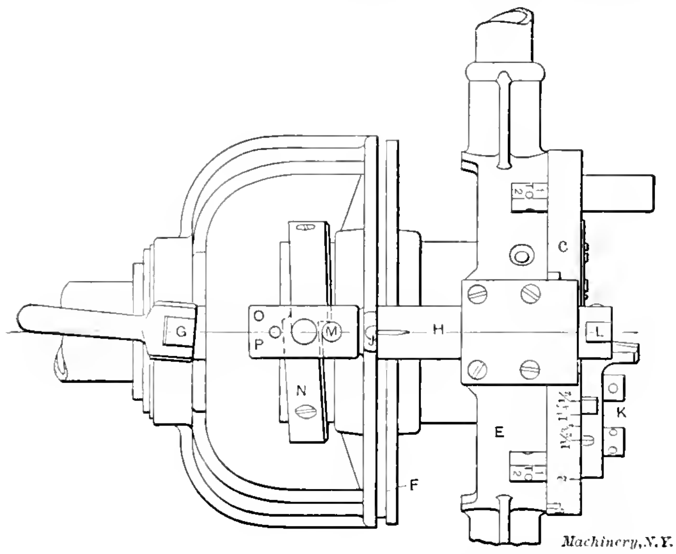
added, as the work requires. The head is fastened to the base by a T-bolt set at an angle, and is brought down and forward into position by the lever and nut shown at the rear of the machine.

The spindles of these machines have a feed of 3 inches, and a vertical adjustment of 7½ inches. The diameter of the spindle in the sleeve is ⅞ inch. The single spindle machine weighs about 250 pounds, the two-spindle 450 pounds, and the three-spindle, 650.

This machine is not an experiment, having been thoroughly tested for several months by everyday use in the Washburn Shops. It is designed for sensitive drill work, and will handle both carbon and high speed steel drills up to 9/16 inch in diameter, at their proper speeds and feeds.

HART'S "BUCKEYE" DIE-STOCK.

The accompanying line-cut, Fig. 1, and the half-tones, Figs. 2 and 3, illustrate an interesting die-stock for threading pipe, manufactured by the Hart Manufacturing Co., 10 Wood St., Cleveland, Ohio. The principal feature of this die stock is that the chasers which cut the tapered thread, and which are inserted into the die body, are not as wide as the length of the thread, but the mechanism permits the chasers to recede from the work as the thread progresses along the pipe, so that a full length thread is cut on the pipe by this means. This construction permits the use of chasers with comparatively nar-



which have been cut, and the die can be removed directly by pulling it outward without turning it backward over the threads. The dies can be instantly reset to the proper position for cutting the thread on another pipe of the same size by simply turning the cam plate back to the original position, no clamping of any kind being necessary.

A third feature wherein this die differs from the ordinary die-stocks for pipe threading is in the adjustment of the dies.

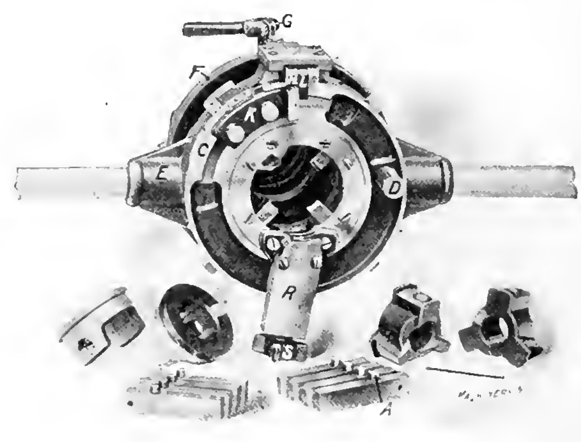


Fig. 2. Front View of the Buckeye Die-stock, showing Cam Plate, Adjusting Dog and Stop, and Cut-off Attachment.

A wide range of sizes may be cut with the same chasers by simply loosening a screw and setting a stop to the required graduation, the chasers thereby being pulled out or pushed in, by means of cam grooves, to the position required for cutting the corresponding sizes of pipe.

Instead of the leader screw ordinarily used in dies of this type, a so-called leader ring has been adopted, which, as will be presently explained, feeds the die inward over the pipe for the first revolution of the die-stock, thus causing the chasers to start the thread without any hand pressure or extra exertion. The same leader ring is employed for different pitches. Theoretically, of course, it might be claimed that the rise of the cam surface of the leader ring, which causes the feeding-in motion of the die, should be exactly the same as the pitch of the thread, so that a different leader ring would be required for each different number of threads per inch, but as this leader ring simply serves the purpose of starting the thread, the slight difference in rise between the cam surface on the leader ring and the pitch of the thread is of no practical consequence.

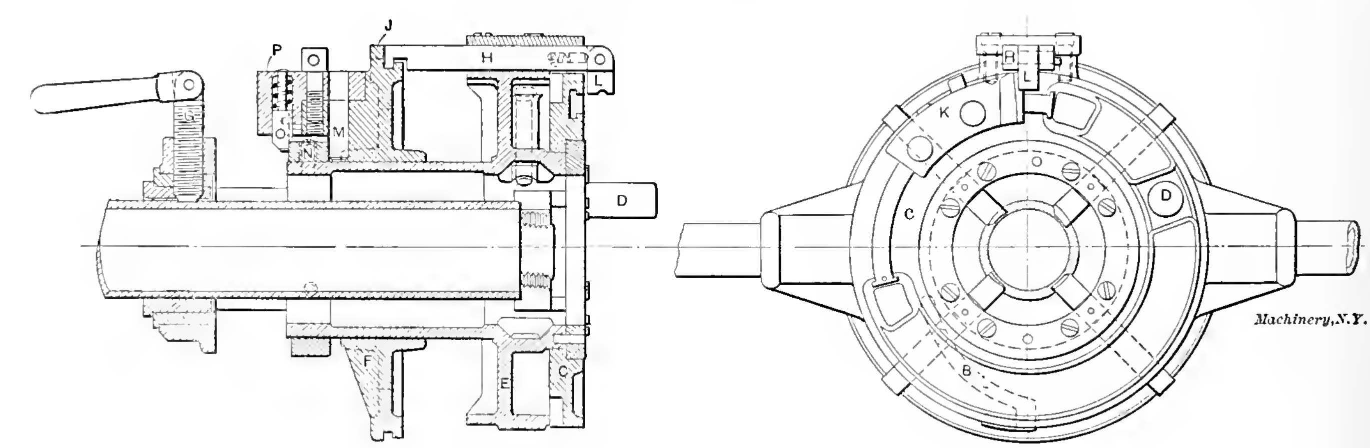


Fig. 1. Plan, Section and End View of Hart's Buckeye Pipe Die-stock.

row faces, and this, in turn, reduces the amount of power necessary for turning the die-stock, which is explained mostly by the reduction of friction between the chasers and the metal being cut, which is considerably less than the friction in the case of dies which have chasers of usual length of face, equal to the length of the taper thread required.

Another of the principal features of the die is that as soon as the full length of the tapered thread has been cut on the pipe, the chasers release automatically, and as soon as a slight turn by hand of the cam which controls the radial position of the chasers has been made, the chasers will clear the threads

A description of the design of the die will show how these various features are accomplished by the mechanism employed. In Fig. 2 is shown a full set of chasers. On the top surface of these chasers a small pin *A* will be noticed. The pin works in an eccentric groove *B* shown in the end view in Fig. 1, this groove being cut in the cam plate *C*. Thus, when this cam plate is turned, the cutting edges of the chasers evidently approach toward, or recede from, the center of the die. A handle *D* is provided for this cam plate, by means of which it can be turned by hand. It will also be seen from Fig. 1 that the die consists, in general, of a revolving part or body *E*, in

which the chasers are inserted, and a stationary part F, called the frame. The actual design of this frame is most clearly shown in Fig. 3. When wanting to thread the pipe, the body E is first placed in the correct position in relation to the frame F, by turning it so that the bar H comes exactly opposite to the indicating boss J on the frame. The body E is also pulled forward out of the frame F as far as possible. The dog K is now placed, and tightened to the cam plate C,

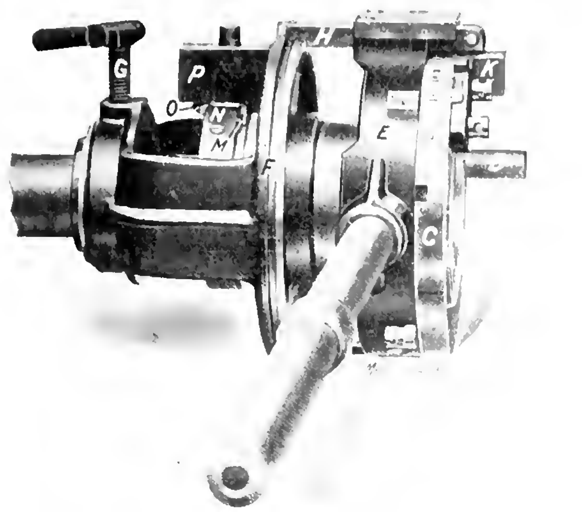


Fig. 3. Side View of Pipe Die-stock, showing Frame, Leader Ring and Graduations on Side of Cam Plate.

in such a position that the indicating mark on the dog coincides with that graduation on the cam plate which corresponds to the size of the pipe to be threaded. This is most clearly shown in Fig. 3. After having clamped the dog K as mentioned, the cam plate C is turned by means of handle D until the face of the dog K touches the side of the stop L. The chasers are now in the proper position to start cutting the size of pipe for which the dog K has been set. The die is placed on the pipe, the bar H being over the center of the pipe, and the pipe is permitted to enter into the die as far as possible, after which the binding screw G is clamped, thereby holding the frame F of the die firmly to the pipe.

The die body E, with the chasers, is now turned, as in ordinary threading. During the first turn the pin M, which is stationary, feeds the body E inward by acting against the cam surface of the leader ring N, which is held to body E by three set-screws. As soon as the die has been turned once, the chasers themselves have gripped the pipe enough to feed the die forward. As this forward motion proceeds, the body E progresses closer toward the frame F, and the bar H, which is held at one end in a groove in the frame F, is pushed forward out through the body E, the distance between the stop L and the face of the cam C, of course, then becoming greater. The face of the stop L and also of the dog K, where they bear against each other, is formed according to such a curve that the plate C will move slightly in a clock-wise direction as the stop moves outward, and by this motion the chasers are withdrawn the proper amount from the center of the die to form the correct taper of the thread. The pressure of the threading operation on the chasers is utilized for effecting the turning of the cam plate, so that the dog K always bears against the stop L. As soon as the thread is fully completed, the stop L slides completely by the dog K, thereby leaving it free to move any amount in a direction toward the right. The cam plate is then turned by the handle D a sufficient amount to the right to release the chasers completely from the thread, and the die is removed from the work by simply pulling it outward, there being no need of turning the die backward. In fact, it should not be attempted to turn the tool backward over the threads, as that might result in injury to the threads.

It will be noticed that a plunger O is located against one side of the leader ring N. This plunger simply serves the purpose of locating the leader ring N against the pin M, at the beginning of the cut. When the body E has almost completed one revolution, the plunger O mounts on an incline, on the rear edge of the leader ring N, and disengages this edge, thereby permitting the body E, with the leader ring, to progress independently of the frame F which holds the bracket in which the pins O and M are mounted. It will also be noted by examining the plan view of the die in Fig. 1 that, at the beginning of the cut, when the pin M is placed in relation to the leader ring N as shown, it is possible to turn the body E only in the right direction for the thread to be cut, the pin M bearing against a shoulder on the leader ring in the other direction, thus preventing turning the die-stock the wrong way.

When left-hand threads are cut, the plunger block P may simply be removed and the operation of threading proceeds in the same way as when cutting right-hand threads, excepting that hand pressure is required to force the chasers to grip the pipe. A left-hand leader ring N, however, is supplied with these dies if required.

Straight threads may be cut by not clamping the binding screw G, thus permitting the frame F to revolve freely on the pipe, together with the body E.

The die-stock is also equipped with a cutting-off attachment, as shown at R, Fig. 2. The cutting-off tool in this attachment is fed inward by the knob S, while the die-stock is turned around in the same way as when cutting threads. Back rests shaped in the same way as the chasers, but having blank end surfaces, support the die on the pipe during the cutting-off operation.

THE POTTER & JOHNSTON LONG TRAVEL CHUCKING MACHINE.

The use of cams in one form or another has been found to be the most practical method of controlling the movements of automatic turret machines of all kinds. There is no limit to the complexity of motion it is possible to obtain from them. The working parts may be advanced, stopped, withdrawn, and advanced again at any rate of speed and for any length of travel desired. Effecting these same movements by the use of the rack and pinion, or a screw and nut, operated by gearing and controlled by clutches, would be a matter requiring mechanism so complicated as to be impracticable.

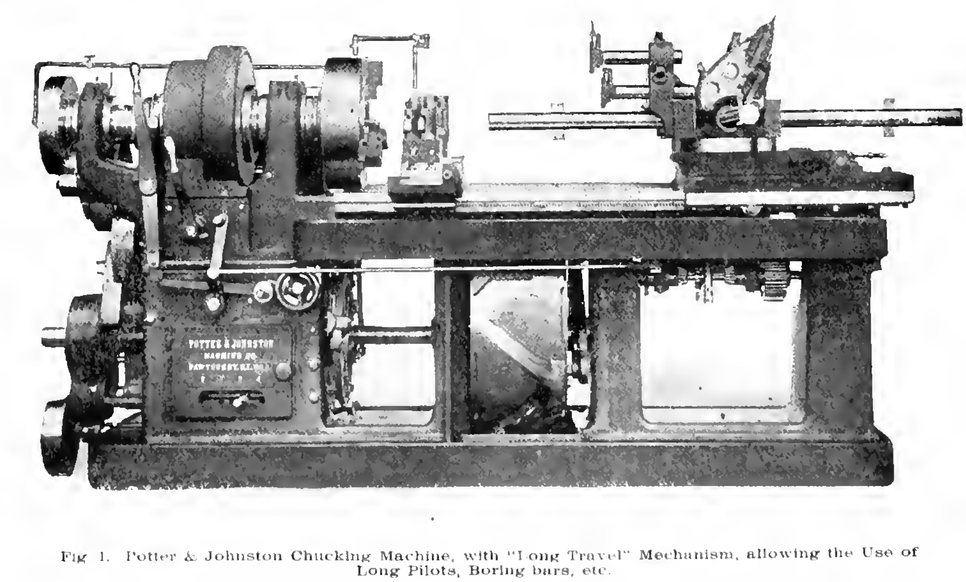


Fig. 1. Potter & Johnston Chucking Machine, with "Long Travel" Mechanism, allowing the Use of Long Pilots, Boring bars, etc.

There is one difficulty, however, with the use of cams for large machines, which is well shown in the case of the automatic chucking machine built by Potter & Johnston, Pawtucket, R. I. This difficulty is the great size of the cam required for movements on large machines. As may be seen by referring to Fig. 1 in the article describing

the operation of this machine (a few pages back in this same issue of MACHINERY), the turret cam drum is made of as large diameter as is possible, filling practically the whole space available between the turret slide and the floor. For the range of work for which the machine is intended, this gives sufficiently easy rises for the cam, and operates the mechanism very satisfactorily.

When it comes, however, to controlling the movements for operations requiring very long travel, the diameter of the

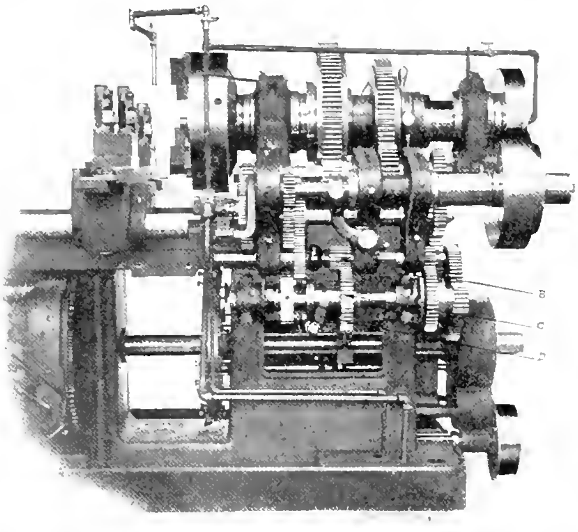


Fig. 2. Geared Connections for Effecting all the Idle Movements at Constant Speed.

drum would have to be so greatly increased to allow the use of the same easy rises for the cams, that it would be entirely impossible to incorporate it in the machine. This difficulty is especially met with in providing for the necessary movements for handling tools carrying pilot bars, which bear in a bushing in the nose of the spindle and are used to steady the tools under the pressure of the cut. These long bars require that the turret slide be moved back a long distance to enable them to clear the work for indexing. They then have to be brought up for a considerable distance again before the tools are ready to cut. This long travel it is impossible to effect by cams, as we have shown. The difficulty has, however, been overcome in another way by the builders, and they have succeeded in building a combination of rack and pinion, and cam operated mechanism which gives the flexibility of the cam mechanism, and the long travel of the rack and pinion device, without requiring the cam drum to be increased in diameter, or involving the complexity usually attendant on the use of the rack and pinion. The machine, as a whole, will not be described, the readers being referred to the article previously mentioned for a more complete treatment; only the difference between the "long travel" and the standard types of machine will be touched on.

The turret slide is under the influence of the cams for the feeding movements, and for returning the turret slide again to the point where the feeding movement commences. When it has been returned to this point, however, a clutch is automatically thrown in which starts the rotation of a pinion geared with the rack connected with the turret slide, so that the latter is rapidly drawn backward as far as may be required for clearing the work with pilot bars, such as those shown in place in Figs. 1 and 3. Here the turret slide stops, the indexing mechanism is thrown into action and the turret is revolved. When this has been accomplished the pinion is again rotated, but in the opposite direction, and by its action on the rack the turret slide is moved forward until the cam roll is again in position to be acted on by the cams for feeding.

This is repeated for each operation of the turret, the front portion of the travel of the slide being taken care of by cams, while the backward end of the movement is effected by the rack and pinion controlled by clutches and reversing movements. These two mechanisms are made so dependent on each other that they work together automatically without requiring any attention or adjustment on the part of the operator at any time, their relations being permanently fixed in the design of the machine. The long travel mechanism may, however, be thrown out of use by shifting to the proper position, a lever shown at the back of the machine in Fig. 3. The long travel mechanism is operated by the same shaft that controls the indexing. There is no limit to the length of bed which may be used with this device. It may be extended as far as necessary to clear the longest tools that the machine may ever be called on to use.

Another important change has been made in the design of this machine, as compared with the previous standard type of automatic chucking machine. In this machine the fast movement of the cam shaft has been arranged (as may be seen in Fig. 2, which shows the rear view of the tool with the guards removed) to be driven by the constant speed pulley, while the slow or fast feed movement is connected directly with the spindle, as before, so that the feed in turns per minute remains constant for a given combination of gearing, whatever the spindle speed. But by this arrangement the fast movements take place always at the highest practicable speed, whatever the spindle speeds may be. The same is true, of course, of the indexing and long travel movements, which are also connected with the constant speed pulley.

In Fig. 2, *B* is a loose double gear connected to the driving pulley, and running at constant speed, driving the gear *C*. When clutch *D* is thrown in by the action of the star-wheel which controls the feed mechanism, a fixed constant speed is transmitted to the drum operating gearing, which is thus moved rapidly, running ahead of the slow feeding motion.

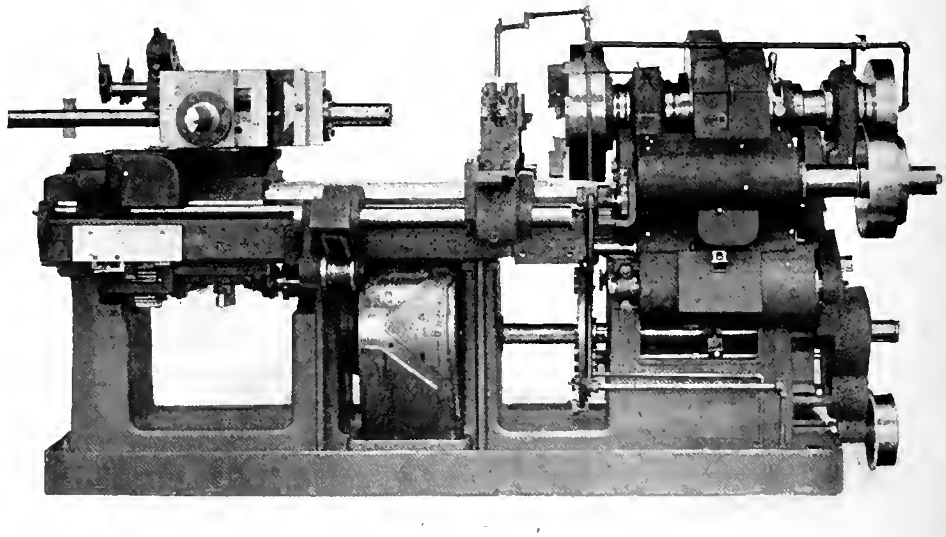


Fig. 3. Rear View of the "Long Travel" Automatic Chucking Machine.

This slow feeding motion again becomes operative as soon as clutch *D* is thrown out. As in the older style of machine, the feeding movement is driven by a belt running from the pulley at the rear end of the spindle to the feed pulley at the base of the machine.

A number of improvements have been made in the general design as well. The ways and slides have been made very wide and substantial throughout, and the turret and its supporting base have been enlarged. While the same principle has been maintained in the turret revolving mechanism of this machine, as in the standard design, a change has been made in the method of operation. When this slide reaches its extreme backward position, it stops for a few seconds while the turret revolves, so that all of the distance possible between the chuck and the end of the bar is gained.

None of the slide movements take place while the rotating is in action. The arrangement is such that with even heavy tools like those shown in Figs. 1 and 3 working on large diameters, the turret revolves very gently and comes to its position without any shock or jar.

The tool equipments shown in Figs. 1 and 3 are interesting, and may be studied in connection with the article on the setting up and operation of the machine. In Fig. 1, long boring bars with pilots entering the supporting bushing in the chuck, are used in combination with standard turning tools, bolted to the faces of the turret. In Fig. 3 one of the faces is provided with this combination of boring-bar and standard facing tool. The other two faces have boring-bars mounted on supplementary cross slides bolted to the table and actuated by the main cross slide. These are used for recessing, etc.

The advantages of this long travel mechanism will be easily understood. Without complicating at all the setting up of the machine (which is in itself a simple matter), it permits the use of tools provided with long pilot bars which, by the support they give to the cutting tools, allow heavier chips to be taken and produce work of very much greater accuracy. It will thus be seen that the arrangement is an important improvement of an already useful machine.

HAHN FLEXIBLE SHAFT.

The flexible shaft shown herewith is made by William Hahn, 220 Washington St., Chicago, Ill. In the sample illustrated, the shaft is covered with a thick braided cover and provided with end couplings of the kind generally used for dental work. It is made in larger sizes, however, for operating grinding

Hahn Flexible Shaft made of Coiled Piano Wire.

wheels, portable drills and other such tools where flexibility of drive is an important factor in the usefulness of the device. This shaft is built up of multiple coiled springs, both right-hand and left-hand, so that it may be run in either direction. These coils are formed of piano wire, and the device is thus as strong and durable as it is possible to make it.

ATTACHMENTS TO THE HAMILTON LATHES FOR TAPER TURNING AND RELIEVING.

Two new attachments of unusual interest have been recently designed by the Hamilton Machine Tool Co., of Hamilton, O., for its line of Hamilton lathes. The first one, shown in Fig. 1, is a taper turning attachment. This attachment is fastened to the carriage, and is always in position to use, the design being such that it can be added to a lathe which has been properly drilled and tapped to receive it, whenever the owner desires to purchase the device. As may be seen, the carriage has fastened to it a bracket, provided with a slide, which is connected by a rod with a clamping bracket, which latter may be fastened to the bed at any desired point. This slide carries a swiveling guide bar, which is adjusted to the degree of taper wanted by the adjusting screw shown, suitable graduations being furnished to facilitate the setting. This swivel slide bar carries, on dove-tailed ways, a sliding shoe, which is pivoted to a connecting bar, in which is journaled the rear end of the cross feed screw. The attachment is never disengaged. To change from straight

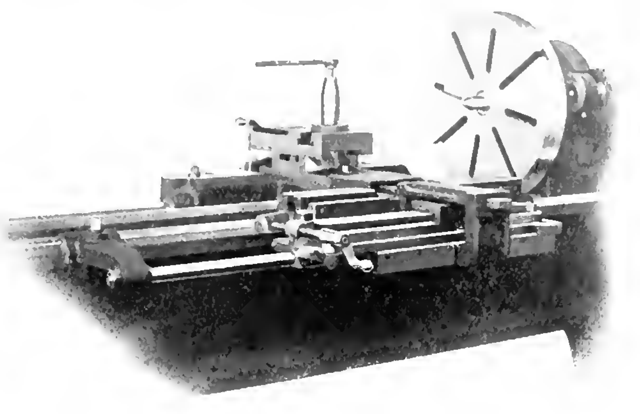


Fig. 1. Taper Attachment for Hamilton Lathes.

to taper work it is only necessary to tighten the bolt in the clamping bracket and set the guide bar to the desired taper, as shown by the graduated scale. To disconnect the taper attachment, the bolt in the clamping bracket is loosened. The tool-post wrench fits all the bolts used for adjusting the taper attachment.

The relieving attachment shown in Fig. 2 is used for backing off the teeth of milling cutters, taps, hobs, and similar tools. It is remarkably flexible in its applications, it being possible to use the attachments with the screw-cutting mechanism and the taper attachment, the relieving action taking place at any angle. This last feature, which is patented, is accomplished by having the reciprocating action necessary for the backing off, act through the center of the compound rest, so that it is effective at any angle through a full circle, not being limited by universal joints, etc., which are effective only through a limited angle. This makes the device universal in relieving formed end mills, counter-bores, etc., where the tool has to work at right angles to the cross slide movement.

The construction is quite simple, the cam being mounted on the carriage or compound rest, while the driving gearing,

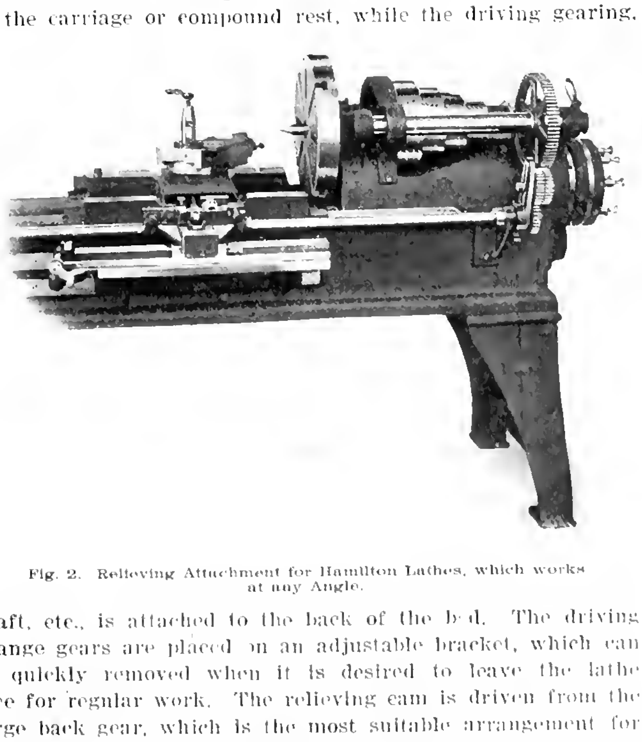


Fig. 2. Relieving Attachment for Hamilton Lathes, which works at any Angle.

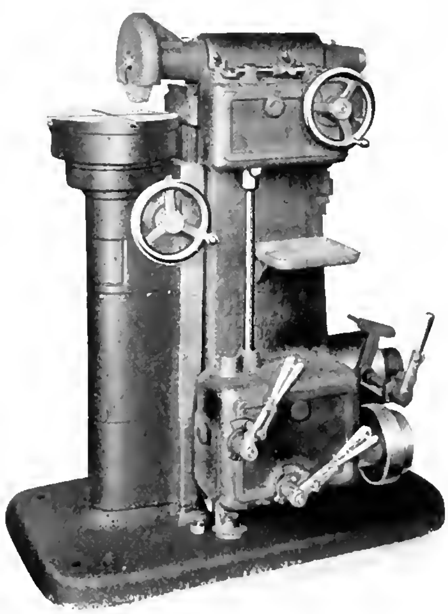
shaft, etc., is attached to the back of the bed. The driving change gears are placed on an adjustable bracket, which can be quickly removed when it is desired to leave the lathe free for regular work. The relieving cam is driven from the large back gear, which is the most suitable arrangement for such work, as it is thus possible to speed the relieving cam up at the proper rate in relation to the work, without strain-

ing any part of the mechanism. The back gears are, of course, naturally used in giving the slow movement required for relieving operations.

This attachment is furnished by the builders only for their 16-inch lathe, this being the size best adapted to general tool-room use. Change gears are provided for relieving cutters having from 2 to 24 teeth. Cams are regularly furnished, giving clearance of 1/32, 1/16 and 3/32 inch, respectively. Two styles of the device are furnished, in one of which provision is made only for the usual relieving movement at right angles to the axis of the lathe. The universal relieving attachment is the same as the plain, with the addition of the necessary parts to provide for relieving at any angle at which the compound rest may be set. These attachments must be ordered at the same time as the lathe they are used on, as a special carriage and tool rest has to be used.

IMPROVED SAXON RING GRINDER.

The accompanying half-tone illustrates a new ring grinder, which has been brought out by the Saxon Machine Co., Holyoke, Mass. The design of this grinder is very simple, and it



Improved Ring Grinding Machine made by the Saxon Machine Co.

can be operated easily by inexperienced help. Care has been taken to place all handles and dogs for adjusting the grinder, on the side nearest to the operator. The machine is driven directly from the main line, a special counter-shaft not being necessary. An important feature in the machine is its weight and stiffness, special attention having been paid to the matter of rigidity, when designing this machine.

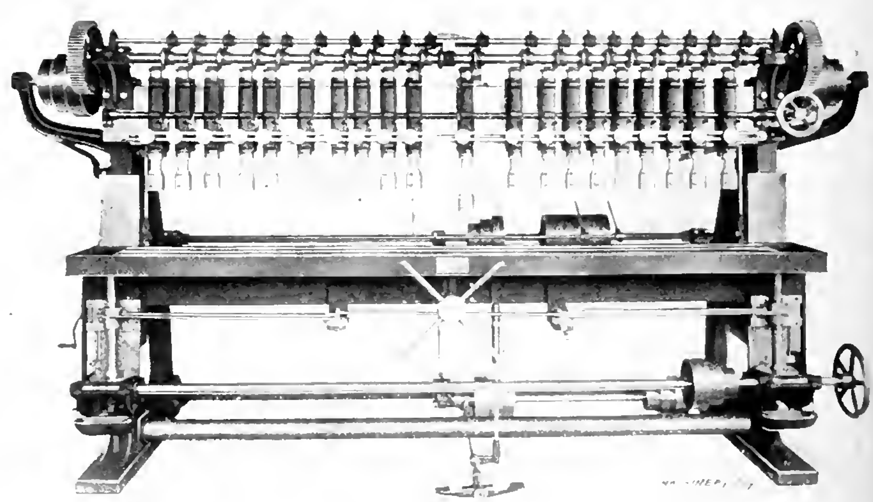
The work-holding chuck is attached to a vertical spindle, driven from the lower gear box. This gear box gives 8 different speeds for work of varying diameters. A magnetic chuck is regularly fitted to each machine, as this affords the quickest way of fastening the work for grinding and eliminates the liability of springing the work, which is always present in greater or less degree when the work is clamped by mechanical means. The magnetic chucks are furnished in three different sizes, having 8⅝, 10⅝, and 12⅜ inches diameter. A direct current of either 110 or 220 volts may be employed for supplying electricity to the chuck, and connection can be made directly to a lamp socket. In cases where direct current is not available, the makers of the grinder furnish a small generator which can be placed in any convenient place around the shop, and wires brought to the grinder. The amount of current required by the chuck when in operation is no more than that required by an ordinary incandescent lamp A plain chuck is furnished for brass, copper, hard rubber and other materials, which cannot be held by magnetism, or for use in cases when the magnetic chuck is not wanted. This plain chuck is furnished with three or four jaws as required.

The wheel-carrying head may be adjusted in such a manner that the work may be ground thicker or thinner at the center than at the circumference. The necessity for such adjustment, as is well known, is present when it is required to grind slitting saws and plain cutters, having no teeth on the sides, but intended for cutting slots or grooves in the work. This head is provided with three speeds. The feed is automatic, but can be operated by hand when necessary. The spindle carrying the grinding wheel is provided with adjustable bushing bearings, thoroughly protected by caps from dust. The use of bearings of this kind permits the best means for taking up the wear. The height of the center of the spindle from the floor line is 46 inches. The greatest distance from the center of the wheel to the chuck is 12 inches, and the size of the grinding wheel is 8 inches diameter by ¾ inch width of face. The speed of the driving shaft is 450 R. P. M. The floor space required for the machine is 26 x 45 inches, and the net weight about 1,300 pounds.

ANDREW IMPROVED MULTIPLE DRILLING MACHINE.

In the November, 1907, issue of MACHINERY, a multiple drilling machine intended for heavy duty, built by M. L. Andrew & Co., 2852-2854 Spring Grove Avenue, Cincinnati, Ohio, was described and illustrated. The accompanying half-tone shows an important improvement introduced on these machines for the purpose of rapid and accurate adjustment of the position of the spindles along the cross rail. This adjustment is accomplished by turning the hand-wheel at the right-hand side of the machine, from which the long adjusting screw receives its motion. Each of the spindle-carrying heads is provided with independent means for connecting them with this screw, they being engaged and disengaged by suitable handles. A slotted bar runs in front of the machine, as shown, and the various heads, when adjusted, are clamped to this bar by knurled nuts. Two men are, of course, necessary to carry out the adjustment, one turning the hand-wheel and with it the adjusting screw, while the other operates the handles, engaging and disengaging each head with the screw until the proper position for each spindle has been obtained. This feature is distinctly new, and will prove a great convenience in adjusting the spindles.

As in the previous machines of this line, the feed movement is effected by raising and lowering the table. Feed screws are provided at each end of the table, engaging half nuts which can be thrown in or out of mesh at any time by



Andrew 20-spindle Multiple Drilling Machine, with Improved Method of Adjusting the Spindle.

a lever conveniently located for the operator. The table, being counterbalanced with adjustable weights, may be easily raised or lowered by operating the pilot wheel at the front. Each spindle has an independent vertical adjustment of 4 inches, to make allowance for the various thicknesses of work

and various lengths of drills. The spindle driving gears are made of high carbon steel, accurately cut so as to be nearly noiseless in operation. The main driving gears are driven by rawhide pinions, keyed to the cone pulleys. The table has sufficient feed and the drive is sufficiently powerful to drill twenty ⅞-inch holes in steel, 8 inches deep, at one time. Larger or smaller machines of this description can be furnished, according to the capacity required.

CHICAGO BORING TOOL HOLDER.

The Krieger Tool & Mfg. Co., of Grand Rapids, Wis. (main office 479 North Park St., Chicago), is making the boring tool holder shown in Figs. 1 and 2. As may be seen, this holder is adapted to a wide range of sizes of boring tool shanks, owing to the peculiar construction of the clamp, which is made

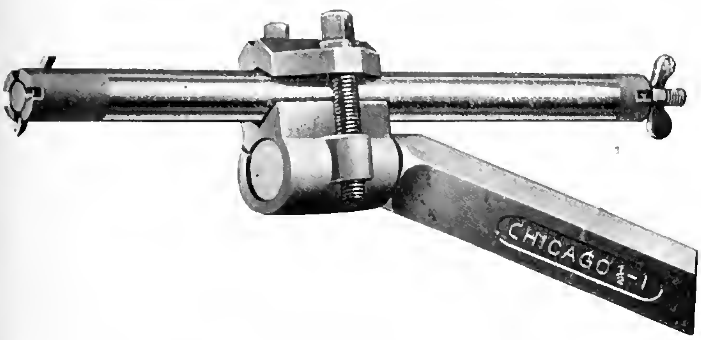


Fig. 1. Chicago Boring Tool Holder with Boring-bar in Place.

with a large V on one side for tools such as shown in Fig. 1, and a smaller V on the other, so that it will hold very small diameters when reversed, as shown in Fig. 2. The full range of diameters is for shanks from ⅛ up to ¾ inch, no blocking being required.

In Fig. 1 a boring-bar is used with an inserted tool. Boring tools of different sizes, such as shown in use in Fig. 2, will also be provided as a part of the outfit. The head can be swiveled about a pivot on the shank, so as to bring the tool

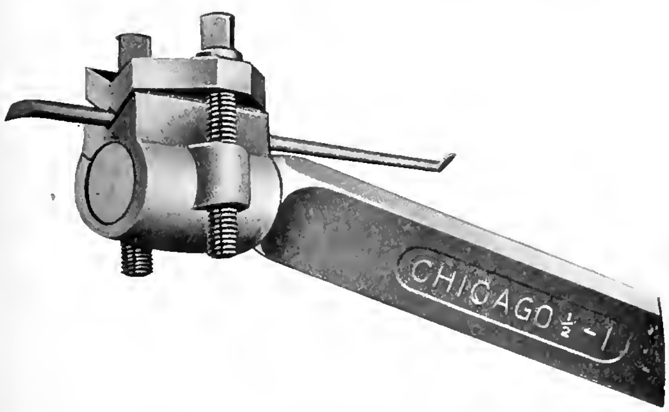


Fig. 2. Holder in Use with Forged Boring Tool of Small Diameter.

to the desired height to center with the axis of the lathe. The boring tools, and blades for the boring-bar, can be furnished in high speed steel or carbon. The steel holding parts are drop forged and case-hardened. The tool may be used for holding inside and outside test indicators, as well as for boring.

IMPROVED MELVIN ADJUSTABLE BORING HEAD.

We have previously described the boring heads made by Melvin & Hamaker, of Meadville, Pa. (see New Machinery and Tools in the November, 1907, issue of MACHINERY). The boring head shown in the cut, made by the same builders, is of larger size than the one previously shown, and includes some new improvements in design. The front collar or clamping ring is provided with graduations, which enable the operator to get the required changes without measurement. An intermediate is provided, having rubber rings, which maintain the pressure on the cutters even when the front collar is loosened. This serves two purposes: First, it prevents the cutters from falling out, or loosening so as to allow chips to accumulate between the cutters and their seats; and second, it allows the operator to make adjustments without the liability of disturbing the seating of the cutters in the grooves which hold them. The blades, as was explained in the previous description, are formed from steel having an equilateral triangular section, and are seated in grooves

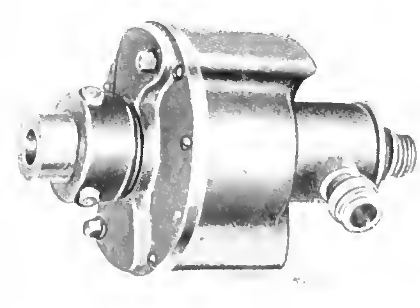
Adjustable Shell Type Boring Head, made by Melvin & Hamaker.

of corresponding shape in the body of the tool, which present them to the work at the required cutting angle. When one cutting edge is dull, the blade may be turned in its seat, presenting a new one. By doing this, six new cutting edges may be obtained in succession. When the point of the tool is rounded to give a smooth finishing cut, four cutting edges are provided for.

These shell type heads are made in all sizes, from 5 inches to 18 inches in diameter. They have an adjustment of from ⅝ to 1 inch in diameter, depending on the size, this adjustment not being provided for on sizes less than six inches.

COFFIELD WATER MOTOR.

The engraving shown herewith illustrates a water motor of the positive piston type, invented by Mr. P. T. Coffield, of Dayton, Ohio, and sold by the Patterson Tool and Supply Co. of the same city. This differs from the ordinary water motor in the fact that the direct pressure of the fluid is utilized on a steel piston, instead of employing the kinetic energy of the fluid, impinging against the floats of a rotating wheel. Numerous advantages result from this arrangement. It is stated that higher power is developed than with jet motors with the same water consumption. The device may be operated at slow speed or at high, often making reduction gearing or countershaft unnecessary. Another important feature is the fact that the exhaust of the water from the motor does not have to be so arranged as to preclude the possibility of back pressure. On the contrary, the exhaust can be piped away for any desired distance, and used for any purpose desired, the back pressure merely serving to reduce somewhat the power instead of entirely stopping the action of the device as in the case of the jet machine.



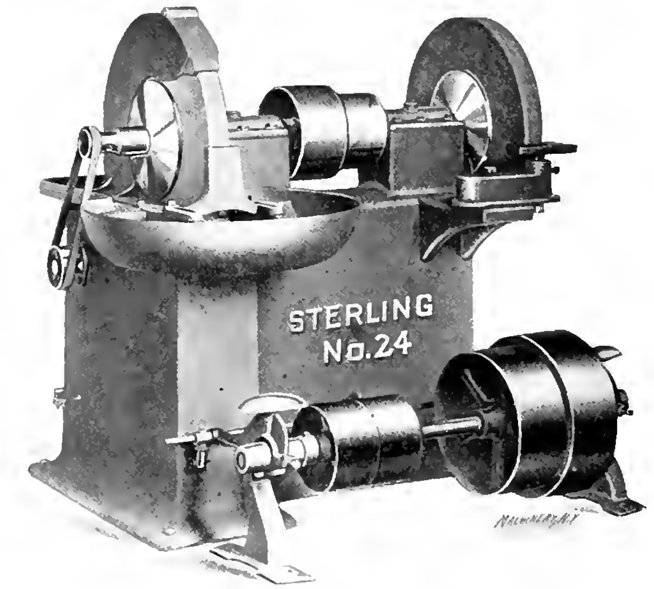
A Positive Piston-action Water Motor.

The motor is simple in construction, having only two valves and a piston. These parts are leather-packed in such a manner that leakage is reduced to a minimum. The machine shown, running at a speed of 100 revolutions per minute, developed 1/10 of a horse-power, with a consumption of water of

1 1/3 gallon per minute—at what pressure the report does not state. An efficiency of 100 per cent would require a pressure of about 110 pounds per square inch, under the conditions given.

STERLING COMBINATION WET AND DRY GRINDER.

The grinder shown in the accompanying engraving has been designed by its builder, the Sterling Emery Wheel Mfg. Co., Tiffin, Ohio, to combine the advantages of the wet tool grinder and the grinder for general purposes in one machine, thus economizing floor space. The water bowl and hood are detachable. The tool grinding section has no pump, but is



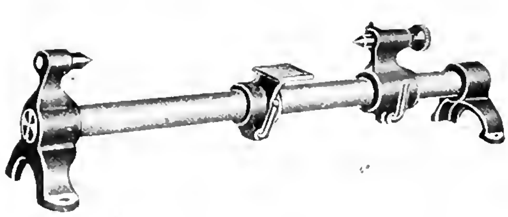
Sterling Combination Wet and Dry Grinder.

equipped with a revolving disk which throws a supply of water on the wheel when running. The tool grinding wheel is 24 inches in diameter by 3 inches wide; the dry wheel is of the same diameter, but 4 inches wide.

The weight of the machine, with the counter-shaft, is 1,800 pounds.

WELLS BENCH CENTERS.

The engraving we show herewith illustrates a new bench center built by the F. E. Wells & Son Co., of Greenfield, Mass. These bench centers are strong and inexpensive, and in many cases they take the place of the lathe in testing work to see if it runs true on the center. The tail-center is pressed outward by a coiled spring, so that it holds the work securely,

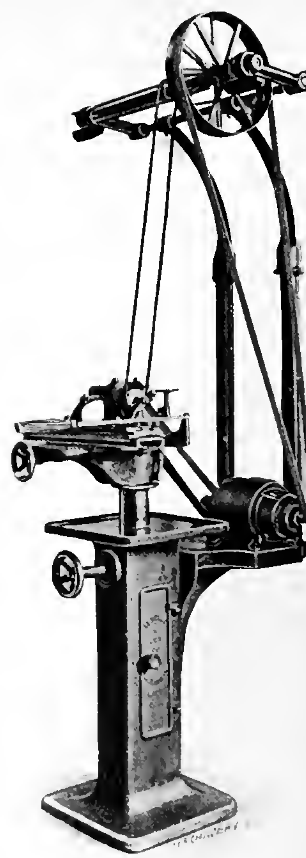


Inexpensive Bench Centers, taking the Place of the Lathe for Balancing Shafting, etc.

while still allowing it to revolve freely. This arrangement also permits the work to be inserted and removed quickly. This center may be adjusted along the bar to suit different lengths of work. A test indicator may be furnished in connection with this center-rest, if it is desired to show how much the work is running out at any point.

MOTOR DRIVE ARRANGEMENT FOR WELLS GRINDER.

F. E. Wells & Son Co., of Greenfield, Mass., has provided a motor drive on its cutter and reamer grinder, arranged as shown in the accompanying half-tone. As may be seen, the motor is mounted on a bracket, clamped to the rear of the column, and is directly belted to the emery wheel spindle. The work spindle, which is given a longitudinal movement in the operation of the machine, is driven from a drum on the overhead counter-shaft, which is supported from the motor bracket, and belted to the outer end of the armature shaft, as may be clearly seen from the engraving. An idler, which does not show in the cut, is provided, by means of which the work driving belt tension is kept the same, regardless of the adjustment of the cross slide on which the work belt is mounted.



Motor Drive with Self-contained Counter-shaft for Wells Grinder.

The motor is so placed that the table can be swung to present the work at any angle to the wheel, without interference with the belts or upright standards. The motor is encased in dust-proof covers, which keep the dust away from the armature and bearings. As may be seen, all the parts of the arrangement are self-contained, and neither the motor nor the counter-shaft has to be fastened to the wall. The plain cutter and reamer grinders are furnished in the same way, but since a revolving work spindle is not used for these, the counter-shaft is done away with, the spindle being driven directly from the armature shaft.

SPRINGFIELD MOTOR-DRIVEN BRASS FINISHERS' LATHE.

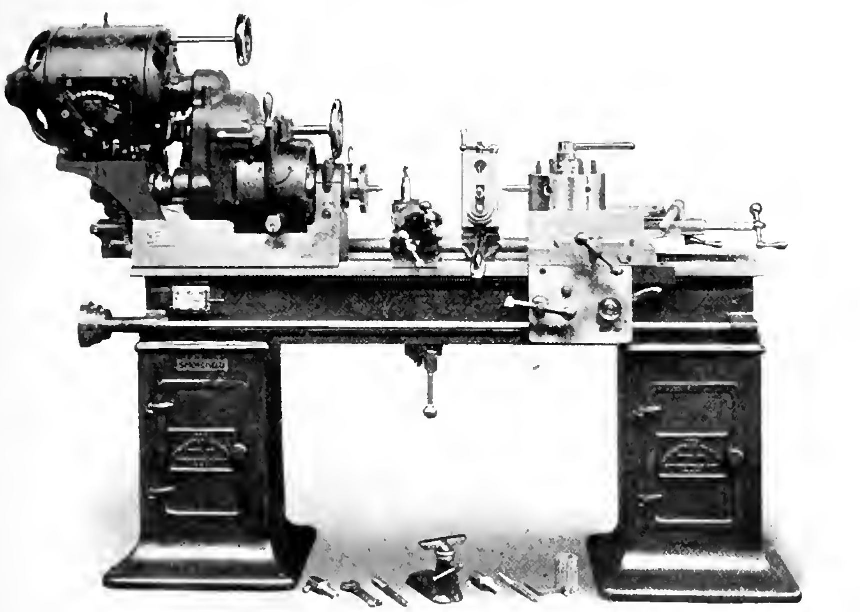
The half-tone engraving shown herewith illustrates quite clearly the motor drive mechanism provided by the Springfield Machine Tool Company, 633 Southern Avenue, Springfield, Ohio, for its brass finishing lathe.

The head-stock shown provides for four mechanical speed changes, and this, in combination with the Lincoln 6 to 1 variable speed motor with which the lathe is driven, gives the entire range of speed necessary for the work for which the machine is intended. The Lincoln motor (see description in the New Tools Department of the March, 1906, issue of MACHINERY) is provided with mechanism for shifting the armature and field longitudinally in relation to each other, so as to obtain a stronger or weaker field at the desire of the operator, thus diminishing or increasing the speed of the machine. This movement is effected by the hand-wheel shown projecting from the upper part of the motor casing. It is within convenient reach of the operator, who can thus make the changes with great ease. The starting box is placed at a convenient point, and releases automatically when the power is turned off. The motor is reversed in this case by a double throw switch on the bed at the head of the machine.

The head-stock, with its gearing, clutches, etc., is of neat and compact design, all the working parts being enclosed to protect them from injury and dust. Of the four mechanical changes of speed, two are obtained by the short lever seen just in back of the friction lever. This operates a sliding gear arrangement. Two more changes are obtained by the usual friction back gear mechanism, operated by the vertical lever. The clutches used for this friction back gear drive have been built by this firm for many years, and have given entire satisfaction. The lower hand-wheel shown just over the main spindle bearing is used for rotating the spindle for such minute adjustments as are required, for instance, in finishing a square thread, ending in a drilled hole. The journals throughout the head-stock mechanism are self-oiling, with large oil receptacles which seldom require refilling.

The turret is large and heavy, with bushed holes. It is provided with an ingenious indexing and locking mechanism operated by the handle shown at the top of the turret. The backward movement of the handle withdraws the locking pin, a forward movement rotates the turret into a new position, when the locking pin drops back into place locating the turret, and then the returning of the handle to its first position clamps the turret firmly to the carriage. Both screw and lever feed are provided for by the slide, the screw feed being used where fine adjustments are required. As is usual in brass finishing lathes, the turret is mounted on a cross slide. The cross slide is centered on the carriage by means of a taper pin, which insures absolute alignment. A taper attachment is also provided, of which the taper bar is contained in the center of the bed. It may be adjusted to any required taper up to 4 inches per foot. The slide on the bar is gibbed to take up all wear. All the ways of the turret, cross slides and carriage are fitted with taper gibs throughout.

The apron is provided with a power feed, driven by a three-



Springfield Brass Finishing Lathe, as arranged to be driven by Lincoln Variable Speed Motor.

step cone. The feed is reversed by the lever at the side of the apron, and is engaged by a friction clutch. When the power feed is not in use, the carriage may be clamped to the bed by means of the rigid clamping device shown at the right of the apron.

The chasing bar is of very heavy construction, supported by large, stiff brackets. The different pitches are obtained by using different threaded leaders and followers in the usual fashion. Provision is made in this machine for cutting either right- or left-hand threads without changing any gears. A handle at the end of the bed operates tumbler gearing, which reverses the direction of the rotation of the leader; this provision makes left-handed leaders and followers unnecessary. Taper threads may be chased with this tool by tilting the slide on which the forward part of the chasing bar rests, when it is in working position. A heavy spring keeps the follower in contact with the leader, thus assuring uniformity of lead to the thread being cut.

* * *

Few people realize what a tremendous industry the moving picture industry has become in a few years. One of the French companies, manufacturing the films for moving picture machines has a capital of $900,000, and in 1906, according to an item in *Industritidningen Norden*, the net profit from this investment amounted to fully one million dollars. In 1907 the sales were nearly twice the sales in 1906. It is stated that the company sells about 19 miles of films a day, and that they keep continually in stock 30 tons of films, representing a value of $1,400,000. It is also stated that all the moving picture enterprises in Paris represent a capital of over $20,000,000, and that there are fully as many English and American firms in this industry as there are French.

AN AMERICAN MECHANIC IN EUROPE—1.

THE FIRST OF A SERIES OF LETTERS FROM OSKAR KYLIN* ON THE EDITORIAL STAFF OF MACHINERY.

Berlin, March 14, 1908.

The industrial depression which last fall started in New York and with that as a center spread over Europe, seems to have affected the machine tool market here to quite a large extent. Machinery dealers report business very dull throughout the country, the machines that they ordered from American manufacturers six months or more ago are now coming in, and as the demand is small at the present time, they are obliged to store them. The depression is most evident in the line of large machine tools. Smaller machine tools for every day uses are in fair demand, and in small tools, business is still better. Schuchardt & Schutte report a falling off of about 50 per cent of last year's business in all kinds of machine tools and small tools.

The machine tool manufacturers here do not seem as yet to feel the depression in any marked degree. They are generally running their shops with nearly full force, and do not complain about any hard times. Ludwig Loewe & Co. reported a fair amount of business on hand, working with very nearly full force. A small manufacturer here that six months ago employed 125 workmen has now reduced his force to about 90 men, but he stated that business was unusually good then, is satisfied with present conditions, and is optimistic about the future. This marked difference between the reports of dealers and manufacturers probably results from the fact that manufacturers are still working on orders received six months or more ago.

Copying American Tools.

I have carefully investigated the copying of American machine tools abroad, and the German manufacturers no longer seem to make any secret of this practice. They openly confess that they do copy American machines, or rather that they imitate them and adapt them to the different requirements that exist in the German shops. Outright copying does not seem to be so common as imitation or rather adaptation.

There seems to be some difference between the structure of the German cast iron and the American, and the small tools designed to suit American conditions and material cannot be used with equal advantage here, as they are too light and do not wear well. The German manufacturers have studied their material and tools, and the consequence is that today a different line of tools is used here from those in America. It is a common complaint that most American manufacturers who are selling machines here do not pay enough attention to this point, and that the American machines are not made to take the German tools. The feeling is that if American manufacturers want to sell machines here they should study the German needs and adapt the machines to meet them; and since this is not being done, the German manufacturers will naturally adapt the latest and best American tools to their own requirements, retaining the new features when they conform to German needs and changing them when they do not. American manufacturers, by neglecting to study the needs here are to a certain extent responsible for present conditions; and it must not be forgotten that this does not apply to the trade in Germany alone, but to all the territory where German tools are sold, which includes all Europe and Asia. Whether justly or not the dealers here continue under the impression that during the past boom American manufacturers did not treat their foreign customers fairly, neglecting them in favor of domestic orders.

* Oskar Kylin is a young American draftsman who is making a trip through Europe for MACHINERY, and recording his impressions of foreign methods and works from the standpoint of a practical mechanic. In addition to having a thorough knowledge of American shop practice, Mr. Kylin speaks several languages fluently.

and for this reason have lost ground on the foreign market, a condition which German manufacturers have been quick to profit by.

An Interesting Interview.

An interview with Mr. C. H. Johnson, who has represented the Gisholt Machine Co. on the Continent for a number of years, is given below, as it is fairly typical of opinions here, and taken from an intelligent standpoint, as Mr. Johnson is an American. "Write the American machine tool manufacturers that more of them should begin to study the needs and conditions here, which are not the same as they are over in America. They build machines there to suit American conditions and American material, and don't think or care about the conditions or material here. Then they send their machines over and want us poor devils to sell them. There are some American concerns that know how to handle European trade, but they are very few. America mustn't think that Europe is in its mechanical baby clothes any longer, or conditions are any longer such that when the American business managers come over, buyers here salute them with 'How d' you do? Glad to see you! I am just ready to buy your machines.' Things have changed. The Germans build pretty good machines themselves now, and the material is not the same here as in America. The cast iron, for instance, that we have here is very much harder or tougher, for the tools don't wear so well here and get dull much faster, so that we can't use the American tools. The tool question has been studied out in both countries, and now they do it one way in America and another way here. We cannot force the Germans to use our tools, and we must make our machines to suit their tools if we want their trade. There are some good American concerns that do so, but the large majority don't. The American business manager goes over to Europe to make a thorough study of the European trade conditions—makes a hurried call in Berlin, and then takes the fastest express for Paris, and that is where he studies 'trade conditions.' And now since the Americans won't make their machines to suit the German tools, the Germans must do it themselves. They simply have to; and you can take my word that they do it, too. The Germans are d— good copiers. They copy lots of American machines and adapt them to their own tools, and what can we do about it? Not a d— thing! They must use their own tools, and the American manufacturer won't make his machines to suit the German tools—so there you are. And it is not so very easy to sell a machine here as in America either. I sold a milling machine here the other day, and when it came, the customer picked up and took apart every piece—in order to clean it, he said, but really to examine it. He looked at every piece, and if he had found any defects he would have refused the machine. And suppose now that I want to sell a lathe. I have to sell it against the competition of a 25 to 50 per cent cheaper German one. If I say that my lathe is equal to two or three German lathes I must get down to figures and show the buyer why. My lathe won't do two or three times as much work as the other one, and therefore I have to figure on the floor space. Three lathes will occupy so much space and mine only so much, and this represents a saving of so much a year for you. I have to figure with power, transmission and everything. So you see that it is not so very easy to sell American machines here.

"And then there is another point. During prosperous times the American manufacturers have neglected their foreign trade. They acted as if they thought, 'We will attend to our home customers and let the devil take the foreigners; they can wait.' And if a German customer has been promised one month's delivery he has often had to wait six. Now everybody wants to sell, but it is pretty hard work to get back the trade for American machines again, and it is the American concerns that are principally responsible for it."

Shop Notes from Ludwig Loewe & Co.'s Shops.

In Ludwig Loewe & Co.'s Works there is a tendency to abandon the milling operation for finishing heavy castings, such as large bed-plates. They are going back to the old way of planing these castings, which they claim costs less, because the milling cutters wear too fast and are too expensive both as to first cost and maintenance. This may be on account of the difference in the wear on German cast iron.

An interesting experiment was tried in these works for forming a milling cutter that would cut a perfectly square thread in the ordinary thread milling machine. As generally known, the "square" thread cut in an ordinarily equipped thread milling machine, although close enough for most ordinary purposes, is not perfectly square but somewhat wedge-shaped. An ordinary Pratt & Whitney thread milling machine was used, a square thread screw, cut in a lathe, being placed in position the same as for milling a thread. In the place of the cutter an antimony disk was mounted on the cutter spindle. The screw was revolved and the antimony "cutter" pressed against it and caused to revolve with it. By this action the disk was formed to the right shape. A steel cutter was made to the shape thus produced, but as it did not work well, the experiment was carried on to find another shape that would cut more satisfactorily. The experiment was made on account of an inquiry from the German government.

[The experiments, if conducted as described, seem quite unprofitable. No one-piece rotary cutter of appreciable diameter can be formed which will not interfere with the overhang of a square thread.—Editor.]

MISCELLANEOUS FOREIGN NOTES.

Projected Russian Steel Trust.—It is stated by *Engineering* that a Russian steel trust is about to be formed and that the promoters of the scheme desire to create a concern along the same lines as the United States Steel Corporation. The present unions between steel makers and the trade agreements are understood to have proved unsatisfactory and inefficient, but definite action has not, as yet, been taken.

Profits in German Machine Tool Trade.—A number of the principal German machinery manufacturing concerns have issued their financial statements for the last accounting year, and it is plainly in evidence that up to the present time the business has financially been an exceedingly good one. Thus, some of the large companies report net profits from $200,000 up to $800,000, and the paying of dividends varying from 12 per cent to 20 per cent as against from 8 per cent to 16 per cent in the previous year. It is now stated that the prospects for the German machinery trade, while not as bright as they have been, are still fully satisfactory.

Messrs. A. A. Jones, Pollard, and Shipman, Ltd., Leicester, England, have placed a new design of high speed drilling and tapping machine on the market. This machine is of stiffer construction than usual, and is particularly intended for using high speed drills up to their full capacity. The machine will drill one inch holes in mild steel at a rate of three inches per minute. The machine is back-geared and the main drive is by a three-inch belt. Instead of the common feed lever, a hand-wheel is employed. The drill spindle is bored to take No. 3 Morse taper shank. It has a vertical travel of 10 inches. The table is 17 inches in diameter. The maximum distance between the drill spindle and the table is 33 inches.

British Shipbuilding Trade.—We have previously referred to the fact that the British shipbuilding concerns were not fully satisfied with the prospects in their trade. Present orders, it is stated, are practically confined to high-class steamers, and for these there is a very keen competition. Of course, the building of large vessels in the last few years has been carried to such an extent that naturally the number necessary for the immediate demands of the trade is filled for the present. The probable state of affairs is that the activities of the past few years have been abnormally high, and that business now recedes temporarily only to enter on thoroughly healthy and normal conditions.

Steel Industries in Europe.—It appears that while the steel industry in certain of the European countries is rather depressed, there is still considerable activity in the development of new plants. A large iron works is under construction in Italy near Naples, for which six blast furnaces and large rolling mills will be erected. From France a depression is reported, although not as accentuated as elsewhere. The exports of iron and steel in that country still show an increase over the exports for the corresponding months last year. In

Germany the steel syndicate has decided to make no change in prices, and it is reported that the export trade shows signs of improvement. To a great extent the works are now kept busy with materials for the German Government railroads.

German Competitive Restriction.—Consul General Richard Guenther mentions in a consular report the following incident, illustrating the restrictive law in Germany covering unfair competition. An Austrian merchant was recently convicted in the criminal court at Konstanz, Germany, of having violated the law against illicit competition. He was sentenced to imprisonment for three months. This foreign merchant, who intended to establish in Austria a factory for preserving vegetables, had come to Singen and approached the employe of a similar factory there, trying to induce him to reveal the business methods, technical appliances, and manner of production in vogue in the establishment; also where the supplies in raw materials were obtained and the names of the customers of the factory. He offered money gratuities to the employe, who was a sort of foreman, and promised him a better-paying position in his factory in Austria. Some of our American manufacturers, says the Consul, are very enterprising and occasionally—when in Europe—seek to obtain information by personal efforts. The case cited may be useful in cautioning personal investigators to be very circumspect, so as not to violate existing laws in foreign countries.

Sales of Machinery in Italy.—According to the *London Commercial Intelligence*, protection as to payment for machinery sold to Italian firms may, according to Italian commercial law, be secured, if the sale, within three months from date of invoice, is registered at the chancery of the civil and penal tribunal of the city where the machinery is to be installed. This registration offers protection for the final payment of machinery. In order to secure this privilege of protection, it is necessary for the seller to send in an application addressed to the "Regia Cancelleria del Tribunale Civile e Penale, Sezione Commerciale" of the city or town where the machinery is delivered, stating details regarding price, terms of payment, etc. This application is made out in duplicate on Italian stamped paper, one copy being returned by the tribunal after registration. The expense for the stamped paper is about 70 cents. The application should also be accompanied by the contract for the sale of the machinery, or by a copy of the invoice. The copies must be stamped and registered with the Italian government at a representative office (undoubtedly the Italian Consular office would in the United States be the proper place). An amount sufficient to cover postage for the return of the duplicate application should be enclosed.

* * *

ANGLES OF HOPPER SIDE INTERSECTIONS.

The perplexing problem of finding the angle of intersection between the various inclined planes in a rectangular hopper has been previously dealt with in the columns of Machinery, in the "How and Why" section of the May, 1907, issue and in the "Letters Upon Practical Subjects" section in the August, 1907, issue. In these articles general formulas were given, which, however, are more or less complicated and require considerable time in applying to each separate case. In the current Data Sheet Supplement, accompanying the engineering edition, diagrams are therefore presented which permit the required angle of intersection to be read off at a glance, when the inclinations of the side planes of the hopper are known.

In sheet metal work of this character it is common to express the magnitude of angles by giving the inclination in inches per foot; in inches rather than by expressing the angles in degrees. This practice has been adhered to in arranging the diagrams given. The curves, however, have been plotted from the formula

$$\text{Cos}\, F = -\cos x \cos y,$$

in which the various angles are expressed in degrees, and where F = the angle of intersection between the sides of the hopper (commonly called the angle of flare), x = the angle which one of the hopper sides makes with a plane parallel to the bottom of the hopper (or with a horizontal plane), and y = the angle which the other hopper side makes with the same plane. Upon examination it will be found that the formula given above is identical with the one given in the article in the August issue, already referred to. This formula in that issue, however, was given the form

$$\cos EBF = \sin \alpha \sin \beta,$$

where angle EBF = the angle of flare, and α and β, the angles made by the hopper sides with a vertical plane passed down the hopper at right angles to the plane in relation to which angles x and y are measured. The angles α and β thus are the complements of angles x and y, and consequently

$$\sin \alpha \sin \beta = \cos x \cos y,$$

from which it is clear that the two formulas referred to are identical.

* * *

PERSONAL.

Charles C. Tyler, lately of the Allis-Chalmers Co., has been appointed works manager of the Remington Arms Co., Ilion, N. Y.

George A. Seib, formerly superintendent of the Monarch Typewriter Factory, Syracuse, N. Y., has been appointed superintendent of the Remington Typewriter Co.'s factory, Ilion, N. Y.

J. L. Cone, for several years foreman of the carriage assembling department of the Remington Typewriter Co., Ilion, N. Y., has been appointed assistant superintendent of the machine assembling department.

David Hunt, Jr., general sales manager of the Warner & Swasey Co., Cleveland, Ohio, sailed February 29 for a three months' trip abroad. He will visit England and the Continent.

John Montgomery formerly foreman of the screw department has been appointed assistant superintendent of the machine tool and equipment departments of the Remington Typewriter Co., Ilion, N. Y.

T. D. W. Moore, for three years general manager of the Remington Arms Co., Ilion, N. Y., has accepted the position of general manager of the Savage Arms Co.'s plant at Utica, N. Y. Mr. W. J. Greene retires as general manager of the Savage Arms Co., but still continues as vice-president.

R. S. Stangland has been placed in charge of Muralt & Co.'s construction office at New Fort Lyon, Colorado, and will superintend the erection of the complete lighting, heating and power plant which his firm is building for the United States government at the New Fort Lyon Naval Hospital.

Jerome Orcutt, who for several weeks has been acting as general manager and superintendent of the Remington Arms Company's plant, Ilion, N. Y., in connection with the management of the Union Metallic Cartridge Co.'s plant at Bridgeport, Conn., has returned to Bridgeport, and will confine himself to the management of the Union Metallic Cartridge Co.

W. O. Renkin, formerly of Valley Park, Mo., and an occasional contributor to Machinery, is now located at Chakradharpen, India, as resident engineer for Julian Kennedy, construction engineer, Pittsburg, Pa., for the erection of blast furnaces and steel works for the Tata Iron & Steel Co. Mr. Renkin expects to be in India at least three years.

The well-known inventor of the Schmidt superheater, Mr. Wilhelm Schmidt, of Kassel-Wilhelmshöhe, Germany, has been promoted to Honorary Dr. Engineer of the Technical Institution of Karlsruhe, "in appreciation of his services for making use of superheated steam in steam engines, particularly in locomotives, and for his initiative efforts in the construction of apparatus and superheaters for highly superheated steam."

Anton M. Olsen, an apprentice of Kempsmith Mfg. Co., Milwaukee, Wis., has the distinction of being the first apprentice west of New England to receive the diploma awarded by the National Machine Tool Builders' Association. Mr. Olsen signed the National Machine Tool Builders' uniform apprentice contract May 25, 1904, at the age of sixteen. The apprentice service required is 11,520 hours divided in four general annual periods of 2,880 hours each. Mr. Olsen completed this term in the early part of March, and received his diploma.

OBITUARY.

George P. Curtis, who for the past twelve years was connected with the city sales department of Charles H. Besly & Co., Chicago, died February 26.

John Burry, inventor of a stock ticker in common use in brokers' offices, hotels, clubs, etc., for recording stock market quotations, died at his home on Staten Island, March 12, of illuminating gas poisoning. Mr. Burry was born in Switzerland in 1861, and came to the United States at the age of nineteen. He had made many inventions and improvements of printing telegraph machines. The stock ticker, brought out in 1880, was the most successful.

George J. Meyer, treasurer of the National Tool Co., Cleveland, Ohio, died at his home, 2003 Holmden Ave., February 23, of consumption. Mr. Meyer was one of the incorporators of the National Tool Co., and held the position of treasurer from its incorporation until his death. He was previously employed by the Dyer Co., Cleveland, as a draftsman and machine designer, and thus was a practical machine designer as well as a business man. Mr. Meyer was highly regarded by his associates, and his untimely death leaves a place hard to fill. He left a widow and two children.

James H. Oliver, a well-known plow manufacturer of South Bend, Ind., died March 2. He was born in Roxburgh, Scotland, August 28, 1823, and came to the United States with his family when a lad of thirteen, settling near Geneva, N. Y. After working on a farm for a few years, he went to Indiana and became a mill worker, and after accumulating a small sum, began to make plows. The problem of making a cast iron plow that would scour in the black Western soils was what he set out to solve, and the Oliver chilled plow was the result. The demand increased so rapidly that in 1875 the present plant at South Bend was built, covering thirty-two acres and employing 5,000 men.

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NEW BOOKS AND PAMPHLETS.

Proceedings of the Seventeenth Annual Convention of the Association of Railway Superintendents of Bridges and Buildings, held in Milwaukee, Wis., October 15-17, 1907. 344 pages, 6x9 inches. S. F. Patterson, secretary Boston & Maine Railroad, Concord, N. H.

Columbia University Quarterly. December, 1907. 141 pages, 7x10 inches. Published by Columbia University, New York.

This issue of the *Columbia University Quarterly* is devoted to the Columbia Schools of Mines, Engineering and Chemistry, and will be found of general interest to those contemplating courses in these well-known institutions.

The Weathering of Coal. By S. W. Parr and N. R. Hamilton. 37 pages, 6x9 inches. Published by the University of Illinois, Urbana, Ill., for general distribution.

The bulletin relates to the weathering of coal and losses in fuel values which result from storage. That coal deteriorates in storage is generally known, but the data available have been meager. The results of tests outlined give specific information that should be valuable to manufacturers, power plants, and others using large quantities of fuel.

Effect of Brake Beam Hanging on Brake Efficiency. By R. A. Parke. 63 pages, 6 x 9 inches. Published by the Westinghouse Air Brake Co., Pittsburg, Pa.

This publication is a reprint of a paper presented by Mr. Parke before the New York Railroad Club, April 18, 1897. It is a clear and comprehensive analytical discussion of the complicated conditions involved in the design of car brake systems of maximum efficiency, and in a way has become a classic that is often referred to for analysis of the complicated forces entering into car braking and brake action. Those familiar with the paper will be pleased to note that it has now been put in shape for general circulation, and it can be recommended to those interested in the design and mathematical analysis of railway car brakes.

Locomotive Catechism. By Robert Grimshaw. 817 pages, 5x7 inches. Published by Norman W. Henley & Son, 132 Nassau Street, New York. Price, $2.50.

This work, first published in 1893, has had a large sale, the present edition being the 27th. It has been entirely revised, enlarged and reset, and contains over 3,000 questions and answers. It is, in fact, a practical treatise on locomotive construction in detail and a treatise on locomotive operation as well. The catechism style enables a great deal of information to be given in short, concise paragraphs, and is well suited to the needs of men who are not used to reading technical books. The work is one, also that can be read with profit by any one who desires to obtain general information on locomotive construction and operation. The illustrations are well made, the paper is of good quality, the binding is flexible, and the corners are rounded, which adapt the book to carrying in the pocket, although its size is somewhat too great to make it a comfortable pocketbook.

Reference Book for Statical Calculations. Vol. I. By Francis Ruff. 136 pages, 5x7½ inches. Published by Spon & Chamberlain, New York. Price 5d.

This book was first published in German and to meet the wants of English engineers has been translated into English. The work presents the application of grapho-statics to the constructions most frequently met in engineering work. It contains tables of moments of inertia and resistance to bending on cross sections most in use, and transverse forces and moments of applications for simple beams subjected to concentrated loads and distributed loads. Bridge trusses, strut frames, roof construction, cantilevers, open web girders are analyzed graphically; also curved beams with three joints, suspension bridges, frame work columns, earth pressure, sustaining walls, vaults with abutments, concrete constructions. The work will be found useful by all who have occasion to analyze the forces in engineering structures. The tables are conveniently arranged and data not usually found in engineering handbooks are included.

Engineering Reminiscences. By Chas. T. Porter. 335 pages, 6x9 inches. Illustrated with portraits of many prominent engineers. Published by John Wiley & Sons, New York. Price, $3.00.

This work first appeared as a series in *Power* and the *American Machinist*. Mr. Porter was the originator of the high-speed engine, and has had a most interesting career. His writings have a charm and interest rarely exceeded by any. The book is a contribution to engineering literature of much historical value, and it is a matter for general congratulation that the memoirs of a man who has done so much for engineering should be put into a book for general circulation. Electrical engineering owes much to the Porter-Allen engine, as incandescent lighting would have been impracticable with the old slow-moving, irregular-acting steam engines in use prior to Mr. Porter's development. So in a sense it may be said that Mr. Porter is very largely responsible for the enormous development of electrical engineering that has taken place since the first high-speed engine was constructed.

The Gas Engine. By Frederick R. Hutton. 562 pages, 6 x 9 inches. 243 illustrations. Published by John Wiley & Sons. Price $5.00.

The first edition of Prof. Hutton's work on the gas engine was published in 1903. The present edition is the third, revised and brought up to date. The development of the internal combustion motor and the importance that it has acquired since the introduction of the automobile makes the study of the gas engine and gas fuels of the greatest commercial importance. The new edition has been revised with this fact in view and special attention is called to the reference table on gaseous fuels now included. Some attention is given to alcohol motors, but the treatment of the design of engine parts included in previous editions has been intentionally omitted, it being thought best not to include this, as it would make the work too large and costly. For design and construction details the author calls attention to the work "Gas Engine Design," by Prof. Charles E. Lucke, who is a colleague and co-worker in Columbia University. Prof. Hutton's work is generally considered to be the most comprehensive theoretical treatment of the gas engine published in America.

Gages and Gaging Systems. By Joseph V. Woodworth. 249 pages, 6 x 9 inches. 258 figure numbers. Published by the Hill Publishing Co., New York. Price, $2.00.

This book on gages and gaging systems is a compilation of articles published in the *American Machinist* and Machinery, contributed by the author and others. It treats of the fundamental practice, development and efficiency of gages and gage making with numerous illustrations of various forms of limit gages, indicators, thread testing gages, snap gages, star gages, caliper gages, etc. A chapter is devoted to tri-squares, knife edge squares, combination squares, straight-edges, sizing blocks and methods of making same. Special attention is given to calipering large work and the methods developed and employed by the Westinghouse Co. are partially described. Simple methods of testing the alignment of machine tools with the ordinary micrometer are illustrated. The Gronkvist or Swedish combination gage system is illustrated, this being a new system by which less than 100 gages are made to have about 80,000 combinations. The work is one that should be useful to tool-makers, gage-makers, machinists, etc.

Practical Steam and Hot Water Heating and Ventilation. By Alfred G. King. 402 pages, 6 x 9 inches. 302 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price, $3.00.

The work reviews modern methods of steam and hot water heating and ventilation, and describes the apparatuses. It treats of the nature of heat, and the evolution of artificial heating apparatus from the open fire-place to stoves, furnaces, steam boilers, and hot water systems. The work is comprehensive and useful. It gives rules for estimating, and tables of value to engineers, estimators and others having charge of the installation of heating systems. The work as a whole appears commendable and we see little in it to criticise adversely, except in one chapter given up to rules tables and general information. Some of the statements contained are puzzling, as for example: "Air expands one one hundred and seventy-ninth of its bulk." This of course means nothing at all without an explanatory statement. A typographical error makes the rule for finding the diameter of a circle when the circumference is given, to read "Divide the circumference by 4.14159," instead of 3.14159. The general arrangement of the work is good and with few exceptions the illustrations are first class. The tables are gotten up in exceptionally fine style.

Handbook for the Care and Operation of Naval Machinery. By H. C. Dinger. 302 pages, 4½x6 inches. Published by D. Van Nostrand Co., 23 Murray Street, New York. Price, $2.00.

The larger part of this series first appeared as a series in the *Journal of the American Society of Naval Engineers*, and has been reprinted in book form with modifications and numerous additions. It is a practical treatise on marine boilers and engines, fittings, auxiliaries, with instructions on the care and preservation of the ship's hull, water-tight compartments, etc. Following are some of the subjects treated which will give a general idea of the contents of the work: Getting under way; running engines under way; accidents under way; general rules for over-hauling machinery; cylinders, valves and valve gears; engine adjustments; lining up engines; friction, oiling and lubrication; condensers and pumps; joints and packing; stuffing boxes; lagging; feed and filter tanks; feed-water heaters; evaporators and distillers; heating system; refrigerating plant; steam steering gear; air compressors, blowers and boiler engines; ash hoists and ejectors, etc. The work is one that can be heartily recommended to any one desiring an elementary, yet comprehensive work on marine machinery. It is gotten up in durable shape and is of convenient size to carry in the pocket.

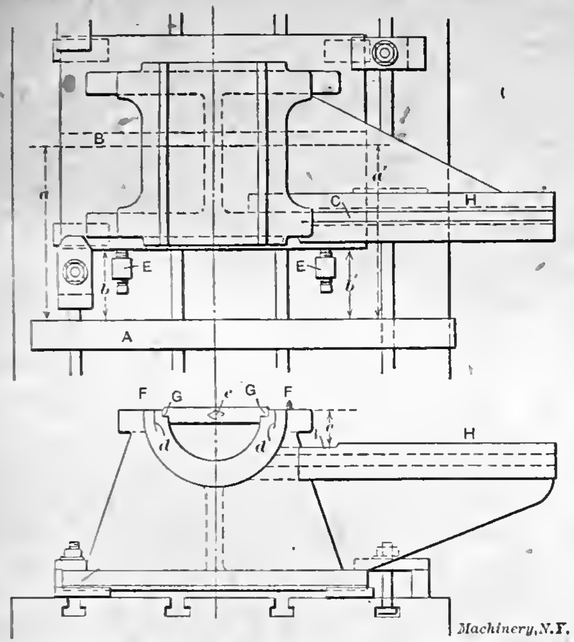
Writing for the Press. By Robert Luce. 302 pages, 5 x 7 inches. Published by the Clipping Bureau Press, Boston, Mass. Price $1.00.

This book, first published in 1886, now appears in the 5th edition. It is deservedly popular, and will be found of general value to all who write for publication or who indite business letters, or in any way express themselves in written language. The instructions to writers for the press are practical and concise and, with one exception, meet our general approval. The exception is in the directions for the preparation of copy containing illustrations. It states that the proof of any cut to be used in illustrating an article should be pasted as near as possible to the proper place in the copy. This is not objectionable when the proof is *not to be used as copy* for making the cuts but in all cases where the illustrations are copies for new cuts they should be separated from the manuscript and numbered or marked in such a way as will distinguish them. This saves the manuscript revisers the trouble of cutting out the illustrations, which will be necessary if they are a part of the manuscript. The book contains lists of common expressions with superfluous words and much other matter that characterizes bad English. A great deal of practical information regarding the business of printing and publishing is included. We would recommend the book to our readers in general, especially those who have the making up of advertising pamphlets, catalogues, brochures, etc.

Operations for the Article in this number entitled "Machine Shop Practice—Machining a Fixture Casting."

SHOP OPERATION SHEET NO. 61.

H. A. S. Howarth. MACHINERY, May, 1908.

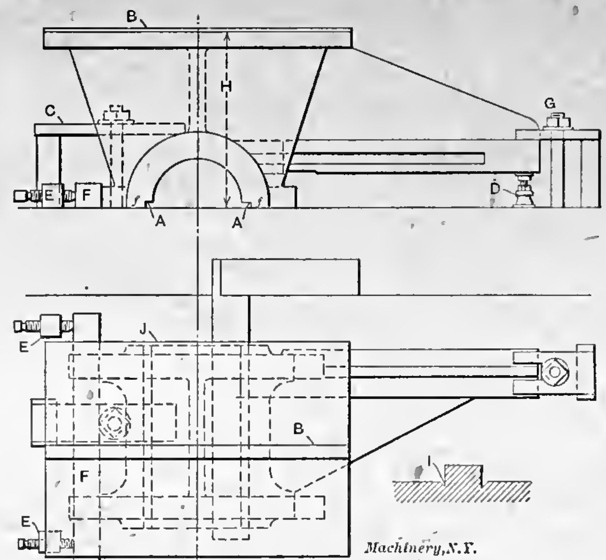


To Set Up and Plane the Bearing of a Fixture Casting.

1. Place the casting on the planer table, and insert small parallel pieces under each corner of the base.
2. Clamp a straight-edge A across the planer table, and set it square with the edge of the table.
3. Set the base of the casting with its tongue-piece B, parallel with the straight-edge by measuring at a and a', and b and b'. Place a square on the planer table and against the straight-edge, and measure from the blade of the square to the T-slot C, and ascertain whether or not it is parallel with the straight-edge. Both the T-slot and base should be as nearly parallel with the straight-edge as possible.
4. Fit a wooden centering piece in each end of the bearing, and locate the center c of the boss.
5. Place a straight edge against the side of the planer table, and measure from the straight-edge to the centers c at each end of the bearing. These measurements should be approximately equal.
6. After the casting is set clamp it firmly to the table, and place set-screw plugs E against the casting to take the thrust.
7. From one of the centers c, scribe arcs d with a radius equal to one-half the cap fitting. Remove the centers.
8. Rough and finish plane the surfaces F, and then plane the corners G to fit the previously finished cap. This fitting is kept central by working to the arcs d.
9. Cross-plane the top of the arm H at I and finish to required dimension e.

SHOP OPERATION SHEET NO. 62.

H. A. S. Howarth. MACHINERY, May, 1908.



To Set Up and Plane the Base of a Fixture Casting.

NOTE.—It is assumed that the top or bearing of the casting has been planed. This part was planed first to facilitate holding the casting when planing the base.

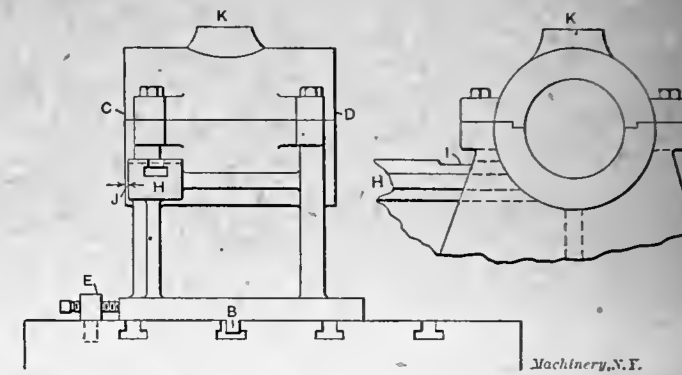
1. Place the casting on the planer with this trued surface against the table.
2. Set the finished surfaces A square with the side of the planer table, using the square as shown in the plan view. Fasten the casting to the table by the clamp C, then place the planer jack D under the projecting arm, and tighten the clamp G.
3. Place a bar F against the two lugs, as shown, and set it against them by the set-screw plugs E. Again test the casting with the square to make sure that it has not shifted. If a slight adjustment is necessary it can be made by the set-screws in the plugs E.
4. Rough and finish plane the base on both sides of the tongue B, making the distance H equal to the dimension on the drawing.
5. Finish the top of the tongue B to the required height, and on this finished surface lay out the tongue in proper relation with the ends of the bearing.
6. Finish one side of the tongue, cutting away the corner as shown at I in the sectional view. Finish the opposite side, making the tongue to the required width.

NOTE.—These corners are cut away as shown at H in order that the base of the casting may have a good bearing. If they were not removed there might be a heavy bearing at these points which would, of course, be undesirable.

7. True up the edge J of the base. This trued surface will be used in connection with a subsequent operation.

SHOP OPERATION SHEET NO. 63.

H. A. S. Howarth. MACHINERY, May, 1908.



To Set Up and Plane the Bearing Ends of a Fixture Casting.

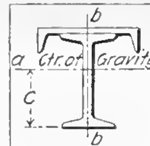
NOTE.—All the necessary drilling and tapping is supposed to have been done, and the cap bolted in position.

1. Place the casting on the planer table with one side of the tongue B against the side of the T-slot, and hold it in this position by the set-screw plugs E, one being placed near each end of the base. Clamp the casting securely to the table.
2. Rough plane one end C of the bearing, using the vertical feed. With a square, test this planed surface before taking the finishing cut, and see if it is at right angles with the table. If the base of the casting projects beyond the bearing ends, the square may be elevated high enough to clear the base by the use of parallels.

NOTE.—Before taking these vertical cuts, be sure that the cross rail is securely clamped, and at each setting of the tool clamp the head to the cross rail by the means provided. It is also well to have the tool slide so adjusted that it works rather snugly.

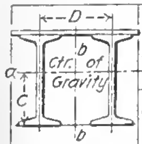
3. When finishing the end C of the bearing, it will be necessary to make the horizontal distance between this end and the tongue B equal to the dimension on the drawing. The tool can be set for the finishing cut by lowering it to the table and measuring directly from the cutting edge of the tool to the tongue; or, a square may be used, the square being set with the T-slot against which the tongue rests, and the measurement being taken from the blade of the square to the cutting edge of the tool. Of course, in this latter case it will not be necessary to lower the tool. After the tool has been properly set, finish the end C.
4. Rough and finish plane the end D, removing just enough stock to make the bearing the required length.
5. Plane one side of the arm H to a distance J from the end C.
6. Finish the top of the arm H, making its surface flush with the surface I which was finished to the required distance below the top of the bearing during the first operation. Before taking the cut over the arm H, be sure that the planer will reverse at the proper point.
7. Finish the boss K on the bearing cap.

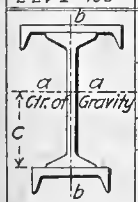
V.—SECTIONS FOR CRANE AND TELPHER RUNWAYS.

	Properties of Sections Consisting of One I- and One ⊔-beam.				
	Sectional Modulus			Moment of Inertia	Distance C
	Upper Chord Axis a-a	Lower Chord Axis a-a	Upper Chord Axis b-b		
10" ⊔ 15# 10" I 25#	52.06	27.15	14.09	182.72	6.73
10" ⊔ 15# 12" I 31.5#	70.22	39.97	14.35	311.78	7.80
12" ⊔ 20.5# 12" I 31.5#	81.71	40.66	22.19	333.39	8.20
12" ⊔ 20.5# 12" I 40#	90.41	50.31	22.55	396.91	7.89
10" ⊔ 15# 15" I 42#	103.55	64.87	14.86	607.83	9.37
12" ⊔ 20.5# 15" I 42#	118.80	66.06	22.62	648.68	9.82
15" ⊔ 33# 15" I 42#	151.94	68.18	42.65	724.77	10.63
12" ⊔ 25# 15" I 50#	135.28	75.02	25.33	742.67	9.90
12" ⊔ 20.5# 15" I 60#	140.17	90.13	23.56	838.22	9.30
15" ⊔ 33# 15" I 60#	173.59	93.20	43.43	933.90	10.02
12" ⊔ 20.5# 18" I 55#	161.57	99.11	23.16	1122.90	11.33
15" ⊔ 33# 18" I 55#	203.18	102.50	43.11	1253.60	12.23
15" ⊔ 33# 15" I 80#	197.81	120.17	44.48	1151.27	9.58
12" ⊔ 20.5# 20" I 65#	199.98	129.60	23.72	1594.03	12.30
15" ⊔ 33# 20" I 65#	247.50	133.85	43.56	1772.11	13.24
15" ⊔ 33# 20" I 80#	278.43	164.98	44.52	2113.31	12.81
15" ⊔ 40# 20" I 80#	305.44	168.05	49.12	2226.62	13.25
15" ⊔ 33# 24" I 80#	339.17	196.13	44.56	3032.18	15.46
15" ⊔ 55# 24" I 100#	455.00	239.53	60.64	3894.80	16.26

Contributed by F. W. Bowman.

VI.—SECTIONS FOR CRANE AND TELPHER RUNWAYS.

	Properties of Sections Consisting of Two I-beams and One Connecting Plate.					
	Sectional Modulus			Distance D	Moment of Inertia	Distance C
	Upper Chord Axis a-a	Lower Chord Axis a-a	Upper Chord Axis b-b			
1-12" x 3/8" Pl. 2-10" I's 25#	81.01	54.18	20.27	5.75	337.02	6.22
1-14" x 1/2" Pl. 2-12" I's 31.5#	131.53	81.72	36.30	7.50	630.03	7.71
1-14" x 1/2" Pl. 2-12" I's 40#	147.64	100.75	40.38	7.25	748.53	7.43
1-14" x 1/2" Pl. 2-15" I's 42#	192.53	131.50	40.03	7.00	1211.00	9.21
1-15" x 1/2" Pl. 2-15" I's 60#	239.39	179.40	55.30	7.50	1589.54	8.86
1-15" x 1/2" Pl. 2-15" I's 70#	251.22	196.35	61.22	7.50	1708.27	8.70
1-15" x 1/2" Pl. 2-15" I's 80#	285.65	230.98	65.55	7.25	1979.53	8.57
1-16" x 1/2" Pl. 2-18" I's 55#	279.02	197.60	60.51	8.50	2140.06	10.83
1-16" x 1/2" Pl. 2-20" I's 65#	347.57	257.80	65.48	8.25	3034.28	11.77
1-16" x 1/2" Pl. 2-20" I's 80#	406.10	318.45	67.99	7.50	3658.97	11.49
1-18" x 1/2" Pl. 2-24" I's 80#	504.42	379.58	90.22	9.50	5306.49	13.98
1-18" x 1/2" Pl. 2-24" I's 100#	545.59	435.11	106.12	9.50	5930.54	13.63

	The channel given first is on the top chord					
	Properties of Sections Consisting of One I and Two ⊔-beams.					
	Sectional Modulus				Moment of Inertia	Distance C
	Upper Chord Axis a-a	Lower Chord Axis a-a	Upper Chord Axis b-b	Lower Chord Axis b-b		
1-10" ⊔ 15# 1-10" I 25# 1-8" ⊔ 11.25#	62.87	43.62	14.09	8.97	321.89	5.12
1-12" ⊔ 20.5# 1-10" I 25# 1-10" ⊔ 15#	76.93	50.92	21.98	14.09	394.66	5.15
1-12" ⊔ 20.5# 1-12" I 31.5# 1-10" ⊔ 15#	99.54	68.40	22.19	14.35	603.23	6.22
1-12" ⊔ 20.5# 1-15" I 42# 1-10" ⊔ 15#	139.08	100.03	22.62	14.86	1040.34	7.80
1-15" ⊔ 33# 1-15" I 42# 1-12" ⊔ 20.5#	185.61	119.97	42.65	22.62	1336.49	8.20
1-12" ⊔ 20.5# 1-18" I 55# 1-10" ⊔ 15#	185.03	138.27	23.16	15.52	1652.32	9.35
1-15" ⊔ 33# 1-18" I 55# 1-12" ⊔ 20.5#	241.06	163.01	43.11	23.16	2075.17	9.79

Contributed by F. W. Bowman.

VII.—MOMENT OF INERTIA AND SECTION MODULUS OF CIRCULAR SECTIONS.

Moment of Inertia $I = \frac{\pi D^4}{64}$ Section Modulus $Z = \frac{\pi D^3}{32}$

D = Diameter in Inches. I = Moment of Inertia. Z = Section Modulus.

D	I	Z	D	I	Z	D	I	Z
1/16	0.000001	0.000024	2 3/16	1.1240	1.0276	4 1/2	20.129	8.9462
1/8	0.000012	0.000192	2 1/4	1.2581	1.1183	4 5/8	22.460	9.7126
3/16	0.000061	0.000647	2 5/16	1.4038	1.2141	4 3/4	24.989	10.522
1/4	0.000192	0.001534	2 3/8	1.5618	1.3152	4 7/8	27.725	11.374
5/16	0.000468	0.002996	2 7/16	1.7328	1.4218	5	30.680	12.272
3/8	0.000971	0.005177	2 1/2	1.9175	1.5340	5 1/8	33.865	13.215
7/16	0.001798	0.008221	2 9/16	2.1166	1.6520	5 1/4	37.291	14.206
1/2	0.003068	0.012272	2 5/8	2.3307	1.7758	5 3/8	40.972	15.245
9/16	0.004914	0.017473	2 11/16	2.5607	1.9057	5 1/2	44.918	16.334
5/8	0.007490	0.023968	2 3/4	2.8074	2.0417	5 5/8	49.143	17.473
11/16	0.010967	0.031902	2 13/16	3.0714	2.1841	5 3/4	53.659	18.664
3/4	0.015532	0.041418	2 7/8	3.3537	2.3330	5 7/8	58.479	19.908
13/16	0.021393	0.052659	2 15/16	3.6550	2.4885	6	63.618	21.206
7/8	0.028774	0.065769	3	3.9761	2.6507	6 1/8	69.087	22.559
15/16	0.037919	0.080894	3 1/16	4.3179	2.8199	6 1/4	74.902	23.968
1	0.049087	0.098175	3 1/8	4.6814	2.9961	6 3/8	81.076	25.436
1 1/16	0.0626	0.1178	3 3/16	5.0673	3.1794	6 1/2	87.624	26.961
1 1/8	0.0786	0.1395	3 1/4	5.4765	3.3701	6 5/8	94.562	28.547
1 3/16	0.0976	0.1644	3 5/16	5.9101	3.5684	6 3/4	101.90	30.193
1 1/4	0.1198	0.1918	3 3/8	6.3689	3.7742	6 7/8	109.66	31.902
1 5/16	0.1457	0.2220	3 7/16	6.8540	3.9878	7	117.86	33.674
1 3/8	0.1755	0.2552	3 1/2	7.3662	4.2092	7 1/4	135.62	37.412
1 7/16	0.2096	0.2916	3 9/16	7.9066	4.4388	7 1/2	155.32	41.418
1 1/2	0.2485	0.3313	3 5/8	8.4762	4.6765	7 3/4	177.08	45.699
1 9/16	0.2926	0.3745	3 11/16	9.0761	4.9220	8	201.06	50.265
1 5/8	0.3423	0.4213	3 3/4	9.7073	5.1772	8 1/4	227.35	55.127
1 11/16	0.3980	0.4717	3 13/16	10.371	5.4404	8 1/2	256.24	60.292
1 3/4	0.4604	0.5262	3 7/8	11.068	5.7124	8 3/4	287.74	65.769
1 13/16	0.5298	0.5846	3 15/16	11.799	5.9932	9	322.06	71.569
1 7/8	0.6067	0.6472	4	12.566	6.2832	9 1/4	359.37	77.701
1 15/16	0.6918	0.7140	4 1/8	14.212	6.8908	9 1/2	399.82	84.173
2	0.7854	0.7854	4 1/4	16.015	7.5364	9 3/4	443.60	90.994
2 1/16	0.8883	0.8614	4 3/8	17.984	8.2212	10	490.87	98.175
2 1/8	1.0010	0.9421						

Contributed by John S. Myers.

VIII.—SHEAR STRESSES COMBINED WITH TENSION OR COMPRESSION STRESSES.

Let S = Unit Shear, t = Unit Tension or Compression,

S_m = Maximum Combined Unit Shear,

t_m = Maximum Combined Unit Tension or Compression.

Then $S_m = \sqrt{S^2 + \frac{t^2}{4}} = S\sqrt{1 + (\frac{1}{2}\frac{t}{S})^2} = Sy.$

And $t_m = \frac{t}{2} + \sqrt{S^2 + \frac{t^2}{4}} = t(\frac{1}{2} + \frac{1}{2}\sqrt{(2\frac{S}{t})^2 + 1}) = tx.$

$\frac{S}{t}$	Tension Factor x	Shear Factor y	$\frac{t}{S}$	Shear Factor y	Tension Factor x
0.05	1.0025	10.0499	0.05	1.0003	20.5060
0.10	1.0099	5.0990	0.10	1.0012	10.5130
0.15	1.0220	3.4801	0.15	1.0028	7.1854
0.20	1.0385	2.6926	0.20	1.0050	5.5250
0.25	1.0590	2.2361	0.25	1.0078	4.5312
0.30	1.0831	1.9437	0.30	1.0112	3.8706
0.35	1.1103	1.7438	0.35	1.0152	3.4006
0.40	1.1403	1.6008	0.40	1.0198	3.0495
0.45	1.1727	1.4948	0.45	1.0250	2.7778
0.50	1.2071	1.4142	0.50	1.0308	2.5616
0.55	1.2433	1.3515	0.55	1.0371	2.3857
0.60	1.2810	1.3017	0.60	1.0440	2.2401
0.65	1.3201	1.2616	0.65	1.0515	2.1177
0.70	1.3602	1.2289	0.70	1.0595	2.0135
0.75	1.4014	1.2019	0.75	1.0680	1.9240
0.80	1.4434	1.1793	0.80	1.0770	1.8463
0.85	1.4862	1.1602	0.85	1.0866	1.7783
0.90	1.5296	1.1440	0.90	1.0966	1.7184
0.95	1.5735	1.1300	0.95	1.1071	1.6653
1.00	1.6180	1.1180	1.00	1.1180	1.6180
1.05	1.6630	1.1076	1.05	1.1294	1.5757
1.10	1.7083	1.0985	1.10	1.1413	1.5375
1.15	1.7540	1.0904	1.15	1.1535	1.5031
1.20	1.8000	1.0833	1.20	1.1662	1.4718
1.25	1.8463	1.0770	1.25	1.1793	1.4434
1.30	1.8928	1.0714	1.30	1.1927	1.4175
1.35	1.9396	1.0664	1.35	1.2065	1.3937
1.40	1.9866	1.0619	1.40	1.2207	1.3719
1.45	2.0338	1.0578	1.45	1.2352	1.3518
1.50	2.0811	1.0541	1.50	1.2500	1.3333

Contributed by John S. Myers.

MACHINERY.

May, 1908.

A 2,000 H. P. GAS ENGINE BLOWING UNIT.*

ONE of the great changes going on in power plant equipment is the use of large gas engines and steam turbines in place of the reciprocating steam engine. The internal combustion engine and steam turbine are slowly but surely supplanting the reciprocating steam engine except for such service as reversing rolling mills and mine hoists. In other fields it apparently has an unpromising future. When the old steam engine is displaced, the fight will be on between the gas engine and the turbine. Considerations of economy incline the engineer to believe that the gas engine will be the favorite motor of the future.

Only a few years ago the internal combustion motor was, at best, considered of comparative inconsequence, its field being limited to motor boats, small power plants, etc. Even in 1893 there was exhibited at the Columbian Exposition a gas engine of about 100 H. P. which attracted much attention because of its large size. Now gas engines of 2,000, 3,000 and even 4,000 H. P. are in use, giving performance much more economical than is possible with the best steam plants using superheated steam. Of particular interest is the use of gas engines in steel plants and blast furnaces, because of the great economy afforded by the use of blast furnace gas. Instead of permitting this valuable fuel, aggregating thousands of horse-power in plants of ordinary size, to be worse than wasted, it is piped away to scrubbers and washers where the dust is so thoroughly removed that it is commonly freer from suspended impurities than the atmosphere. Delivered to the engines, it is quite capable of turning every wheel in the plant, lighting every lamp, compressing the blast and (were it not for the mechanical difficulties of reversing) the entire power of a steel plant could be derived from the gases of the blast furnaces.

The illustrations show a Westinghouse 2,000 H.P. gas-engine-driven blowing engine recently built for the Edgar Thompson plant of the Carnegie Steel Co., Pittsburg, which will serve as an example of recent gas engine and blowing engine development. The blowing cylinders are of particular interest because of the novel way in which clearance is reduced to a minimum and the inlet valves mechanically operated. This construction, known as the "Slick air tub," is one of several schemes for preventing wire drawing of the incoming air because of having to lift inlet valves. Opening the valves by power effects a considerable economy of operation, and increases the volumetric capacity.

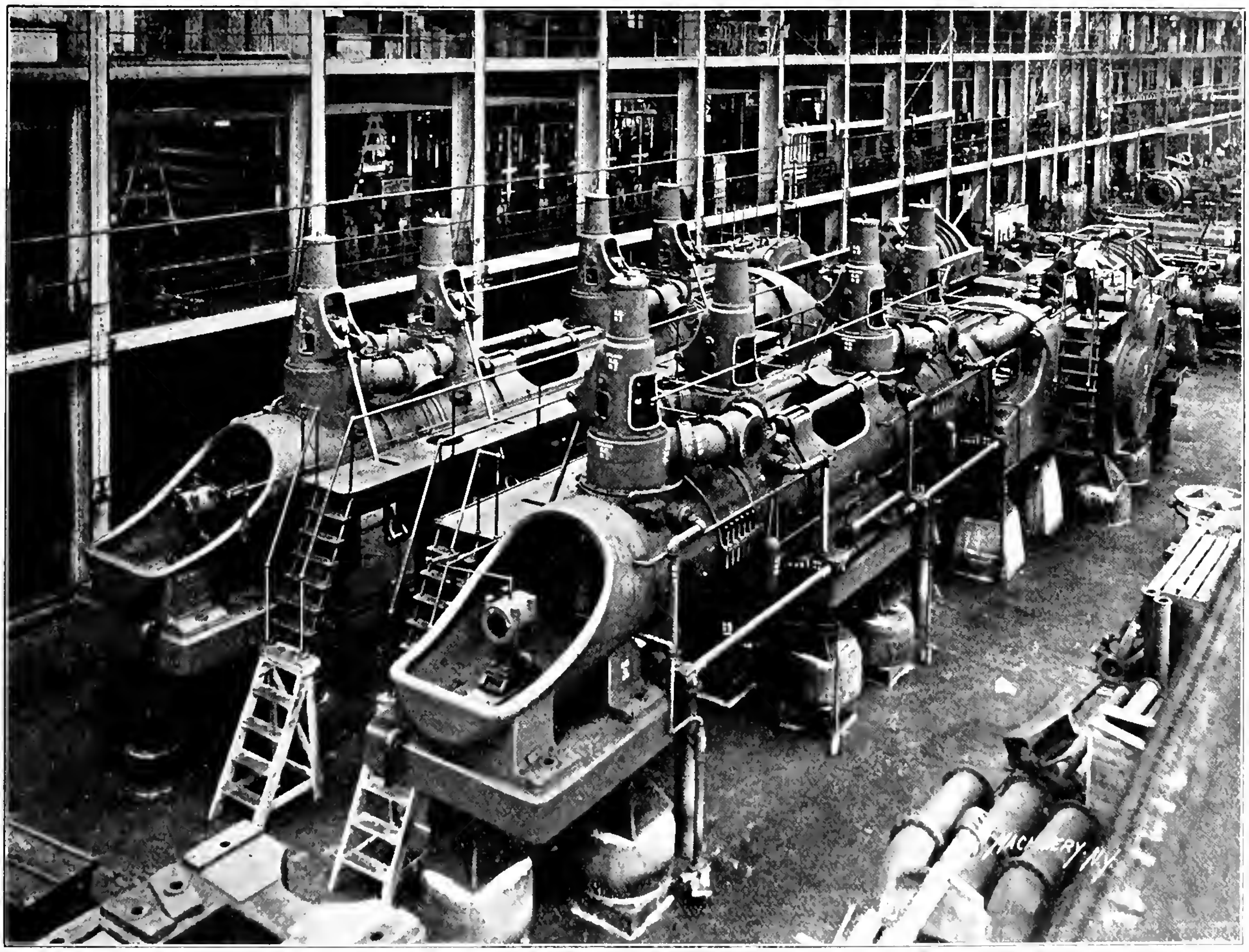


Fig. 1. The 2,000 H.P. Westinghouse Gas Engine Blowing Unit for the Edgar Thompson Steel Works, in the Course of Erection in the Shops of the Builders.

These engines are of the 4-cycle type, with two double-acting horizontal tandem cylinders acting on each of the two cranks; this gives four power strokes per revolution, the cranks being set ninety degrees apart. The cylinders are each 40 inches in diameter, and 54 inches stroke. The speed ranges from 65 to 75 revolutions per minute. The engines are intended for blowing service for the Bessemer converter plant, the blowing cylinders being of the "Slick air tub" type, which will be described later. Their capacity is 25,000 cubic feet of free air per minute, at a normal pressure of 18 pounds per square inch, running up to a maximum of 25 pounds. On blast furnace gas the brake horse-power is 2,400, which is increased to 3,100 when natural gas is used.

* For additional information on this subject, see the article on "Four 4,000 H. P. Gas Engines," published in the January, 1908, issue of MACHINERY, and other articles there referred to.

The Crank-shaft and Bearings.

The side crank construction is employed. This has the advantage of requiring but two bearings, which are easily aligned. As shown in Fig. 3, the shaft is solid, with solid cast steel cranks mounted on it. An unusual feature of the design is the fact that the pins are cast integral with the cranks, as shown in Fig. 4, thus avoiding the possibility of straining the metal between the crank-pins and the shaft in making press fits. The crank disks are cast with the crank-pins at the bottom of the core, thus insuring solid metal at this point. The dot and dash lines in Fig. 4 show the contour of the rough casting.

The main bearings, seen best in Fig. 2, are made in four parts, of which the two side pieces are adjustable by wedges. The two sides of these bearings are held together by tie-rods, passing through from side to side above the shaft. These tie-rods and the nuts for straining them may be seen projecting from the outer end of the housing in Fig. 2. By tightening the two sides together in this way, the thrust of the shaft is distributed equally between both sides of the bearing housing. This is a point of great importance in engines of large capacity. The bearing cap has a large central opening extending to the shaft, which is visible while the engine is running.

Cylinders and Housings and the Provision for Expansion.

One of the most serious difficulties met with in the design of gas engines of large size, is that of making provision for the expansion of the structure, resulting from the high heat to which the working parts are subjected. In the case of this engine, only the front housing is fastened to the foundation. The cylinders are supported by the housings at the ends, not resting on the foundation at all; and the center and rear housing are not bolted to the foundations, but are free to slide on them, as the whole structure (fastened only at the other end) expands or contracts with the heating and cooling of the parts.

This high heat also makes necessary great care in the design of the cylinders. They must be of such form that they will expand evenly under the influence of the heating, without warping or twisting in any way. As may be seen in Figs. 6 and 7, they are very nearly symmetrical. In the case of large engines, such as the ones shown herewith, the cylinders are cast in two pieces, as may be seen in Fig. 6. The two halves of the cylinders are held tightly together by the links shown, shrunk into slots in the flanges where the joint between the two halves is made. This makes the two castings practically a solid piece.

The cylinders are, of course, water jacketed. As may be seen in Fig. 6, the jacket walls of the cylinders are cast open at the center, thus avoiding cooling strains in the metal. In Fig. 7, which shows the completed cylinder, the gap between the two jacket castings is covered with the jacket band piece, which is fitted with a water-tight joint, permitting expansion or contraction without the serious strain which would result in so large a cylinder, from the difference in the expansion of the hot inner wall and the cool outer wall of the jacket, if the latter were one solid piece. The removal of this jacket band gives free access to the water spaces for cleaning. Free access is also given to the interior of the cylinder through the large valve opening shown. The valve covers and cylinder heads are also cast hollow for water-jacketing and are provided with suitable openings to facilitate cleaning them thoroughly.

Another variation from steam engine practice made necessary by the great weight of the parts and the high heat to which they are subjected, is the provision made for supporting the pistons from the cross-heads outside of the cylinder, so that no part of their weight bears on the interior surface of the cylinder. The piston of the front cylinder is carried by the main and intermediate cross-heads, while that of the rear cylinder is carried by the intermediate cross-heads and the tail bearings. The pistons are one-piece symmetrical castings, with no sharp corners to induce premature ignition. The rods are packed by water-cooled metallic packings, which receive their oil supply at the center of their length, thus properly distributing the lubrication. The hollow rods serve to feed cooling water to the interior of the piston.

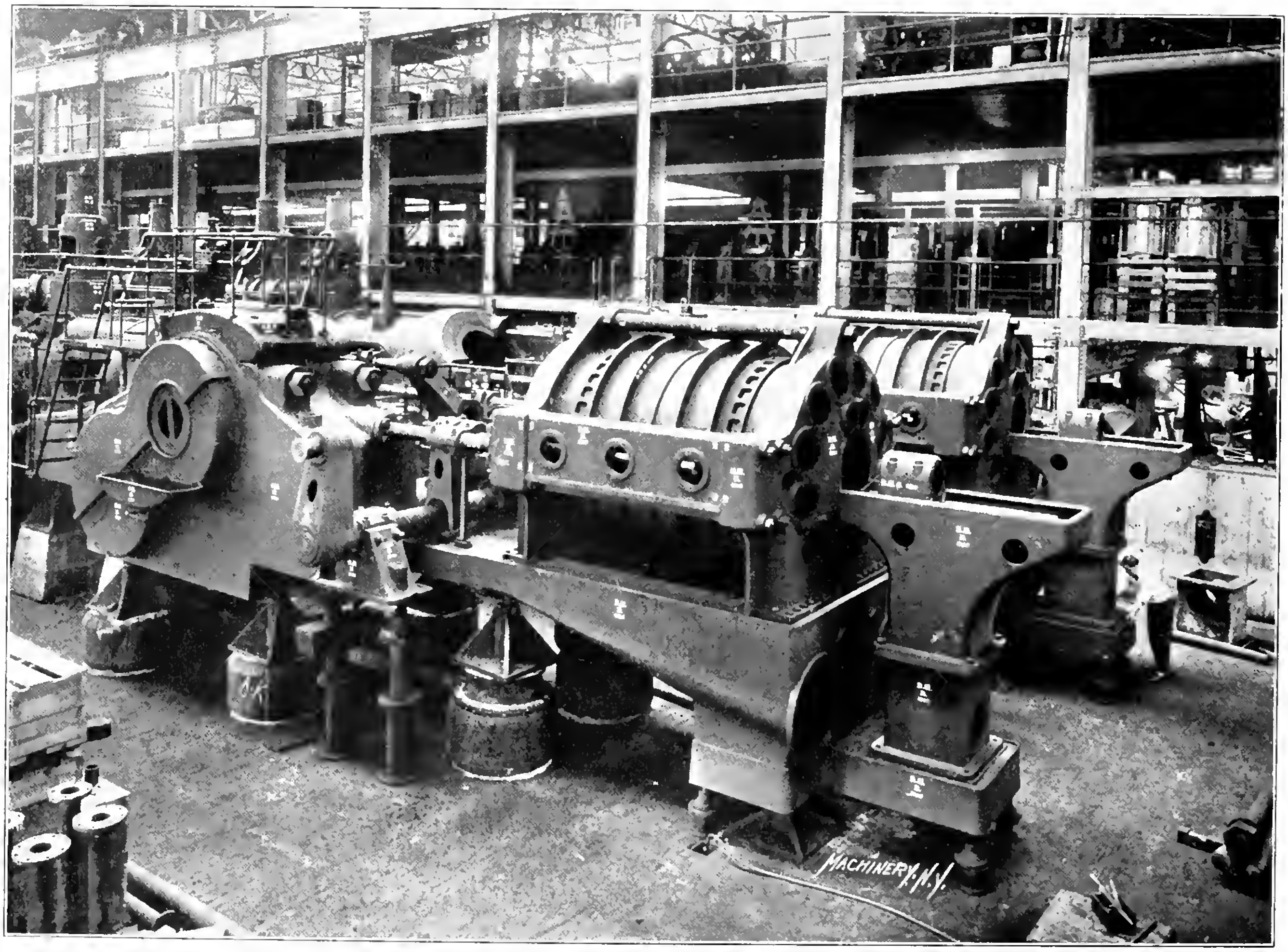


Fig. 2. Another View of the Engines, taken during Erection, showing Blowing Cylinder and Main Bearings.

Valves and Valve Mechanism.

The valves are of the poppet type, with inlet valve ports located at the top of the cylinder, and the outlet ports directly opposite, at the bottom. A mezzanine floor below the level of the engine room is provided for inspecting the lower valve gear, easy access being given to all parts of the mechanism, owing to the fact that the cylinders are separated from the housings, leaving a free, open space beneath them.

The valve gear will be best understood by reference to Fig. 8. It is operated from a lay-shaft, driven by bevel and

Fig. 3. A Completed Crank-shaft with the Cranks, Spur Gears, Blowing Engine Eccentrics, and Fly-wheel Flanges in Place.

spur gears from the spur gears on the crank-shaft, shown next to the eccentrics in Fig. 3. This use of bevel and spur gears in the place of the usual spiral gears obviates the back-lash resulting from the rapid wear of the latter type of gear, and removes the necessity for taking care of the end thrust to which it is subjected. These driving gears have "hunting teeth" to distribute the wear evenly. An eccentric is provided on the long shaft, at each end of each cylinder, the same one serving to operate both the inlet and the outlet valve.

The inlet valves (of the poppet variety, as previously explained), are held up to their seats by helical springs, as shown. The reach rod from the eccentric operates a rocker cam bearing on a lever, which forces the valve open at the proper time, and allows it to return under the influence of the spring when it is time to close it. This valve operating mechanism is an improved form of the well-known gear used on four-valve paddle-wheel engines. It is especially suited for use on gas engines, as it may be arranged to give a great

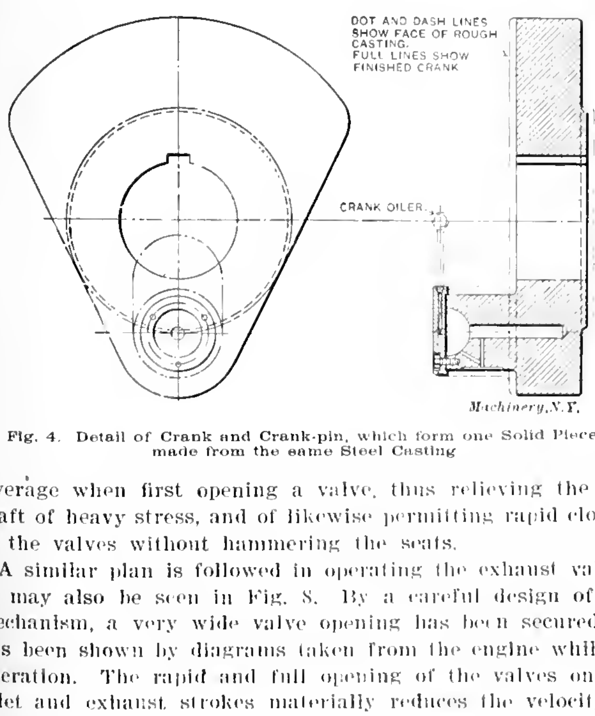


Fig. 4. Detail of Crank and Crank-pin, which form one Solid Piece made from the same Steel Casting

leverage when first opening a valve, thus relieving the lay-shaft of heavy stress, and of likewise permitting rapid closing of the valves without hammering the seats.

A similar plan is followed in operating the exhaust valves, as may also be seen in Fig. 8. By a careful design of the mechanism, a very wide valve opening has been secured, as has been shown by diagrams taken from the engine while in operation. The rapid and full opening of the valves on the inlet and exhaust strokes materially reduces the velocity of the gases, lessens the resistance to passage through the valves, and considerably increases the capacity of the cylinders.

The exhaust valves are made hollow, and are water-cooled. The cooling water is supplied to the outside portion of the valve, the outlet being by means of a pipe extending through the interior to the top, thus insuring that the valve is always full of water, and preventing the possibility of air pockets. The valve stems of both inlet and exhaust valves are oiled at about the middle of the bearing, thus insuring the lubrication of the whole surface. The valve covers are fitted with a tight joint at their inner ends, thus exposing a minimum surface to the heating action of the products of combustion, and insuring well-cooled valve seats.

Governing Mechanism.

The inlet valve combines the function of inlet, mixing, and governor valves in the single mechanism. A cast-iron sleeve, carried on the valve stem, and free to revolve on it, is provided with two sets of ports, one for gas and one for air, registering with corresponding openings in the valve bonnet in which it fits. This sleeve is revolved on the stem by reach rods from the governor, thus more or less throttling the mixture supplied to the cylinder. It is evident that the sleeve on the valve stem moves up and down, in addition to its rotation under the influence of the governor. This compound movement prevents any possibility of the governor valve sticking when the engine is running under constant load for long periods, during which the governor valve does not change its position.

Another advantage of this arrangement is the fact that the gas and air are mixed at the point where they enter the cylin-

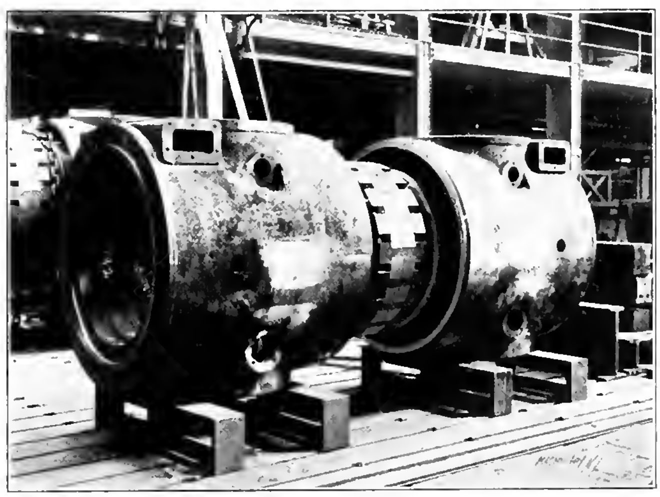


Fig. 5. Partly Finished Cylinder Casting, the Two Halves are shrunk together by the Links shown.

der, as fast as they are needed by the engine, thus avoiding large quantities of idle mixed gases with the resulting difficulty of a large volume of gases exposed to premature ignition. The governor also has the most effective possible control of the engine under these conditions, as the mixture at each end of each cylinder is independently controlled, thus giving far better regulation than can be obtained when the controlling is done at a distance from the inlet ports.

The governor acts on the mixing valves through a relay cylinder, operated by oil pressure. The sole function of the governor is to operate a small pilot valve which controls the movement of the piston in the governing cylinder, which latter is connected by reach rods with the mixing valves on the cylinders of the engine. It is evident, therefore, that the governor is not affected by the movement of the reach rods or by the force required to move them, as it has only to move this small pilot valve. A dash pot is provided on the governor to prevent hunting under variable loads. The governor is driven directly from the main shaft at a point near the front of the machine, where it is unaffected by any slight torsional deflection to which the lay-shaft may be subjected.

In addition to the governor a safety stop is provided, consisting simply of a spring-balanced pin supported in the rim of the fly-wheel, which is forced outward by centrifugal force, if the speed exceeds a predetermined limit. It then

strikes a pawl, which in turn releases a weight attached to a knife switch, which falls and thus opens the igniter circuit, this being the simplest and most positive method of instantly cutting off the power of a gas engine. A safety stop is also provided to automatically open the igniter circuit in case of the failure of the cooling water supply.

Ignition.

The method of ignition used is the result of careful and extensive experiments. The jump spark system was found impractical on all but small engines, operating on rich gas, or

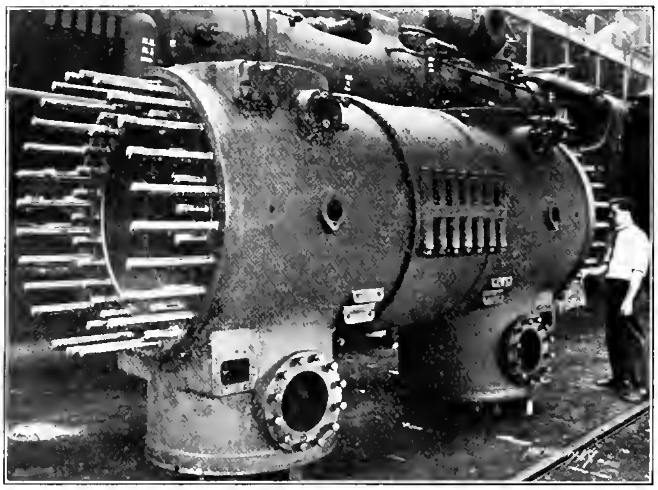


Fig. 6. Completed Cylinder Casting with the Jacket Band in Place.

low compression gasoline gas, because of the fact that the potential required to jump the gap increases directly with the pressure, so that for the high compressions necessary for producer, blast furnace and other "lean" gases, excessive potential is required. The make-and-break system of ignition has therefore been adopted. Each end of each cylinder is provided with three igniters, each with its own independently fused circuit, so that the possibility of a misfire is reduced to a minimum. This gives uniform combustion as well, the charge being lighted at more than one point. The igniter contacts are of cast iron or special bronze which has been found to have remarkable wearing qualities, especially for the low temperature required for ignition by this system. Each igniter circuit is provided with an indicator, which gives visible witness of its operation. Each side of each circuit is separately insulated so that six separate grounds are required to put one end of the cylinder out of commission.

Two forms of ignition gears are employed in the Westinghouse engine, one being mechanically, and the other electrically operated. In either case provision is made for adjusting the time of the ignition. The electrical ignition gear, used on this engine, is operated from a timer or contactor for making and breaking the igniter circuits. In place of the knock-off cams used on the mechanical gear, an electrical knock-off device is used, which is controlled by electrical magnets, operated by the timer mentioned. The advantages of this system are that the ignition is easily advanced and retarded, the same as in the mechanical gear, and that all the igniters at each end of each cylinder are necessarily operated simultaneously. The timer is shown at the right of Fig. 8.

Lubrication.

The engine oil lubrication is effected by a continuous gravity system with filters, insuring ample lubrication of all bearings, crank-pins, cross-heads, etc. All important parts are supplied with right feed oilers. The lubrication of the cylinders is effected by a timed forced lubrication system somewhat similar to, and a development from, that used in automobiles. This system, as applied to the engine, is shown in Fig. 8. Four eccentrics are used, operating valves for each of the two ends of the two cylinders. The oil is supplied at four points in the cylinder, during the suction stroke only. This is a point of great importance, as it gives two working strokes at low temperature, during which all the oil is evenly distributed over the cylinder, thus insuring good lubrication with a minimum supply of oil. The pistons do not touch the cylinders at any point, so that the piston rings form recesses which distribute the oil evenly.

Automatic Starting Mechanism.

The starting mechanism is automatic, and is operated by compressed air. An air supply pipe, controlled by an unbalanced poppet valve, is fitted to each end of each cylinder, this valve being located directly under an air knock-off cam mounted on the main lay-shaft. To start the engine it is only necessary to turn on the main air valve. This causes the poppet valves to move upward to their seats, one or more of the valves being held down, thus admitting air to the proper cylinders, causing the engines to turn over. As the air is admitted to the cylinder during the power stroke, the exhaust valves permit thė escape of the air from the cylinder during the succeeding stroke.

The "Slick Air Tub."

The blower end of this engine is not the least interesting part of the machine. It is of the design known as the "Slick air tub," which has been very successfully used for the handling of air at low and medium pressures. A great point in the mechanical handling of air at low pressures is the provision for ample port area and small clearance. This is effected in the Slick air tub in a way that will be understood from reference to Figs. 2 and 9.

The cylinder heads are stationary and are fastened to the bed, but the cylinder itself slides on the heads, being reciprocated by reach rods from a rock-shaft driven from the air tub eccentric. The eccentrics may be seen between the spur

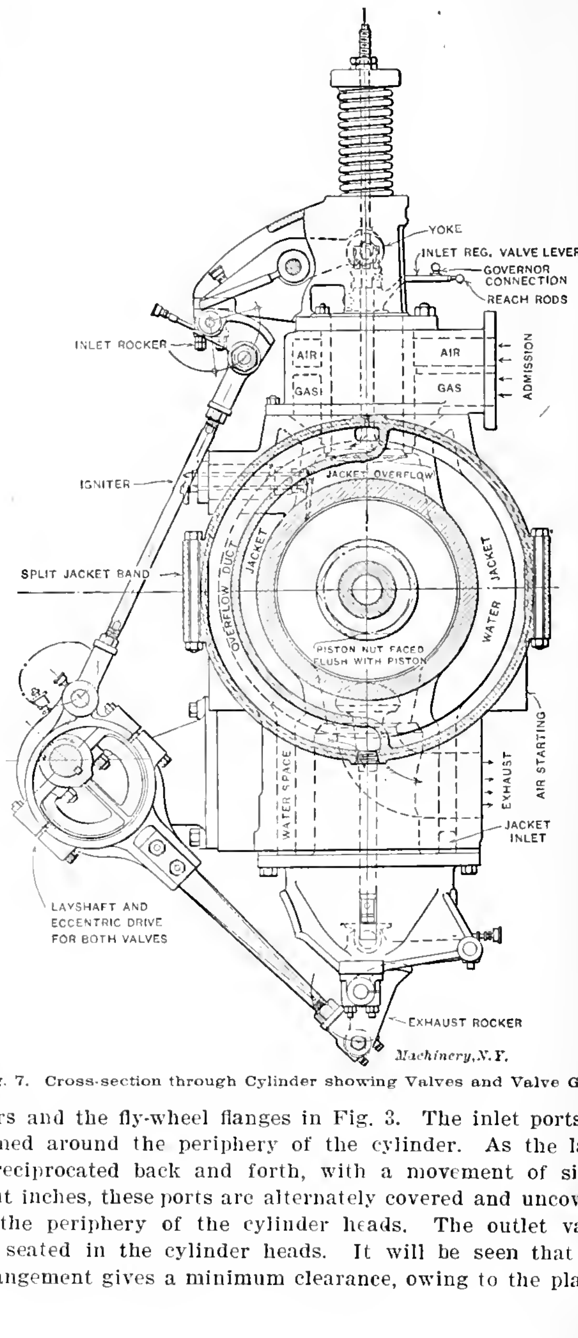


Fig. 7. Cross-section through Cylinder showing Valves and Valve Gear.

gears and the fly-wheel flanges in Fig. 3. The inlet ports are formed around the periphery of the cylinder. As the latter is reciprocated back and forth, with a movement of six or eight inches, these ports are alternately covered and uncovered by the periphery of the cylinder heads. The outlet valves are seated in the cylinder heads. It will be seen that this arrangement gives a minimum clearance, owing to the placing

of the outlet valves in the heads, and the fact that no clearance whatever is required for the inlet ports. The whole area of the heads is available for the outlet valves, while as much of the cylinder periphery as may be necessary can be devoted to the inlet ports.

The parts shown in diagrammatic form in Fig. 9, may be easily followed in the half-tone engraving in Fig. 2. It will

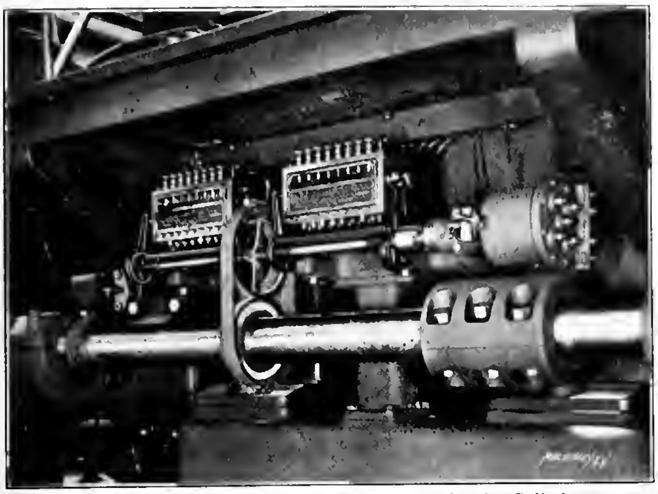


Fig. 8. The Forced Lubricating Apparatus for the Cylinders, and Ignition Timer.

be seen that the piston of the blowing engine cylinder is driven by distance rods from the main cross-head, the crank lying between the cross-head and the blowing cylinder.

The Westinghouse Line of Gas Engines.

The line of gas engines of which the one we have shown is an example, has been designed to be operated without change of design on the wide range of fuels available for the purpose. These fuels include blast furnace gas of 85 to 90 B. T. U. per cubic foot, producer gas from anthracite and bituminous coal, natural gas from the Kansas and Pennsylvania fields, and by-product coke oven gas running as high as 66 per cent hydrogen. All are being successfully employed in the same design of engine.

Various sizes are built, both vertical and horizontal, the former being employed up to 300 H. P., and the latter from there on up to the maximum 3,000 or 4,000 H. P. units. By far the largest number of them are used for driving electric generators, either directly connected or belted, the majority being for alternating current plants. The vertical design has made use of the spring coupling in this service. In horizontal engines, such as that shown in this article, these are unnecessary, except for some particularly difficult high fre-

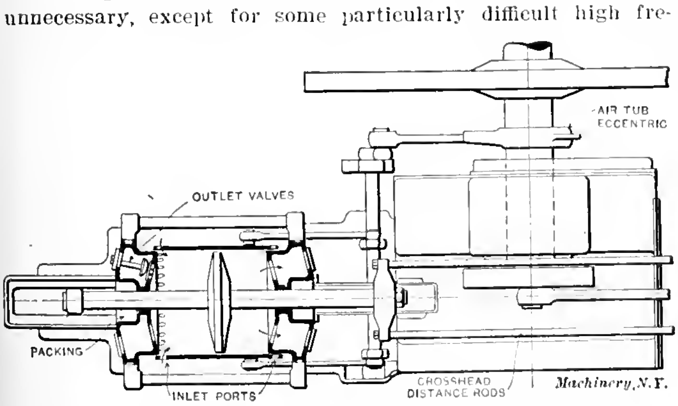


Fig. 9. Diagram showing the Mechanism of the "Slick Air Tub"

quency installations. Owing to the system of governing, applied directly to the inlet of each cylinder, a speed regulation as close as 2½ per cent may be obtained.

Owing to the inherent efficiency of the four-stroke cycle, gas engine economy is largely independent of the size, and a 200 or 300 H. P. vertical engine will give nearly the same efficiency as a large horizontal engine like the one shown. This efficiency ranges close to 10,000 B. T. U. per brake horsepower per hour. The efficiency is largely independent of the kind of gas used, owing to the fact that weaker gases will take a higher compression—almost 200 pounds per square inch, for instance, for furnace gas.

THE DESIGN OF SPRINGS FOR GAS ENGINE VALVES.

F. E. WHITTLESEY.*

Springs for gas engines should be carefully designed, and if properly proportioned for the work they must do, should be just as reliable as any other part of the mechanism. While the general data for spring design are well known to engineers, yet attention may properly be given to some considerations specially applicable to gas engine valve springs. This article will consider compression springs of round steel wire only, as the writer knows of no valid reason for the use of any other material or section for this class of springs. It is well known that square steel is less desirable than round steel for springs, both on account of the higher cost of the springs per pound, and from the standpoint of efficiency.

The first consideration is the selection of the proper values for the fiber stress S and the torsional modulus of elasticity G. Experiments have shown that a fair value for G is 12,500,000, which value is fairly constant for the various grades and tempers of steel within their elastic limits. The safe value for S is not so easily determined, because the correct value for any given class of springs is largely a matter of experience. The highest normal value of S varies from about 120,000 pounds per square inch for 1/16-inch wire, to 90,000 pounds for ⅝-inch wire, which includes the range of sizes generally used on valves. The term "normal value" is used to distinguish these figures from the higher values which can be reached by spring makers, and which are sometimes necessary, but should never be used for rapidly vibrating springs, or for springs where safety and long life are primary considerations, as in this class of springs. In fact, even the above normal values are far too high for gas engine springs. These values are used very generally on machinery springs, etc., but should be reduced very materially to obtain springs which will give the maximum of service in gas engine work. A value of S of from 25,000 to 30,000 pounds per square inch has been found to give best results for gas engine valves.

The third variable is the length of the spring, which should be as long as practicable in order to keep the pressure on the lever or cam which operates the valve from being higher than necessary at the extreme lift of the valve. To illustrate this point we will take a valve on which a pressure of 40 pounds when closed is desired, and which opens ½ inch. If the spring is under ½ inch compression when the valve is closed, and holding 40 pounds, the pressure when the valve is open will be 80 pounds. But if we use a spring under 1¼ inch compression to hold 40 pounds when the valve is closed, when the valve is opened the ½-inch travel, the pressure will be increased to only 56 pounds. The diameter and assembled length of the spring will usually be determined by the general design of the engine. The diameter should be as large as convenient, which will lessen the tendency to buckle.

We will now design a spring for an exhaust valve, the lift of the valve being ½ inch, the assembled length of the spring 6 inches, the pitch diameter of the spring 2 inches, and the value of S at extreme compression 25,000 pounds per square inch. We will make the spring 7¼ inches long, thus giving a total compression of 1¾ inch, and a final pressure of 56 pounds. The following formulas will be used:

$$P = \frac{11d^3S}{28D} \quad \ldots (1) \qquad f_1 = \frac{22D^2S}{7Gd} \quad \ldots (2)$$

P = pressure at given compression,
d = diameter of wire in inches,
D = pitch diameter of spring in inches,
f_1 = deflection of one coil in inches,
S = fiber stress in pounds per square inch,
G = torsional modulus of elasticity.

[The common form of the formulas (1) and (2) is

$$P = \frac{S\pi d^3}{16R} \quad \ldots (3) \qquad f = \frac{32PR^2l}{G\pi d^4} \quad \ldots (4)$$

In these formulas P, d, S, and G, denote the same quantities as in formulas (1) and (2), and

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R = pitch radius of spring in inches,
f = deflection of the whole spring under load,
l = full length of wire in spring.

The formulas (3) and (4) can easily be transformed to the form in (1) and (2) by writing $\pi = 22/7$, $R = D/2$, and $l = \pi Dn$ (n being the number of coils in the spring).—EDITOR.]

We use formula (1) to determine the size of the wire. Substituting the known values, we have

$$56 = \frac{11d^3 \times 25{,}000}{28 \times 2}, \text{ or } d = 0.225.$$

We therefore will use No. 4 Washburn & Moen gage wire, which is 0.225. To determine the deflection per coil, we will substitute the known values in formula (2), as follows:

$$f_1 = \frac{22 \times 4 \times 25{,}000}{7 \times 12{,}500{,}000 \times 0.225} = 0.112 \text{ inch.}$$

The free length of the spring is $7\frac{1}{4}$ inches, and the length with the valve open is $5\frac{1}{2}$ inches, the compression therefore is $1\frac{3}{4}$ inch. Then $1\frac{3}{4} \div 0.112$ (the compression per coil) gives $15\frac{3}{4}$ acting coils approximately, and adding one coil on each end, for a flat bearing to be ground at right angles to the axis of the spring, gives $17\frac{3}{4}$ total coils. Therefore the spring will be 2-inch pitch diameter, $7\frac{1}{4}$-inch free length, No. 4 W. & M. gage wire, $17\frac{3}{4}$ total coils, squared and ground ends, holding 40 pounds at 6 inches long, and 56 pounds at $5\frac{1}{2}$ inches long, with a fiber stress at $5\frac{1}{2}$ inches long of 25,000 pounds per square inch.

If it is desirable that the pressure, when the valve is open, rise *as little as possible* above 40 pounds, we must make the spring as long as possible and still compress to the closed length given. We will assume a spring 2 inches pitch diameter, to hold 40 pounds when 6 inches long, and as little over 40 pounds as possible at $5\frac{1}{2}$ inches long. As we do not know the pressure at $5\frac{1}{2}$ inches long, we will take the fiber stress 25,000 pounds at 6 inches long, instead of at total compression.

Using formula (1): $40 = \frac{11d^3 \times 25{,}000}{28 \times 2}$, or $d^3 = \frac{224}{27{,}500}$, and $d = 0.200$.

We will therefore use No. 5 W. & M. gage wire, which is 0.207.

Using formula (2): $f_1 = \frac{22 \times 4 \times 25{,}000}{7 \times 12{,}500{,}000 \times 0.207} = 0.1215$ inch

compression per coil when holding 40 pounds. Then $5\frac{1}{2}$ inch solid length less twice 0.207 gives the length occupied by the acting coils when solid, or 5.086 inches, and $5.086 \div 0.207 = 24.5$ acting coils. Further, $24.5 \times 0.1215 = 2.975$ inches compression, which added to 6 inches gives 8.975 inches free length of the spring, say 9 inches. The spring therefore compresses 3 inches when holding 40 pounds, with a value of S of 25,000 pounds and at $5\frac{1}{2}$ inches long, being compressed $3\frac{1}{2}$ inches, holds $46\,2/3$ pounds, with a value of S of $\frac{46\,2/3}{40} \times$ 25,000 or $29{,}166\,2/3$ pounds.

In these examples we have not corrected the values of S to allow for the variation in sizes of wire used, from the theoretical sizes obtained, as it is not necessary to do so in practice. It is interesting to note, however, the difference in this value at final compression, obtained by the above method of proportion based on 25,000 pounds at 40 pounds pressure, from that obtained by using the original formula with the final pressure of $46\,2/3$ pounds, and wire of 0.207 inch diameter. The first method gives 29,166 pounds, while the second method gives 26,782 pounds, this difference being caused by the difference of 0.007 in the size of wire.

* * *

The growing practice of casting threaded holes in machine details is referred to by the *Engineering Record*. Wrought iron nuts are inserted in the molds and properly located, being held securely by projections from the cores. For work which does not necessitate any high degree of accuracy, the nuts can be placed in the casting close enough for the purpose required. This obviates the necessity of drilling and tapping operations at the same time, as wrought iron threads have greater strength than the threads cut in the cast iron itself.

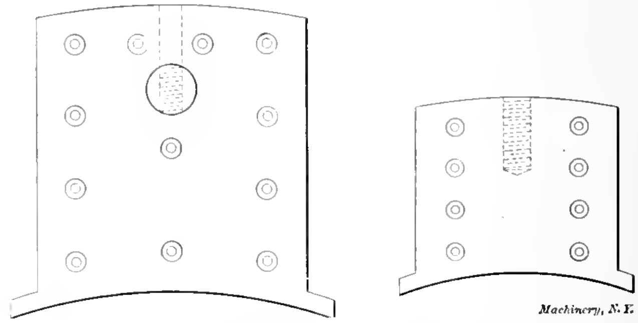
POLE PIECE DESIGN FOR DYNAMOS.*

E. A. LÖF.†

To give a definite rule for the design of pole pieces is almost impossible, due to the many different shapes of poles used by the various dynamo manufacturers. The parts of which a pole piece consists are the punchings, the end-plates, the rivets, and the bolts holding the pole piece to the frame. Each of these parts will in the following treatise be treated separately, and some data and dimensions will be given, illustrating the present practice of their design.

Punchings.

The punchings are made up of soft sheet steel, carefully annealed, and of a size of about No. 16 U. S. gage. Before assembling, each punching should be thoroughly lacquered with an approved insulating varnish, and then left to dry. For determining the number of punchings required for a pole piece of a certain width, it may be said that the lacquer occupies about 5 per cent of the total width. The punchings are pressed together in a hydraulic press. The shapes of the punchings vary greatly, dependent upon the electrical design.



Figs. 1 and 2. Examples of Types of Pole Piece Design.

Figs. 1, 2, and 3 show a few of the various forms of punchings used. Some manufacturers have one of the face-corners of each punching cut off, and the laminations are laid with the beveled corners alternately to one side and then the other, thus producing a pole piece with saturated tip.

End-plates.

To give the pole piece a more substantial construction, an end-plate of heavier thickness is provided for each end. These end-plates are made up of tank steel, and are of the same form as the punchings. The edges are either straight or rounded. If straight, they should be chamfered at 45 degrees, and if rounded, the radius should be equal to the thickness of the plate, as shown in Figs. 4 and 5. The thickness of the plate is determined by the size of the rivets holding the pole pieces together. Table I gives suitable thicknesses based upon standard rivet diameters.

TABLE I.

Rivet diameter	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{3}{4}$
End-plate	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{3}{4}$

Rivets.

Some methods of distributing the rivets are shown in Figs. 1, 2, and 3. This distribution, however, is entirely dependent upon the shape and size of the pole piece. If there is not sufficient space for a standard size rivet, a greater number of smaller diameter rivets should be used. Rivets should not be placed too close to the edges. The distance from the rivet to the edge should never be less than the diameter of the rivet. If less, the end-plate is liable to break.

TABLE II.

Building-up pressure in tons	10	15	20	25	35	40	60
Rivet diameter	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{3}{4}$

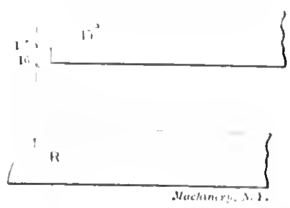
The building-up pressure required for a pole piece is usually a reasonable guide for determining the rivet diameters. Table II gives dimensions of rivet diameters such that the building-up pressure will head-up the rivets cold in pairs.

* See MACHINERY, January, 1907: Mechanical Calculations and Data for Dynamo Design.

† Address: 2121 W. Monroe St., Chicago Ill.

When the building-up pressure is 60 tons and over, 3/4-inch rivets should be used, if there is sufficient space for them. Larger size of rivets than 3/4 inch should not be used.

Fig. 3. A Third Type of Pole Piece Design.



Figs. 4 and 5 Design of Edge of End-plates

For determining the number of rivets required, it has been found from actual practice that as an average for every square inch of rivet there is about 40 square inches of punching area. Thus,

$$\text{Approximate number of rivets} = \frac{\text{Area of punching in square inches}}{40 \times \text{area of one rivet}}$$

Table III gives for each rivet diameter the area of the rivet, and a suitable pitch that will allow 40 square inches punching area for each square inch of rivet cross-section. It also gives the distances from the center of the rivets to the edge of the end-plate.

TABLE III.

Diameter of rivet....	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{3}{4}$
Area................	.049	.077	.110	.150	.196	.249	.307	.442
Pitch..............	$1\frac{3}{8}$	$1\frac{3}{4}$	$2\frac{1}{8}$	$2\frac{1}{2}$	$2\frac{3}{4}$	$3\frac{1}{8}$	$3\frac{1}{2}$	$4\frac{1}{4}$
Distance to edge.....	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$2\frac{1}{8}$

As mentioned before, the spacing of the rivets is, to a great extent, dependent upon the size and shape of the pole pieces, and good judgment must be relied upon to adjust the diameters and pitch so as to suit each particular case. The rivets may be either of the cold rolled steel tight-fit type or of the wrought iron clearance type.

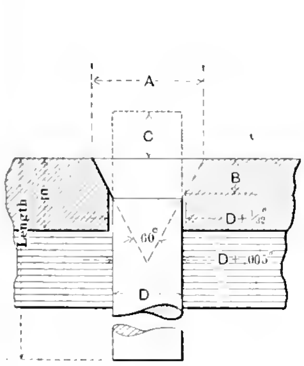


Fig. 6. Tight-fit Rivets.

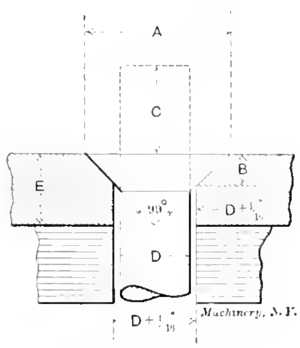


Fig. 7. Clearance Rivets.

Cold Rolled Steel Tight-fit Rivets.

For this type of rivets the holes in the punchings should be 0.005 inch larger than the rivet diameters. This will produce a tight fit when assembled. The holes in the end-plates should be 1/32 inch larger than the rivets. The riveting is done cold in the press; only the final peening of the head is done by hand. Tight-fit rivets are used in all bolted-in pole pieces. Fig. 6 and Table IV give dimensions for a standard line of tight-fit rivets.

TABLE IV. TIGHT-FIT RIVETS.

(See Fig. 6 for notations.)

Rivet Diameter D	A	B	C	E
$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$
$\frac{5}{16}$	$\frac{1}{2}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{3}{8}$
$\frac{3}{8}$	$\frac{5}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{3}{8}$
$\frac{7}{16}$	$\frac{3}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$
$\frac{1}{2}$	$\frac{13}{16}$	$\frac{9}{32}$	$\frac{5}{16}$	$\frac{1}{2}$
$\frac{9}{16}$	$\frac{15}{16}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{5}{8}$
$\frac{5}{8}$	1	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{5}{8}$
$\frac{3}{4}$	$1\frac{3}{16}$	$\frac{3}{8}$	$\frac{9}{16}$	$\frac{3}{4}$

Wrought Iron Clearance Rivets.

The rivet holes in the punchings and the end plates for this type of rivets are made 1/16 inch larger than the rivets.

TABLE V CLEARANCE RIVETS

(See Fig. 7 for notations.)

Rivet Diameter D.	A	B	C	E
$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{5}{16}$	$\frac{1}{4}$
$\frac{5}{16}$	$\frac{5}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{8}$
$\frac{3}{8}$	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{3}{8}$
$\frac{7}{16}$	$\frac{7}{8}$	$\frac{3}{16}$	$\frac{9}{16}$	$\frac{1}{2}$
$\frac{1}{2}$	1	$\frac{3}{16}$	$\frac{5}{8}$	$\frac{1}{2}$
$\frac{9}{16}$	$1\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{8}$	$\frac{5}{8}$
$\frac{5}{8}$	$1\frac{1}{4}$	$\frac{1}{4}$	$\frac{11}{16}$	$\frac{5}{8}$
$\frac{3}{4}$	$1\frac{1}{2}$	$\frac{5}{16}$	$\frac{3}{4}$	$\frac{3}{4}$

All riveting is done hot. Clearance rivets are used in all cast-in pole pieces. Fig. 7 and Table V give dimensions for a line of clearance rivets.

Bolts.

The pole pieces are secured to machined surfaces inside the frame by one or two bolts for each pole piece. These bolts pass through the frame into the pole piece. They do not, however, pass entirely through the poles, but leave the pole faces smooth and unbroken. For smaller pole pieces the treading is done directly in the punchings, but for larger sizes it is advisable to provide a large solid iron cross bar passing lengthwise through the pole piece. This bar in then drilled and threaded for the bolts. The former practice is shown in Fig. 2 and the latter in Fig. 1. The method of fastening the pole pieces by means of bolts permits the removal of the poles and the field coils without separating the frame, and repairs can be made in the shortest possible time. If only one bolt is used for holding the pole piece in place, it is advisable to provide a dowel pin to prevent the pole piece from turning.

In Figs. 8 and 9 are shown two kinds of bolts. The one shown in Fig. 8 is mostly used for rotating field pole pieces. Fig. 9 shows a machine bolt tapped into the pole punchings.

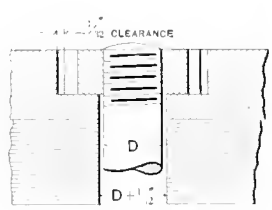


Fig 8 Steel Bolt for Rotating Field Pole Pieces.

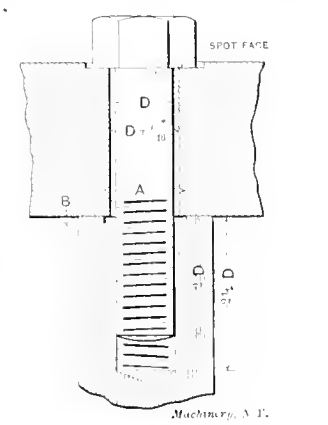


Fig 9 Machine Bolt tapped into Pole Punchings

Referring to the reference letters in Fig. 9, if D is less than $1\frac{3}{8}$ inch, then $A = D + \frac{1}{4}$ inch, and $B = \frac{1}{8}$ inch. If D is larger than $1\frac{3}{8}$ inch, then $A = D + \frac{3}{8}$ inch, and $B = 3/16$ inch. The diameter D of the bolts can be calculated from formulas as given in any mechanical handbook.

* * *

A new employers' liability bill, intended to meet the objections found by the Supreme Court of the United States, in declaring the previous bill passed unconstitutional, was passed by the House of Representatives at Washington on April 6. On April 9 the bill was also passed by the Senate. This law is specifically directed towards railroads engaged in interstate commerce, and will hold railroad companies liable for all injuries to employes while engaged in commerce between the states or territories, and also when engaged in commerce wholly within a territory. The bill passed in the House by a vote of 300 to 1, but it is feared that the present bill may not stand the test of constitutionality when subjected to the test of the Supreme Court.

COMPARATIVE VALUE OF ALCOHOL AND GASOLINE AS ENGINE FUELS.

The technologic branch of the United States Geological Survey, under the direction of Mr. J. A. Holmes, has recently completed an elaborate series of tests on the relative value of gasoline and alcohol as producers of power. The tests, over two thousand in number, probably represent the most complete and exact investigation of the kind that has been made either in this country or abroad, and includes much original research work.

Professor R. R. Fernald, engineer-in-charge of the gas producer section and professor of mechanical engineering in the Case School of Applied Science, Cleveland, Ohio, was in general charge of the tests. R. M. Strong, formerly connected with the engineering department of Columbia University, had personal supervision of the work. He was assisted by a corps of specially-trained men.

These tests were conducted at the fuel testing plant of the Geological Survey at Norfolk, Va., and show the following results in regard to the comparative fuel consumption of 73 degrees specific gravity gasoline and commercial completely denatured alcohol, per unit of power.

Correspondingly well-designed alcohol and gasoline engines when running under the most advantageous conditions for each, *will consume equal volumes* of the fuel for which they are designed. This statement is based on the results of many tests made under the most favorable practical conditions that could be obtained for the size and type of engines and fuel used. An average of the minimum fuel consumption values thus obtained, gives a like figure of eight-tenths pint per hour per brake-horse-power for gasoline and alcohol.

Considering that the heat value of a gallon of denatured alcohol is only a little over six-tenths that of a gallon of gasoline, this result of equal fuel consumption by volume for gasoline and alcohol engines probably represents the best comparative value that can be obtained for alcohol at the present time, as is also indicated by Continental practice. Though the possibility of obtaining this condition in practice here has been thoroughly demonstrated at the Government fuel-testing plant, it yet remains with the engine manufacturers to make the "equal fuel consumption by volume" a commercial basis of comparison.

The gasoline engines that were used in these tests are representative of the standard American stationary engine types, rating at 10 to 15 horse-power, at speeds of from 250 to 300 revolutions per minute, while the alcohol engines were of similar construction and identical in size with the gasoline engines.

The air was not preheated for the above tests on alcohol and gasoline, and the engines were equipped with the ordinary types of constant level suction lift and constant level pressure spray carbureters. Many special tests with air preheated to various temperatures up to 250 degrees F., and tests with special carbureters were made, but no beneficial effects traceable to better carburation were found when the engines were handled under the special test conditions, including constant speed and best load.

The commercial completely denatured alcohol referred to is 100 parts ethyl alcohol plus 10 parts methyl alcohol plus ½ part benzol, and corresponds very closely to 94 per cent by volume or 91 per cent by weight ethyl alcohol (grain alcohol). No detrimental effects on the cylinder walls and valves of the engines were found from the use of the above denatured alcohol.

The lowest consumption values were obtained with the highest compression that it was found practical to use; which compression for the denatured alcohol ranged from 150 to 180 pounds per square inch above atmosphere.

Eighty per cent alcohol (alcohol and water) for use in engines of the present type would have to sell for at least 15 per cent less per gallon than the denatured alcohol in order to compete with it. The minimum consumption values in gallons per hour per brake-horse-power for 80 per cent alcohol is approximately 17.5 per cent greater than for the denatured alcohol used, or for gasoline. A series of tests made with alcohol of various percentages by volume, ranging from 94 per cent to 50 per cent showed that the minimum consumption values in gallons per hour per brake-horse-power increased a little more rapidly than the alcohol decreased in percentage of pure alcohol. That is, the thermal efficiency decreased with the decrease in percentage of pure alcohol. This decrease in thermal efficiency or increase in consumption, referred to pure alcohol is, however, comparatively slight from 100 per cent alcohol down to about 80 per cent alcohol. Within these limits it may be neglected in making the calculations necessary to compare the minimum consumption values for tests with different percentages of alcohol.

The nearer the alcohol is to pure, the greater the maximum horse-power of the engine. The per cent reduction in maximum horse-power for 80 per cent alcohol as compared with that for denatured alcohol used was less than 1 per cent, but the starting and regulating difficulties are appreciably increased.

With suitable compression, mixtures of gasoline and alcohol vapors (double carbureters) gave thermal efficiencies ranging between that for gasoline (maximum 22.2 per cent) and that for alcohol (maximum 34.6 per cent) but in no case were they higher than that for alcohol. The above thermal efficiencies are calculated from the brake-horse-power and the low calorific value of the fuel, which for the gasoline was 19,100 British thermal units per pound and for the denatured alcohol was 10,500 British thermal units per pound.

As has been previously demonstrated, alcohol can be used with more or less satisfaction in stationary and marine gasoline engines, and these gasoline engines will use from one-and-one-half to two times as much alcohol as gasoline, when operating under the same conditions. The possibilities, however, of altering the ordinary gasoline engine as required to obtain the best economies with alcohol are very limited; for the amount that the compression can be raised without entirely redesigning the cylinder heads and valve arrangement is ordinarily not sufficient, nor are the gasoline engines usually built heavy enough to stand the maximum explosive pressures, which often reach 600 and 700 pounds per square inch. With the increase in weight for the same sized engine designed to use alcohol instead of gasoline, comes an increase in maximum horse-power of a little over thirty-five per cent, so that its weight per horse-power need not be greater than that of the gasoline engine, and probably will be less.

The work was taken up to investigate the characteristic action of fuels used in internal combustion engines with a detailed study of the action of each fuel (gasoline and alcohol) as governed by the many variable conditions of engine manipulation, design and equipment. These variables were isolated, so far as possible; their separate and combined effects were determined; worked out under practical operating conditions; and lead up to the conditions required for minimum fuel consumption. The results show the saving that can be obtained over conditions for maximum consumption, and also establish a definite basis of comparison under conditions most favorable to each fuel. This latter is a point of much commercial interest and a study of the comparative action of gasoline and alcohol may be of great service in solving some of the general internal combustion engine problems where other than liquid fuels are used.

Many of the tests of internal combustion engines have been made, but most of them, especially in this country, were by private concerns, for a specified purpose, and the results are not generally available. Furthermore, as is generally recognized by those familiar with gas and especially gasoline engine operation, the conditions influencing engine performance are so numerous and varied as to make the value of off-hand comparison very limited and oftentimes misleading, exact comparisons only being possible under identical conditions or with reference to the actual known differences in all conditions that influence the results.

This investigation was made with a view to supplying the continually increasing demand for more complete and exact information concerning the operation and design of gasoline and alcohol engines and to assist the Government and others interested in the larger and more general internal combustion engine problems.

GEAR-CUTTING MACHINERY—5.

RALPH E. FLANDERS *

This installment of this series of articles on gear-cutting machinery, continues the discussion of machines for cutting the teeth of worms, and of spiral and herring-bone gears, begun in the last issue.

Automatic Machines for Milling Helical Gears with Formed Cutters.

A number of full automatic machines have been built in an experimental way for milling spiral gears with formed cutters. They have usually been modelled after the automatic spur gear cutter. Evidently the mechanism has to be considerably more complicated. The first complication involved is due to the fact that the index wheel must be under the influence of both the helical and the indexing movements, as in the Reinecker machine in Figs. 85 and 86. The differential gearing there shown is the arrangement generally used to effect the combination of these movements in the automatic helical gear-cutter.

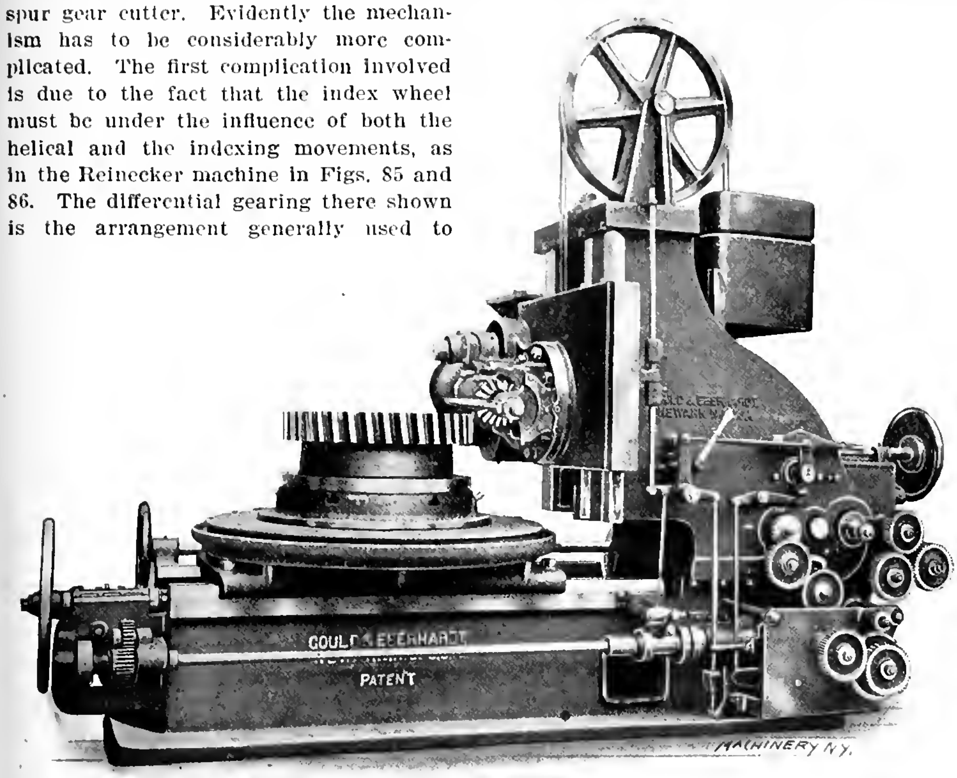


Fig. 91. Automatic Helical Gear-cutting Machine, made by Gould & Eberhardt.

Another complication is introduced by the necessity for relieving the cutter on its return stroke, after finishing the forward feed through the blank. Backlash in the rotating mechanism between the cutter slide and the work so alters the position of the cutter and the work on the return stroke, that the latter will drag on the one side of the groove it has just cut, unless it is separated slightly from it. This has been done in various ways in the various machines built; in some cases by mounting the cutter on a supplementary holder which rocks back out of the way on the return stroke, and in other cases by withdrawing the work by mechanism provided for the purpose.

These various complications seem to have militated against the commercial success of the automatic spiral gear cutting machine to such an extent that, so far as we know, but one of the various designs built has ever left the shop where it was made. The design we refer to is that shown in Fig. 91, built by Gould & Eberhardt of Newark, N. J. As will be seen, it is a machine of large capacity, built in the form of the horizontal machines for cutting spur gears, shown in Figs. 29 to 36. The cutter spindle is, of course, set in a swiveling head, and is driven by worm gearing. Three sets of change gears are used—one of them for the indexing mechanism, one for obtaining the proper lead of the helix, and one for changing the feed. The relieving mechanism operates as follows: As the cutter is being rapidly returned to allow the work to be indexed for a new cut, the work is withdrawn slightly from contact with the cutter by a cam actuated device, connected with the indexing mechanism. On the conclusion of the indexing, the work is again brought up to the cutting position, and the cutter is fed downward for a new tooth.

Molding-Generating Principle for Cutting Helical Gears—Planing Operations.

Passing by the templet, odontographic, and describing-generating principles, for the reasons mentioned in the introduction to this section (page 511), we come to the molding-generating principle. This is applied to helical gears in the same way as to spur gears, with such modifications as are necessary to allow for the helical shape of the teeth. The counterpart of Fig. 6 is shown in Fig. 92. The forming cutter and the blank to be cut are rolled together as in Fig. 6, while the forming cutter is reciprocated axially. In combination with the axial movement, however, the cutter has to be given a rocking movement about its center line, so that its teeth will follow the path of the dotted lines shown, which indicate the helix of the spiral gear which the cutter represents.

This process was contemplated by Mr. Fellows, of the Fellows Gear Shaper Co., in the original working out of his system of gear-cutting. Given suitable cutters, the necessary changes in the machine shown in Fig. 63, would simply be those involved in giving the cutter a rotary rocking motion in unison with its reciprocating movement, to compel the tooth to follow the line of the helix of the gear which the cutter represents. It is not probable that this process will ever come into commercial use, as the great number of helix angles required would involve too large a stock of cutters.

The counterpart of Fig. 7, for helical gears, is shown in Fig. 93. Here the forming rack has teeth set on the same angle as the helix angle desired in the gear being formed. The rolling of a plastic blank over this forming rack will form in the blank helical teeth of the shape desired. A top view of the rack is shown, which will make this clearer. Instead of the forming rack shown by the full lines, we may use one like that shown in the dotted lines, whose teeth coincide with those of the first, but which moves in a direction at right angles to the direction of its teeth. If this dotted rack is moved at such a rate of speed that its teeth always coincide with those of the rack shown in full lines, they will evidently both form teeth of exactly the same shape in the blank.

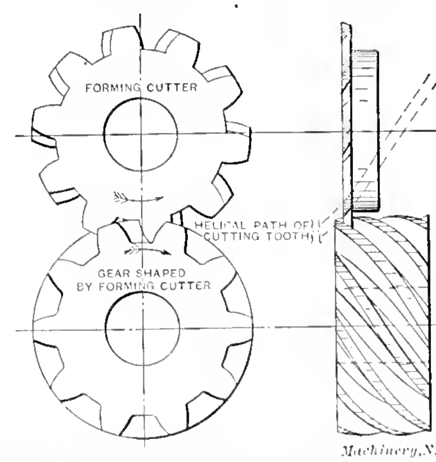


Fig. 92. The Molding-Generating Principle arranged to employ a Cutter having a Helical Shaping Action, cutting Teeth in a Solid Blank; compare with Fig. 6

In Fig. 94 we have the dotted rack of the top view of Fig. 93, shown engaged in the operation of generating the teeth of a

* Associate Editor of MACHINERY.

gear identical with that in Fig. 93. This view has been taken at an angle so as to show the normal view of the rack. If the proper relative rates of rotation of the work and movement of the rack are maintained in Figs. 93 and 94, and the normal sections of the racks in each case are the same, the gears generated will be the same. It is evident in Fig. 94 that the teeth of the rack may be replaced by shaper or planer tools T_1 and T_2, which may be used in forming teeth on the blank

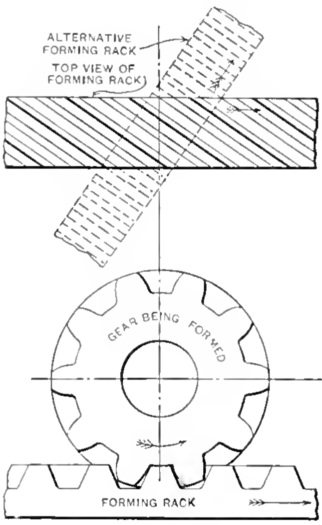


Fig. 93. A Rack with Teeth set on an Angle, Operating by Impression on the Molding-Generating Principle, to form Teeth in a Helical Gear; compare with Fig. 7.

Fig. 94. Shaper Tools representing Teeth of Imaginary Rack, Operating on the Molding-Generating Principle to generate Teeth in a Helical Gear; compare with Fig. 8.

by rotating the gear and moving the tools endwise, in the proper ratio prescribed by the conditions in Fig. 93. Fig. 94 is thus the counterpart of Fig. 8 for helical gearing. Similar counterparts may be drawn for Figs. 9 and 10, showing the milling and grinding processes, but since no practical application is made of these, they are omitted.

Fig. 94 is interesting in that it hints at the principle on which the action of the helical gearing is based. As drawn, it shows very plainly the action of the well-known Sellers drive for planers. It will be noted that for a short space the rack teeth exactly fill the outline of the gear tooth. Contact between the gear and the rack takes place on straight lines, running diagonally across the plane faces of the rack teeth. Much might be written about the contact between spiral gears and racks, and the contact of spiral gears with each other, that has not been published, so far as the writer is aware; but since this subject is not germane to the subject of this series of articles, it will not be touched on here.

Practical application has been made of the principle shown in Fig. 94. The Bilgram spiral gear planing machine, involving this principle, is shown in Fig. 95. The work is mounted on a spindle carried in a head, which swivels about a vertical axis so that it may be set to the helix angle of the gear being cut. The cutting tool, having a shape to represent a tooth of the imaginary generating rack, is carried by a ram which works in and out, cutting on the return stroke. This ram is carried by a head which is fed along the bed of the machine. This longitudinal feeding of the ram-carrying head is connected with the rotary movement of the work spindle by change gearing, in the proper ratio for the case in hand, so that the gear will roll with the movement of the head just as it would if it were acting under the influence of the imaginary rack, one of whose teeth is represented by the cutting tool. The conditions are thus exactly the same as in Fig. 94.

Under these conditions, if the machine is set properly, the cutting tool will start to work at one side of the blank, and pass through it, feeding at the end of each successive stroke, with the work rolling in such a way as to form a tooth space of the proper shape. This action is modified somewhat by the method of indexing adopted, which is the same as for the somewhat similar spur gear planing machine by the same builder, shown in Fig. 48. The arrangement used indexes the work at every stroke, so that when the tool has once passed through the work, the gear is entirely completed, every tooth having been worked on. This indexing movement and the rolling motion required for the generating are superimposed on each other by suitable mechanism so that neither interferes with the other.

It may be mentioned incidentally that this machine is the only one known to the writer in which *all* the requirements for theoretical accuracy in cutting helical gears have been taken care of. There is a minute, though actual, error involved in even the otherwise perfect hobbing process for cutting these gears.

The Hobbing Modification of the Molding-Generating Principle of Cutting Helical Gears.

Instead of using the shaper or planer tool to take the place of the teeth of the imaginary rack shown in Fig. 94, we may use a hob, in the same way that it was used in Fig. 50 for hobbing spur gears. This condition is shown in Fig. 96, which should be compared with Figs. 50 and 94. The upper or plan view best shows the respective angular settings of the work and the hob. The hob is set at an angle with the line of movement of the imaginary rack equal to its own helix angle, as for spur gears. The gear being cut is set at an angle with this same line equal to its own helix angle, so that in this case (in which both gear and hob are right-hand) they are set at an angle to each other equal to the difference between the helix angles. If the hob represented by the worm in the diagram is revolved in the direction shown, its teeth will have the same outline and the same movement as the teeth of an imaginary rack, moving in the direction shown. If the work be revolved in the proper ratio with the hob, the latter will form the teeth in the former in the same way that the imaginary rack would, provided it is fed progressively through the work in the direction of line X X.

This necessity for feeding the hob through the work introduces an added complexity to the machine in the case of

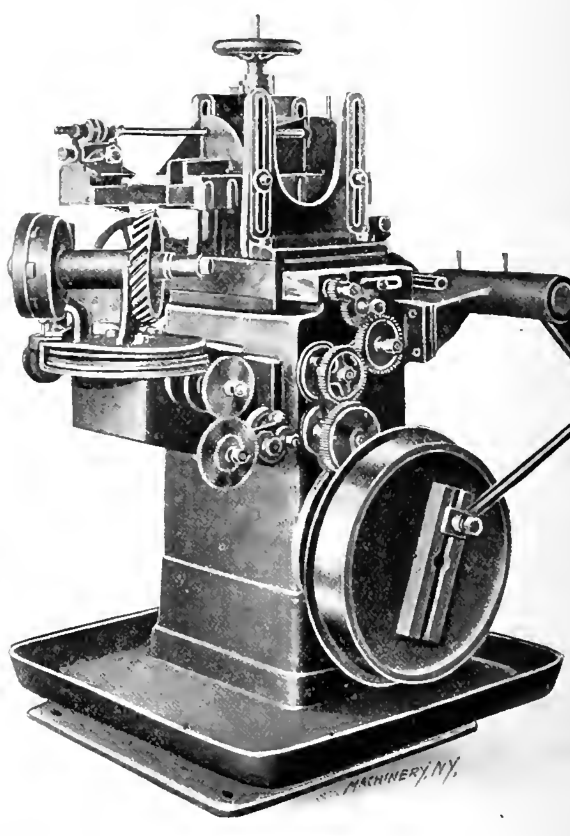


Fig 95. The Bilgram Machine for Cutting Helical Gears, operating on the Principle of Fig. 94.

spiral gears, beyond that needed for the spur gear hobbing machine. To understand this, suppose that in Fig. 96 the spindle mechanism is stopped, so that both the spindle and work ceased to revolve. To make it possible to feed the hob through the work in the direction of line X X without having the teeth of the one strike against the other, it will be necessary to revolve either the work or the hob. Suppose that the work be connected by change gearing with the feed-

screw of the cutter slide, so that it is revolved as the cutter is fed up or down, in the same way that the work in Fig. 81 is revolved as the table is fed backward and forward. Under these conditions, the cutter may be moved through the work freely, the latter revolving to allow the cutter to pass. Not only must the work revolve in a definite relation with

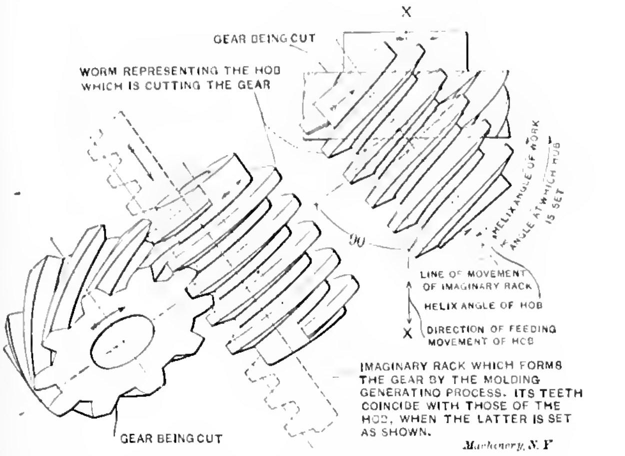


Fig. 96. Molding-Generating Method of Cutting Spiral Gears, as Exemplified in the Hobbing Process; compare with Figs. 50 and 94.

the feeding of the cutter slide, but the work must also revolve in unison with the cutter or hob, as for spur gears. It must then be so connected with the cutter and with the cutter slide feed-screw that it will be under the influence of either or both of them, without any interference of the two movements with each other. This connection is usually made by a "jack-in-the-box" or differential mechanism, exactly identical in principle with that shown in Fig. 86 for combining the indexing and helical feeding movements for revolving the work in the Reinecker universal machine. In the case of the spiral gear hobbing machine we have a helical feeding movement and a cutter spindle movement to combine for revolving the work.

A typical arrangement of the mechanism used for this purpose is shown in diagrammatic form in Fig. 97. Power is applied to the machine through driving shaft G. The bevel gears shown connect this driving shaft with vertical shaft H, by means of which the hob is driven. Change gears shown connect shaft G with shaft E. Considering for the time being that worm-wheel B and the attached bevel gear D are stationary, the rotation of E and the cross arm A keyed to it,

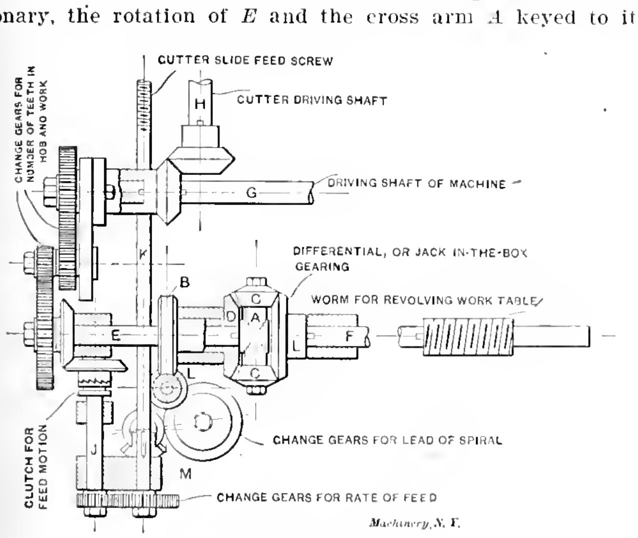


Fig. 97. Typical Arrangement of Gearing for Spiral Gear Hobbing Machine.

will cause bevel gears C to roll around on stationary gear D, thereby revolving gear L and shaft F to which it is keyed, thus rotating the work table. The change gears connecting G and E are selected to give the proper ratio of movement between the hob or cutter spindle and the work table, to agree with the number of threads in the hob and the number of teeth in the gear being cut. The cutter slide feed-screw K is connected by change gears with shaft J, which is, in turn, connected through the clutch and the bevel gears shown with shaft E. The clutch furnishes the means of stopping and starting the feed, and the change gears serve to give the rate of feed desired. Change gears are also provided connecting bevel gear M on feed-screw K, with worm L, which drives worm-wheel B, running loosely on shaft E. By this means, supposing for the moment that shaft E and its attached cross arm A are stationary, the rotation of the feed screw is communicated through the change gears to worm-wheel B and its attached bevel gear D, which, driving bevel pinions C on their stationary studs, revolve gear L, and with it shaft F and the worm driving the work table. In this way, by selecting suitable change gears, the work may be revolved to agree with the length of the lead of the spiral on which its teeth are formed, so that the cutter may be fed up and down through it without interfering with the teeth.

We thus see that the mechanism shown in Fig. 97 may be arranged to connect the hob and the work in the proper ratio, as for cutting spur gears, and also for connecting the feed-screw and the work in the proper ratio as for cutting spiral gears in the milling machine. But this mechanism not only performs these two functions separately, but it will perform them together, as well, so that either the feed or the cutter

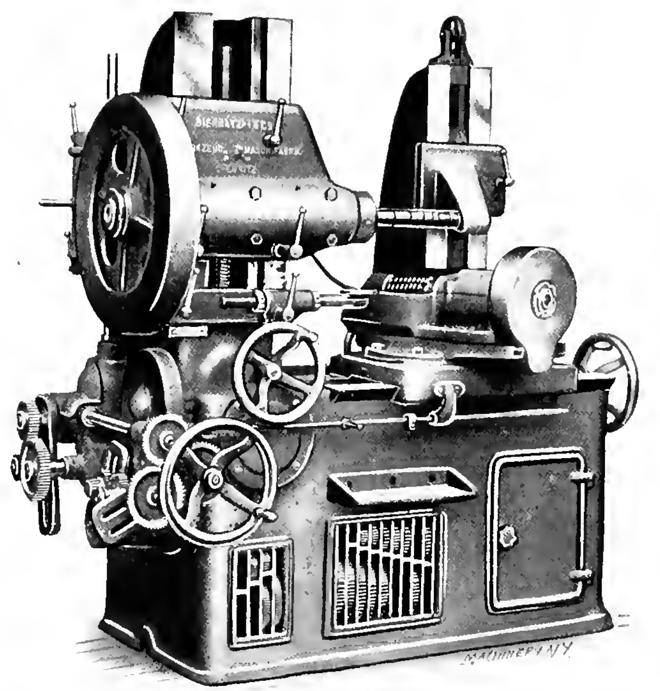


Fig. 98. Biernatzki Gear-hobbing Machine.

revolving mechanism may be started, stopped or reversed independently of the other movement, and the work will still be properly controlled under all conditions. The mechanism shown is not that invariably used, but it is typical of the arrangement employed in many hobbing machines designed for cutting helical gearing.

Hobbing Machines with Cutter Slide on Bed.

The first hobbing machine for spiral gears we show is that in Fig. 98, made by Biernatzki & Co., 60 Zschopauerstrasse, Chemnitz, Germany. This machine is built on the general lines of the orthodox automatic spur gear cutter shown in Figs. 21 to 28. The machine is stiffly constructed, the column and head being apparently made in one piece. A noticeable feature is the rigid construction of the outer work support. In a smaller size machine this is mounted on the front of the bed, but in the case shown it is supported on ways at the rear, behind the cutter slide. A rack and pinion movement, operated by hand-wheel, is provided for moving it toward or away from the column. This rapid adjustment is very convenient in changing the work. Three sets of change gears are used, as in Fig. 97. Those just behind the hand wheel at the left are set for the lead of the spiral, those at the end of the bed are set for the feed of the cutter, while the ones at the rear are altered to give the proper ratio of movement for the number of teeth in the work and the hob. The arrangement of the machine in general is the same as

for its prototype, the automatic gear-cutter. One point of difference which may be noted is made necessary by the fact that the work is constantly revolving, instead of being intermittently indexed. The work support clamped to the face of the column in the regular gear-cutter is usually a simple abutment, adjusted by screw and nut to support the work against the thrust of the cutter. In this case, as may be seen, the support carries a disk or roller against which the work bears as it revolves.

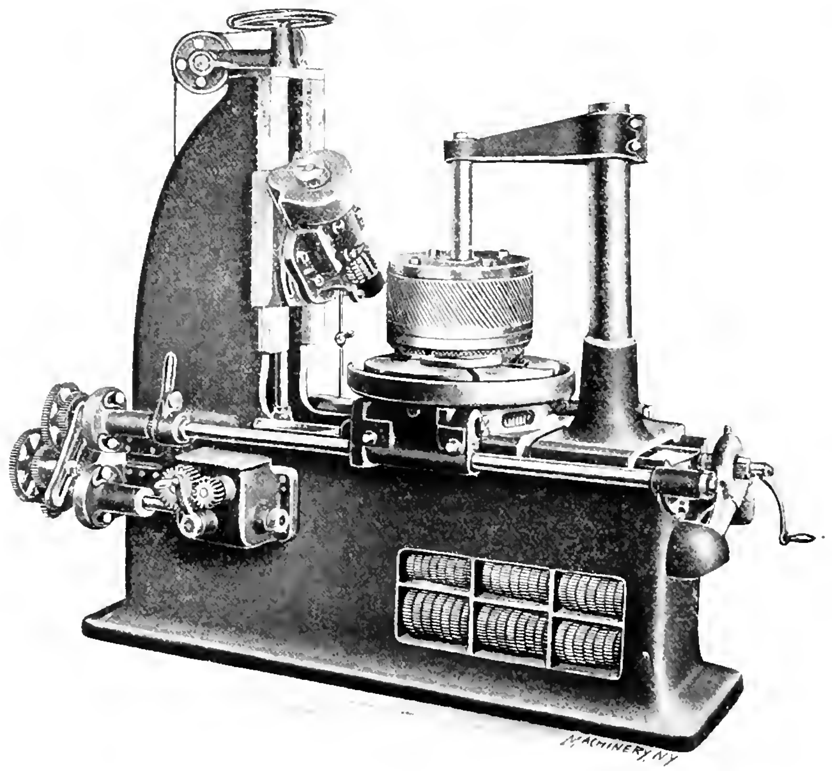


Fig. 99. Gear-hobbing Machine, made by Gould & Eberhardt, Newark, N. J.

Horizontal Form of Gear-hobbing Machines.

The Gould & Eberhardt hobbing machine, shown in Fig. 99, has previously been described in MACHINERY.* In this machine the "horizontal" form of construction has been adopted, in which the work is carried by a slide adjusted longitudinally on the top of the bed, while the cutter slide is mounted on the face of a vertical column, following thus the general plan of the machines shown in Figs. 30 to 39, and 53 to 57. This machine is rigidly constructed, the column and bed being in one piece, and special attention being given to the construction of the cutter head and work table to give the stiffness so necessary for accuracy and output in a machine of this kind. The outboard support for the work is particularly noticeable. It consists of a heavy post, carried by a slide working on the same ways as the work table, to which it may be connected to form one piece. A rapid traverse for the cutter head is provided, so that it is ordinarily unnecessary to operate the feed of the cutter slide manually. The cutter head may be swung around through an angle of 180 degrees above the horizontal. With this arrangement, the driving gear is always above the center line of the head, so that less clearance is required below the work. This means that blanks can be held down closer to the table, giving less overhang and greater rigidity. In Fig. 100 this machine is shown hobbing spiral gears.

In Fig. 101 we show a machine built by Holroyd & Co., Ltd., of Milnrow, near Rochdale, England. The engraving shows a spur gear in the machine having its teeth hobbed, but provision is made for hobbing spiral gears as well. As may be seen, the cutter spindle is driven by an internal gear of large diameter. The engraving shows quite plainly the usual method followed of supporting work in machines of this type. The work is centralized with the table by the arbor which passes through it, but most of the support is taken by brackets mounted on the table or face-plate, and provided with T-slots in their upper faces by which the work is clamped to them. This arrangement makes the work practically solid with the face-plate.

Of the three shafts extending along the front side of the bed, the lower one (E in Fig. 97) is connected with the cutter driving mechanism and drives through change and differential gearing the upper of the three shafts (F in Fig. 97) which is connected with the index worm of the work table. A place for change gearing will be seen at the base of the column carrying the cutter slide. This connects the feed movement of the cutter with the central shaft (L in Fig. 97) which in turn is connected with differential gearing in the enclosed casing seen at the right-hand end of the bed, in the foreground. In this, as well as in previous machines shown, provision is also made for hobbing worm gearing, the mechanism being introduced at the right-hand end of the bed for this purpose. Reference will be made to this later.

A still larger size of this machine is made, though for spur and worm gears only. This will operate on blanks up to 72 inches in diameter, and will cut gears up to 2 inches circular pitch by the hobbing process. The makers state that with these machines, the time for cutting a cast iron wheel of 84 teeth, 4 inches circular pitch, 21½ inches face, was 1 hour 21 minutes. Another one of the same pitch with 144 teeth, 3 inches wide, took 2 hours. Reckoning on the basis of 84 teeth, this would make about 6 inches feed per minute, and allowing for about 3 feet a minute quick return, an automatic gear-cutter would barely be able to accomplish this.

In both of these machines provision is made for intermittent indexing, so that a formed gear-cutter can be used. For this purpose the lower shaft in Fig. 101 may be driven through a friction slip if desired. The lever shown below the differential gear box at the right-hand end may be used to release or arrest a disk keyed to this shaft, so that it may be allowed to make one revolution when desired. The change gears at the end of the machine are then set for the number of teeth required. Under these conditions it will be seen that it may be used for gear-cutting by the formed cutter method, being then practically the same sort of machine as those illustrated in Figs. 33 to 36, except that it is not fully automatic.

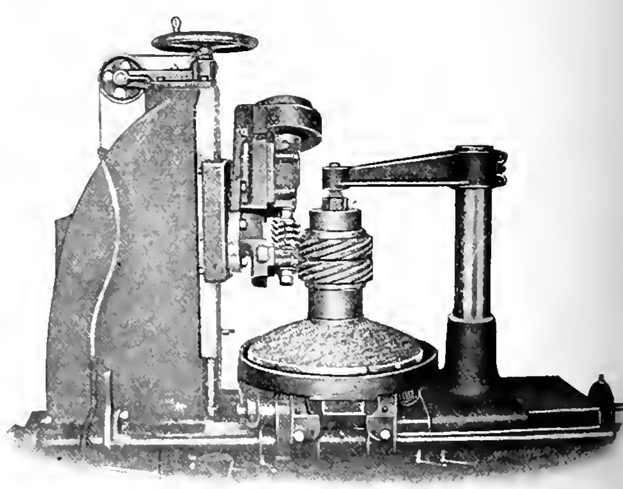


Fig. 100. Gould & Eberhardt Machine cutting Spiral Gears.

In Fig. 102 is shown a gear-hobbing machine* built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. It is shown at work on a spiral gear, which is supported in a somewhat different manner from the cases previously shown.

* See "New Machinery and Tools" in the November, 1907, issue of MACHINERY.

* See "New Machinery and Tools" in the December, 1907, issue of MACHINERY.

A special support, in the form of a cast sleeve or column, is provided for raising the work high enough above the table so that the driving gear of the spindle clears the table when the cutter has been fed through the work. In cutting spur gears, of course, it is not necessary to set the work so far above the table, less clearance being required for the spindle driving gear.

The Pfauder machine, shown in Fig. 103, is sold by Schuchardt & Schütte of New York, Berlin, London, etc. The differential mechanism is shown quite plainly in this engraving, which represents the No. 4 machine. The change gearing above the index worm shaft is for the lead of the helix, that below, for the feed, while the larger gearing at the left end of the machine is for connecting the hob and the work in the proper ratio. The cutter spindle of this machine is driven by herring-bone gears to insure smoothness of action. This line of machines is made in a great range of sizes. The smallest of these has a maximum capacity for a blank 6 inches in diameter, while the largest will take a gear 101 inches in diameter. Provision is made in the larger sizes for intermittent indexing of the work table by hand, so that the teeth may be cut by formed cutters if desired. The swiveling head is adjusted by a worm on the larger sizes.

Hobbing Machines of Special Types.

The machine shown in Fig. 104, made by the Grant-Lees Machine Co., 6901 Quincy Avenue, Cleveland, Ohio, cannot be classified structurally with any of the previous examples. It is an outgrowth from a hobbing machine for worm gears, formerly built by its designer, Mr. John Grant. It has previously been described in MACHINERY* where its novel features have been explained. The work is mounted on a vertical spindle, carried by a slide which is adjusted horizontally for the diameter. The feed of the cutter through the work is effected by raising the spindle vertically. The cutter is driven by a combination of bevel gears which is best shown in Fig. 105, and it may be adjusted throughout a full circle. The bevel gear on the hob spindle meshes with a large ring bevel gear, which in turn is driven by a bevel pinion on the driving shaft. The bevel pinion on the hob shaft occupies a different portion of the ring bevel gear from that occupied by the driving pinion, so it may be adjusted around the full circle without interference. Provision has been made in the mechanism to revolve the work as it is fed upward, independently of the movement given by its connection with the hob, thus meeting the requirements for spiral or helical milling. The machine is shown in Fig. 105, completing a helical gear.

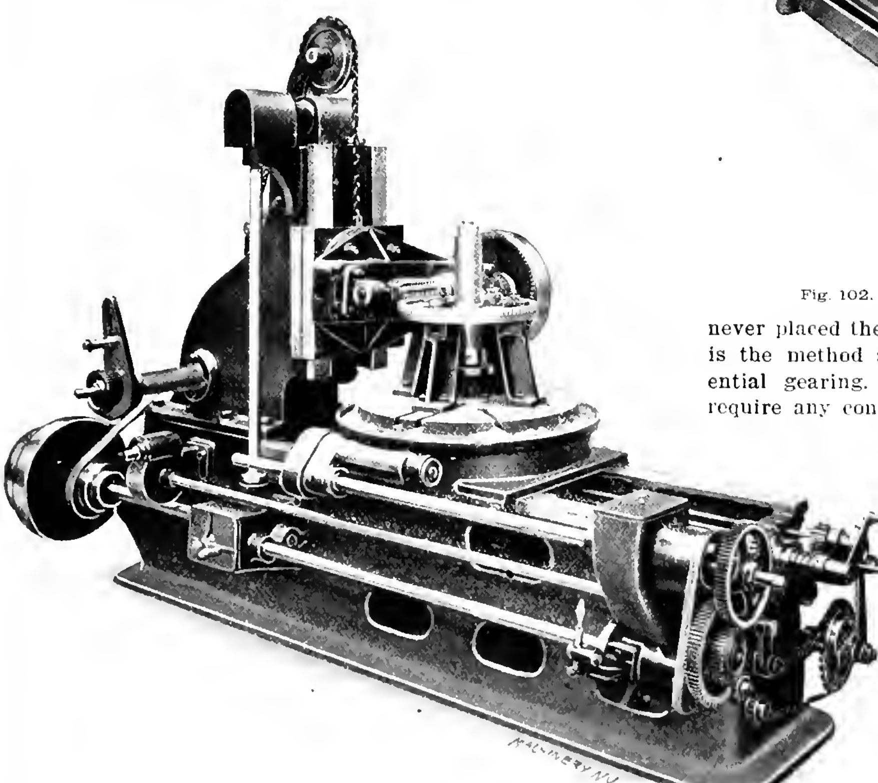


Fig 101. Holroyd Gear-hobbing Machine. Though shown cutting Spur Gears, it will cut Helical Gears as well

A gear-hobbing machine, built by Geo. Juengst & Sons, Croton Falls, N. Y., is decidedly worthy of study on account of the unique principle involved, although the builders have never placed the machine on the market. The unique feature is the method adopted for avoiding the necessity for differential gearing. The spur gear hobbing machine does not require any connection between the feed-screw and the work-revolving mechanism, because the hob can be fed back and forth through the work after it has been completed, without interference. In the Juengst machine the same effect is accomplished by setting the feeding movement at the angle of the teeth of the work. As is shown in Fig. 106, the work is mounted on the column, while the cutter, which may be swiveled to agree with its helix angle, is fed along a slide which may be, in turn, swiveled to agree with the helix angle of the work. The line of travel of the hob, as shown in Fig. 107, being thus set in the same direction as the teeth of the gear, the hob can be fed diagonally through the work without interfering with the teeth, whether the machine is in motion or not, it being taken for granted, of course, that the hob and the work are properly geared together. Differential gearing is thus done away with, being replaced by the swiveling adjustment of the cutter slide, which permits the line of travel of the hob to be adjusted to the helix angle of the work.

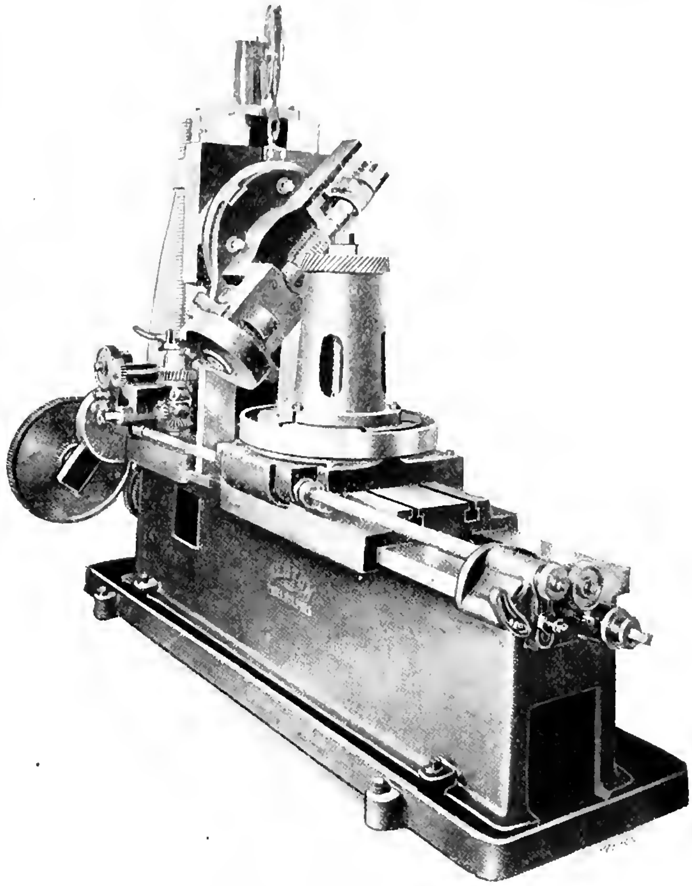


Fig. 102. Newton Machine at Work on a Helical Gear.

This same result has been accomplished in another way by a patent granted to an English inventor. With his arrangement the work is mounted on a table on the bed, while the cutter slide feeds up and down the column as in the orthodox arrangement for hobbing machines, shown in Figs. 53 to 56

* See "New Machinery and Tools" in the October, 1907, issue of MACHINERY.

and 99 to 103. The column, however, instead of being solid with or bolted to the bed, is mounted on ways so that it may be fed horizontally at right angles to the line of adjustment of the work table. The feed-screw controlling this adjustment is connected by change gearing with the vertical feed-screw of the cutter slide on the column, so that these two movements take place simultaneously in any desired ratio

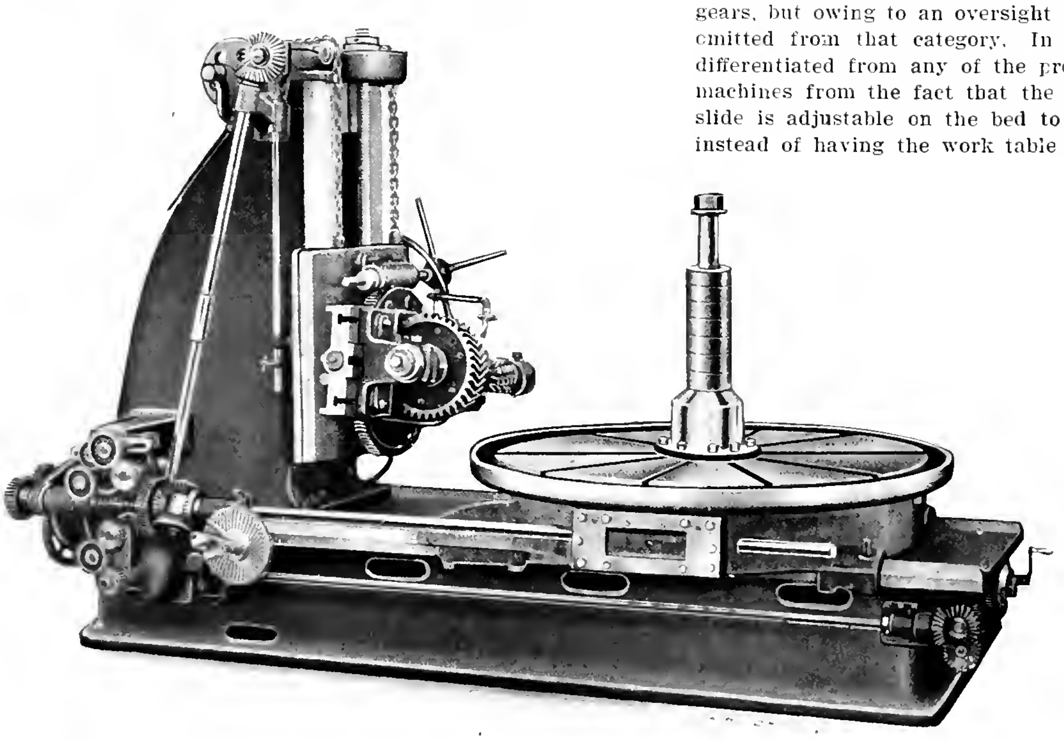


Fig. 103. Pfauder Gear-hobbing Machine, sold by Schuchardt & Schutte.

with each other. By this means the combined vertical and horizontal movements of the cutter slide give a component in an angular direction, which may be made to give any desired angle of travel, such as that shown, for instance, in the line of travel of the hob in the Juengst machine, Fig. 107.

The difficulty with this otherwise attractive plan for hobbing helical gears by moving the hob at an angle instead of using differential gearing, appears to be that a longer hob is required for going in an angular direction across the face of the gear, than would be necessary in feeding vertically downward, as is the case with the usual differential mechanism. The hob would have to be unusually long if it were desired to cut a bank of spiral gears in one operation, as is being done in Fig. 99.

There are still other methods possible for taking care of the helical movements required besides those already discussed. For instance, instead of using differential gearing to combine the motion derived from the feed-screw with that of the index worm shaft, it may be used to combine movements derived from the feed-screw with that of the cutter spindle driving shaft. Furthermore, the differential mechanism may be discarded entirely, by providing an index worm of considerable length and shifting it longitudinally at the proper rate in connection with the feeding of the cutter slide. This would impose on the work rotation in connection with the cutter slide feed without interfering in any way with the rotation due to the connection with the cutter or hob. Differential gearing would thus be avoided as in the case of the Juengst machine. This device would have its limitations for gears of small lead, as it would require too great a length of worm to give the proper amount of rotation to the work.

Another interesting spiral gear hobbing machine which has been described in MACHINERY* is that furnished by the Pratt & Whitney Co., of Hartford, Conn., for cutting the wonderful herring-bone gears, run at such tremendous speed in the De Laval steam turbine. A particular feature of this machine was the provision for correcting by a link motion the slight inaccuracies inherent in the use of change gears for obtaining exactly the lead required for the helical teeth it is desired to cut.

In Fig. 108 is shown a gear-hobbing machine made by Maschinen Fabrik Lorenz, Ettlingen, Baden, Germany. This machine should properly be shown among the spur gear hobbing machines, as no provision is made for hobbing helical gears, but owing to an oversight on the writer's part, it was omitted from that category. In its structural design, it is differentiated from any of the previous examples of hobbing machines from the fact that the column carrying the cutter slide is adjustable on the bed to the diameter of the work, instead of having the work table adjustable. In this respect it resembles the hobbing spur gear cutting machines using formed cutters, illustrated in Figs. 37, 38, and 39. The machine is made in several sizes. The example shown, which is next to the largest size, will take work up to 110 inches in diameter.

Spiral gearing is cut on this machine in a way analogous to that followed in the Reinecker universal machine shown in Figs. 85 and 86, although the provisions for indexing are entirely different. A formed cutter is used, which is fed down through the work, the latter being revolved in unison with the feeding as in the case of the universal miller. The indexing is then effected by change gears and the one revolution crank shown at the side of the base in the engraving. In indexing, the dividing worm is connected with the index gearing and disconnected from the spiral mechanism; after

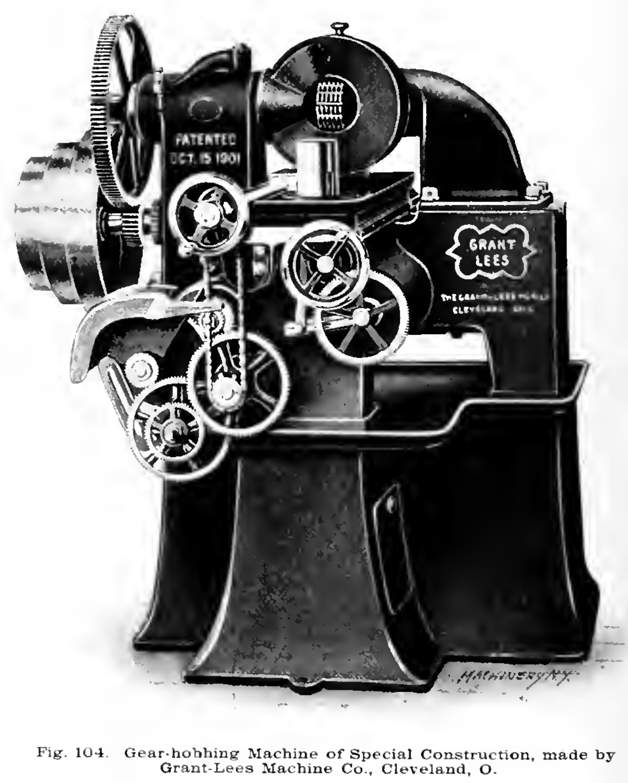


Fig. 104. Gear-hobbing Machine of Special Construction, made by Grant-Lees Machine Co., Cleveland, O.

the indexing, the connection is again made with the spiral mechanism, while the indexing motion is released. The index or work-driving worm-wheel is of bronze, driven by a worm of special construction, which the builders claim gives a much more durable contact than is ordinarily obtained.

* See "The De Laval Steam Turbine and its Manufacture" in the November, 1904, issue of MACHINERY.

It would appear from the drawings furnished the writer that the Reinecker universal gear-cutting machine (see Figs. 85 and 86) could be arranged to hob spiral gears by the simple expedient of connecting the indexing change gear train positively with the cutter driving mechanism instead of through the friction slip used for the semi-automatic indexing. This would give a combination identical in principle with that shown in Fig. 96. Probably the matter of German patent infringements accounts for not using the machine for hobbing spiral gears.

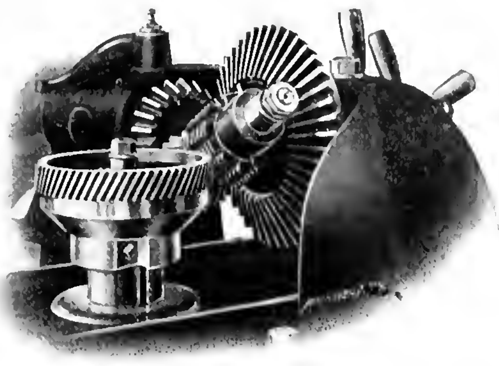


Fig. 105. Grant-Lees Machine hobbing a Helical Gear.

Besides the machines we have just described, two of the hobbing machines illustrated and described under the heading of spur gear machinery are adapted to the cutting of helical gears as well. These machines are the Rhenania machine shown in Fig. 54, and the Wallwork machine shown in Fig. 56. The only change necessary to adapt these machines to cutting spiral gears is the addition of the differential gearing, and the connection for change gearing between the feed-screw and the work table revolving arm. Provision is made for this mechanism in the design of the machines. Of course all of the hobbing machines we have described are adapted for cutting spur gears, and those shown in this installment of this series should be included in the list when studying spur gear cutting machinery.

The Field of the Hobbing Process for Cutting Helical and Herring-bone Gears.

There are some limitations to the hobbing process of cutting helical gears. It is not particularly successful in the cutting of gears of such small lead and great helix angle that they would be classed as worms, rather than spiral gears. For such cases, the rate of rotation which has to be given the blank is so great in proportion to the downward feed of the cutter by which the rotation is effected (through the change and differential gearing) that it is almost impossible to drive it, the difficulty being the same in kind, though reversed in direction, as that met with in cutting very steep pitches in the lathe. By a slight complication of the machine, however, mechanism could be introduced to overcome this difficulty, and make the hobbing machine universal for all kinds of gears within its range.

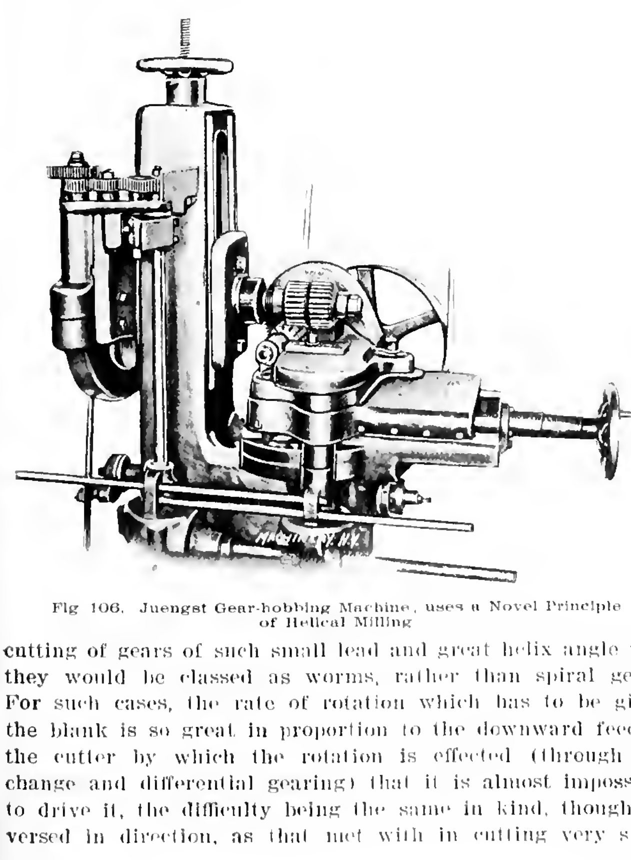


Fig. 106. Juengst Gear-hobbing Machine, uses a Novel Principle of Helical Milling

In the discussion of the hobbing processes for cutting spur gears, it was stated that its field was not yet definitely determined. It may be said, on the whole, that there is no such indefiniteness in regard to the field of the hobbing machine for cutting helical gears. With a well-constructed machine and with hobs of proper shape, spiral gears can be cut more accurately and cheaply by this method than by any other known. There are none of the mechanical difficulties of indexing and relieving to be taken care of as is the case in automatic machines working on the formed cutter process; and there are none of the uncertainties as to tooth shape due to interference met with in cutting a helical groove with a formed cutter, as shown in Fig. 80. There has been some little difficulty in getting the correct shape of teeth by the hobbing process, due to the elasticity of the mechanism connecting the hob and the work, and to errors in the construction of the hob itself. These difficulties, however, will surely disappear with further experience and investigation.

Apparently the recent rapid development of the hobbing process for cutting spiral gears is the solution of a problem which has long seemed somewhat perplexing. The flexibility of the spiral gear, and the numerous advantages of the herring-bone or the twisted tooth spur gear for transmitting great power noiselessly and smoothly even at high velocities, have long been appreciated, but their extended use has waited for the development of some accurate and inexpensive method of forming helical teeth.

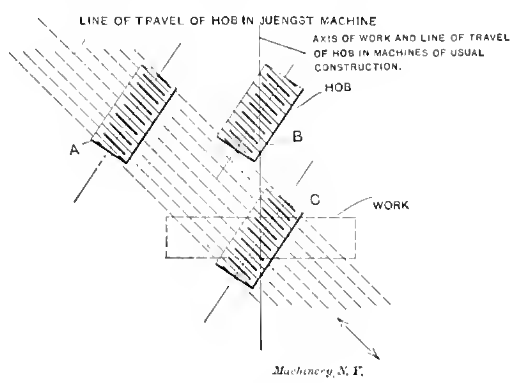


Fig. 107. Method of Feeding the Hob in the Juengst Machine

MACHINES FOR FORMING THE TEETH OF WORM-WHEELS.

To correctly classify and comprehend the various methods and machines for cutting the teeth of worm-wheels, it is first necessary to clearly define the term "worm gearing." We will consider that by worm gearing we mean gearing of the type of which a cross-section is shown at the right of Fig. 109, in which the acting face of the wheel is curved to fit the form of the worm, and in which the whole width of the wheel face is in active working contact with the worm.

The action is best understood by taking vertical sections on the center line *A-A*, and other lines such as that at *B-B*, parallel with the center line. Sections on lines *A-A* and *B-B* are shown at the right of the cut. With worm gearing of standard form, the section on line *A-A* shows the worm to have the profile of an involute rack, while the teeth of the wheel show outlines identical with those of the corresponding involute gear of the same pitch and number of teeth, suited to engage with the rack. In other words, the teeth of the gear are such as would be formed by the teeth of the worm if the latter acted as a rack in a molding-generating operation identical with that shown in Fig. 7. A section on line *B-B* shows that the teeth of the worm have a distorted outline on planes removed from the axial plane. If we consider these distorted teeth as the teeth of a rack, molding their mating tooth spaces in a gear running on the same center as the worm gear and at the same speed, it will form, by the process of Fig. 7, the distorted wheel teeth shown

for the section on line *B-B*. In a word, each section of the worm parallel to the axial section *A-A*, is a rack section, which molds in the wheel below it the proper teeth to mesh with it in accurate conjugate action. The true worm-wheel, it is thus seen, must be formed by the molding-generating process.

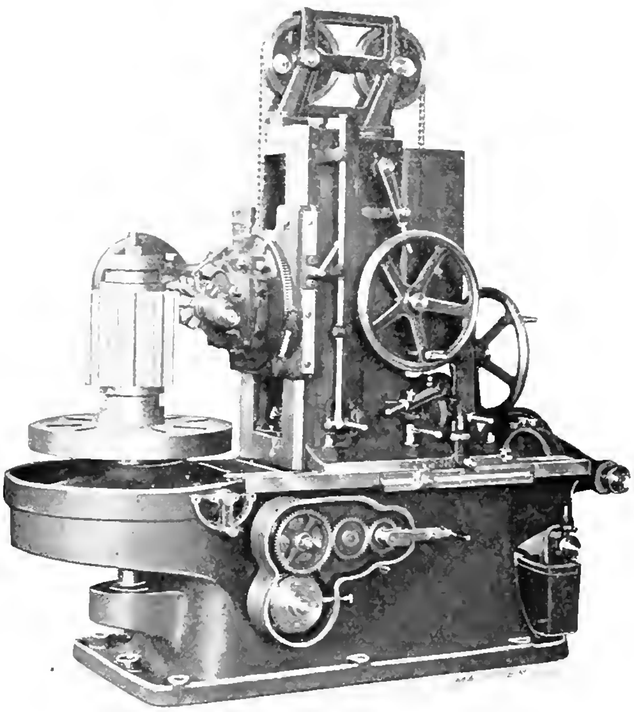


Fig. 108. Lorenz Gear-hobbing Machine.

The same worm as that shown in Fig. 109 may be made to engage with a spiral gear of the same number of teeth as the worm-wheel, provided the teeth are of the proper pitch and set at an angle to agree with the helix angle of the worm. The action of such gearing, however, does not, like that in Fig. 109, take place on all sections *A-A*, *B-B*, etc., but is confined to a point at or near the center line *A-A*. The contact, in other words, is point contact, and not line contact extending clear across the face of the wheel. Such a combination, in fact, is not a case of worm gearing, but a case of spiral gearing—and a very poor case at that.

Gashing Worm-wheels by the Formed Cutter Process.

While the method of forming a true worm-wheel is thus seen to be accurately performed only by the molding-generating process, the accurate teeth produced by that process may

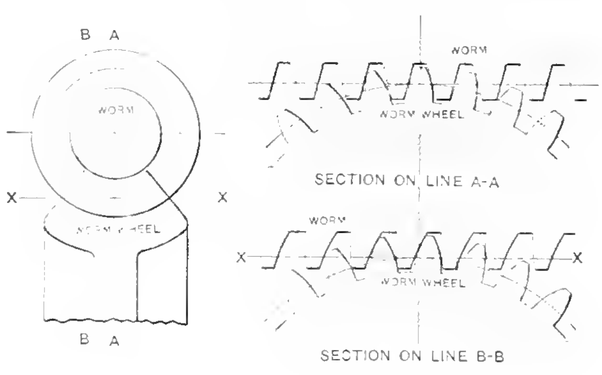


Fig. 109. Action of a True Worm-wheel.

be closely approximated in many cases by the "gashing" method, which belongs in the formed cutter classification. In this operation, illustrated in Fig. 110, a milling cutter is used, having approximately the outline of a normal section of the teeth of the worm to be used. This cutter is of the same diameter as the worm, and is set with relation to the axis of the work at the helix angle of the worm, as measured on the pitch line. It is centered over the wheel, and fed into the latter to the proper depth to form a tooth space; it is then drawn out again, the work is indexed to the next tooth space, and the cutter again sunk in to depth, the operation being repeated until the wheel is completed. In Fig. 110 a universal milling machine is being used for this operation.

With the table set at 90 degrees, the cutter is first brought centrally over the work arbor by adjusting the saddle on the knee of the milling machine, and then the work is brought centrally with the cutter arbor by adjusting the table by the feed-screw. The work table is next swung to the helix angle of the worm which is to be used with the wheel. Then the cutting is proceeded with.

This gashing process gives a tooth very closely approximating the true tooth form, when the diameter of the worm is large as compared with the pitch, and when the worm is single threaded. For multiple threaded worms of smaller diameter in proportion to their pitch, the process is impracticable. This method is used by at least one of the best known builders of gear-cutting machines in forming the teeth in the index worm-wheel. It is used under the conditions which give a very close approximation to the true form of tooth, and is employed in this particular case for the sake of the high degree of accuracy obtainable. The index wheel is divided, in cutting, by a carefully-made and carefully-preserved master wheel. The step by step gashing process allows the spacings of this superior master wheel to be accurately reproduced in the index wheel being cut—more accurately

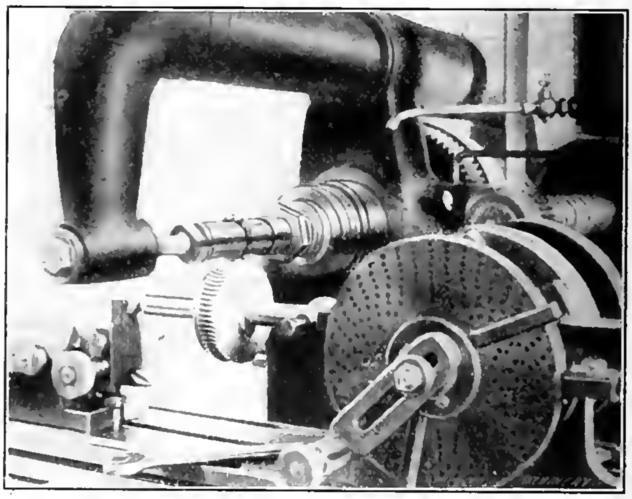


Fig. 110. Gashing a Worm-wheel in the Milling Machine.

than would be possible if it were to be reproduced by the hobbing operation.

The gashing process is also used for roughing out worm-wheels preparatory to hobbing. In a previously gashed wheel, as will be explained later, the hobbing operation is one of extreme simplicity, not requiring special machines or mechanism of any kind.

The discussion of methods and machines for hobbing worm-wheels will be continued in the next issue of MACHINERY.

* * *

The Northern Railway of France has recently conducted some tests for the purpose of comparing the superiority of locomotives of the 4-cylinder double bogie Mallet type, with two 6- and 8-wheel coupled freight engines of smaller design. According to the *Mechanical Engineer*, the tests were made on two trains weighing each 950 tons One was hauled by the two smaller engines, and the other by one Mallet locomotive. The trials extended over a period of six months, the distance run being about 12,500 miles in each case. The fuel consumed by the Mallet engine cost $458, as compared with $582 for the two smaller engines. The cost of lubricants and up-keep cost for the Mallet engine amounted to $85 as compared with $90 for the smaller engines. The wages for the men employed on the Mallet engine amounted to $219, as compared with $369 for the smaller engines. Thus, the total sum of running expenses for the Mallet engine amounted to $762, as compared with $1,041 for the 6- and 8-coupled engines, running in tandem. The first cost of the Mallet engine was $23,300, and the two 6- and 8-coupled engines used cost, together, $30,100, so that the capital saved by using engines of the newer type is nearly $7,000 per locomotive.

NOTES FROM THE NEW SHOPS OF THE HEALD MACHINE CO.

The Heald Machine Co. was incorporated in September, 1903, and succeeded to the business of L. S. Heald & Son, of Barre, Mass. The business in Barre was established by Stephen Heald in 1830, and for forty or fifty years this shop was the principal machine shop within a radius of 20 or 25 miles. While the business consisted largely of building agricultural and wood-working machinery and doing work of a local nature, large numbers of wire-drawing machines were constructed, which were sold to the most up-to-date wire manufacturers of that time. A foundry was also established in connection with the machine shop and at that time was the only foundry within a radius of 25 miles, all iron and coal being teamed that distance from the nearest railroad.

About 1860, two sons of Stephen Heald were taken into partnership under the firm name of S. Heald & Sons. In 1890, after the death of Stephen Heald, one of his sons, Leander S. Heald and his son, Jas. N. Heald, carried on the business under the firm name of L. S. Heald & Son until the year 1903, when the need of better shipping facilities (the nearest railroad then being located three miles from the factory), better labor market, and growth of the business, led to its removal to the city of Worcester, the senior partner, L. S. Heald, selling his interest to his son, Jas. N. Heald, who organized the company known as the Heald Machine Company, of which he is treasurer and manager.

For the last twenty years special attention has been given to the manufacture of grinding machinery, the line first beginning with the American twist drill grinder, which has had a wide sale, not only in this country but also in many foreign countries. Later, this line was increased by a line of grinding attachments and center grinders for use in connection with lathes, and later yet a line of ring and surface grinders was brought out for grinding piston rings, disks, dies, and similar work, this being known as the Heald ring and surface grinder. The attention of the company was then called to the importance of furnishing the automobile manufacturers with a machine which would grind the interior of the cylinders for their engines so that a better surface could be produced than by boring and reaming.

While previous practice in steam engines having thick cylinder walls had been to smooth bore for a finish, and, in some of the smaller sizes, ream for the same purpose, this was not a satisfactory method in finishing automobile engine cylinders having thin walls which spring under the pressure of the boring tool and reamer. Therefore, a method of finishing these cylinders which would produce a more perfect surface and uniform diameters was greatly needed. The company took up the study of the problem and developed a machine for accomplishing this work, known as the Heald cylinder grinder. This machine has been adopted by almost all the leading automobile manufacturers of this country, and many of the machines have been shipped to England, France, Germany, and Italy for the same service. The latest tool brought out by the company is a new internal grinder which has just been put on the market.

Fig. 1. View of Central Bay in the Heald Machine Co.'s Shop, showing Section devoted to Assembling of Machines

Fig. 5 shows the well-known cylinder grinder built by the company, under inspection test. It will be noted that the machine is built according to the unit system,—that is to say, the different portions are grouped into units as shown in Fig. 6, which is a part of the latest machine brought out. These units are afterward assembled to the frame or bed by suitable fastenings. This accords with the most modern practice and is undoubtedly a time-saver. Carborundum wheels are recommended for internal grinding on cast iron parts. The writer noted, however, that the carborundum wheels in

stock were not made by the producers of carborundum, but by another firm.

The works of the company are located in Greendale, a suburb of Worcester, directly across the street from the works of the Norton Co., and the Norton Grinding Co., making a sort of grinding settlement at this point. The shops were enlarged during the past summer, an addition of 150 feet by 90 feet being made to the main building, and wash room and toilet rooms covering a space of 30 feet by 45 feet being built in addition. This, with the new power house 26 feet by 43 feet, gives a total floor area, at the present time, of over 28,000 square feet. The number of employes before the present falling off in business was from 90 to 100.

In regard to shipping facilities, the works are located directly on the spur of the Boston & Maine Railroad system, so that cars are loaded directly at the door for shipment to any section of the country. The cuts, Figs. 1 and 2, show two views of the general arrangement of the shop. All the rooms are well lighted and ventilated, and this, together with the modern wash-room, Fig. 3, makes a very pleasant place in which to work. In all the arrangements for handling the work a complete business system is maintained, and the exact standing of manufacture in any or all of the departments is known at all times.

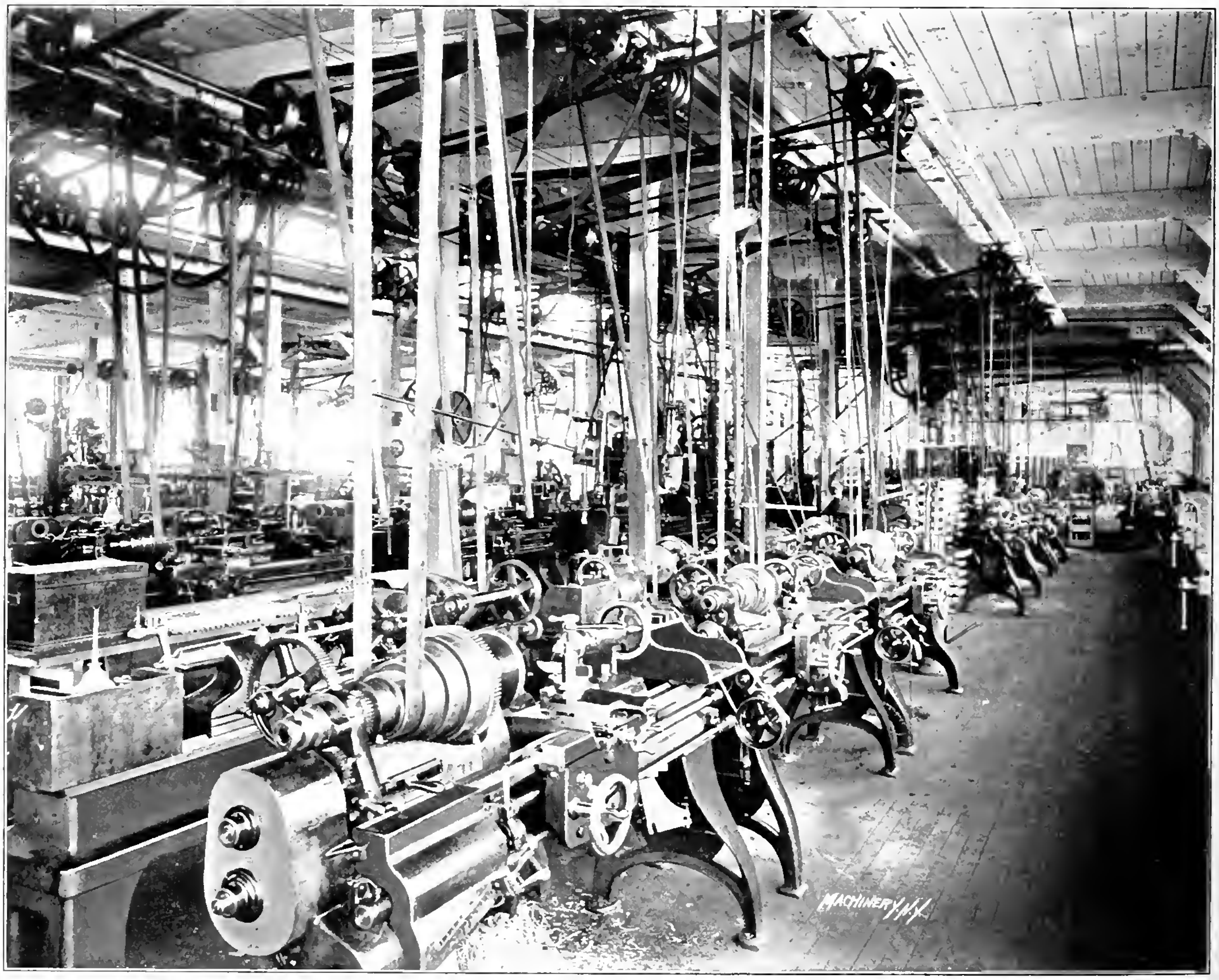


Fig 2 Lathe Department, showing the Light and Neat Appearance of the Factory.

Outline of the Heald Machine Co.'s Shop System.

In originating the stores system in use in the factory, the Heald Co. goes on the principle that a satisfactory cost system and a well-kept and well-organized stores-room go hand in hand. Fig. 4 shows a rack for holding bar stock. As this stock is of varying grades, each bar has its own color denoting its particular grade. For example, soft machine steel might be denoted by yellow, wrought iron by red, hard machine steel, blue, etc. One end of each bar is painted the denoting color when the stock is received, and the cutting off is from the unpainted end. All bar stock is cut in the stores-room.

While the stores-room can do fairly well without the cost system, the latter is a failure without the former. By that is meant that one of the factors in cost work is the material used, and unless all material is handled correctly, and properly issued to the department and to the work on which it is used, the figures obtained by the cost department would be proportionately inaccurate. The Heald Co. has, therefore, so arranged the stores-room that all material is received by that department, and complete records are kept of all material in stock (which amounts to a perpetual inventory of stock on hand), and of the proper distribution of stock, same being issued against the shop orders on which that material is to be used. There is no question but that a well-handled stores-room pays for itself many times over because of the fact that the stores department is constantly on the lookout for the future needs of the factory, and sees that the material is on hand, and that it is so kept that it can be found when wanted, which cannot be the case if material is handled in such a way that any one of the workmen can help himself to it, or when some one endeavors to anticipate the needs of the factory without some good system connected with the use of the material. So simple and yet so complete is the system installed that but three people are required to receive, keep careful record of, and issue all the stock to the factory, do the time-keeping, and figure all the cost connected with the product, for a force of from seventy-five to one hundred workmen. The same stores-room force could well take care of from 25 to 50 per cent more men.

The system originates or starts from the "production department," which issues what is called an "assembly factory order." This order covers all the work done and material

used in the manufacture and assembling of a definite number of machines of a certain kind. After the assembly order is issued, the drawing-room furnishes the factory with several sets of complete drawings showing every part used in the construction of the machines. It also furnishes, at the same time, to the production department and stores department, what is known as a schedule of parts used in the construction of the machines. This schedule shows every part used on the

Fig. 3. Wash Room. Note Individual Wash Bowls and Lockers, and Spacious Accommodations.

machine, gives the name of the part, the part number, shows how many parts of each kind are used on the machine, the material of which each part is made, and gives the rough dimensions from which the stores department makes up requisitions for the stock that will be needed to build the different parts. The schedule also gives the number of the blue-print on which each machine part is shown.

When the production department receives the schedule from the drawing-room, individual shop orders are made up for the number of each piece required for the lot of machines. These orders are made in triplicate, one copy going to the time-keeper, one copy to the stores department, and one copy to the foreman of the department in which the first operation on that particular part takes place. Immediately upon receipt of the shop orders, the stores department makes out what is called "traveler tags." These tags are held by the stores department until the material is ready for the factory, at which time they are delivered to the superintendent, who sees

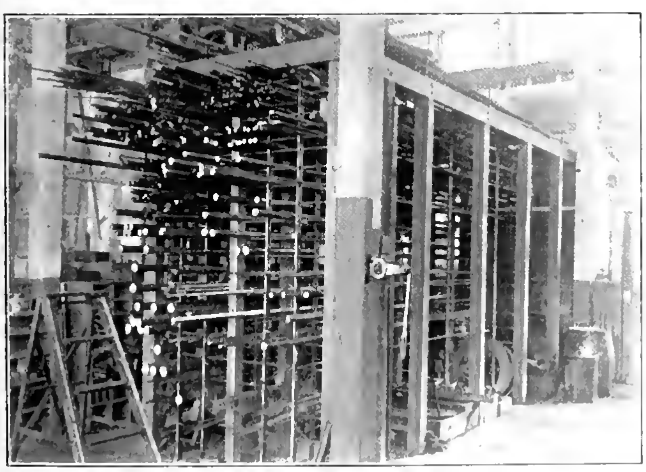


Fig. 4. Rack for Holding Bar Stock.

to it that the foreman of the department in which the first operation on the piece takes place receives the tags, each being withheld, however, until the superintendent is ready for that particular job to go through. On the back of the traveler tag is indicated the list of operations in the order in which they are to be performed. The names of the various operations are printed, and in a column in front of the name of the operation a number is placed in ink or pencil, indicating the order of the operations for the particular piece in question.

When the foreman of any department is ready to commence work on any part, he hands the workman the traveler tag for that part, which this man then presents to the stores department delivery window. He receives the stock for making up the required number of parts, after which he presents the tag to the time-keeper's window and receives his time-card, together with the proper blue-print, for which he leaves a brass check with the time-keeper, going from there directly to the time-clock, where he rings "in" on the time-card. The time-clock in use is known as the "Rochester."

After ringing in, the workman is ready to proceed with the work. He rings "out" on the time-card when leaving off work at any time, and rings "in" on the same card when commencing work again. When each operation, however, on those parts is finished, he must change his time-card for a time-card covering the following operation. This is done in order that the cost of each operation may be known, and thereby the company be in position to make comparisons of labor cost, and ascertain whether one man is a more skilled and a better producer than another. This information is valuable in order that proper adjustments of wages may be made, and is a very valuable feature for the workman, especially a good one, for when an increase in his pay is under consideration, records are ready at hand from which to determine whether or not he is worthy of an increase.

The inspection system calls for the inspection of all work after each operation. It also calls for the immediate inspection of the first part finished on each operation. The piece when finally inspected as a completed machine part is turned

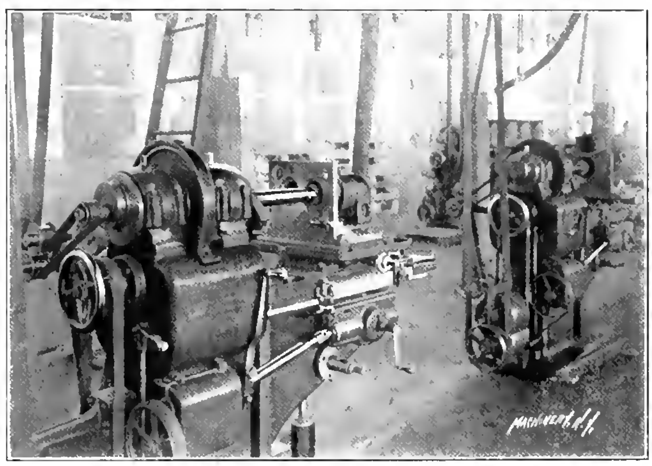


Fig. 5. Heald's Internal Cylinder Grinder under Inspection Test.

in to the stores-room by the inspector, who alone has authority to turn in material to the stores department from the factory.

Upon receipt of these finished parts by the stores department, they are placed on the shelves to await the assembling of the machines, at which time they are drawn out of stock and charged against the assembly order, the same as other material. The copy of the order originally sent to the stores department is turned in to the time clerk, who immediately proceeds to figure the cost of all operations on the part, material used, factory overhead charges, etc., making a record of these costs on a cost record card.

When the stores department issues material to the factory, the workman taking out the material fills out a blank headed "Storekeeper: Please furnish:". These blanks are each day turned over to the stock clerk, who enters on his stock sheets the material shown as given out. It sometimes happens that material is given out to the factory and afterwards returned, at which time a credit is rendered to the shop order on which it was originally issued. Such a credit is made out on a pink slip headed "Storekeeper: Please credit:". These issues and credit slips are turned over weekly to the cost clerk, and represent the actual material used for the shop order on which those parts are made up. On these issue slips the value of the material appears. This is written in by the cost clerk, who takes the prices from his stock sheets.

In order that the cost clerk may have correct prices for this purpose, the following purchasing system is in use: When purchased stock is needed, the stores-keeper notifies the pur-

chasing agent. When the purchase order is made out by the purchasing department, a copy of this order is sent to the stores department, who receives the material when it is delivered, and fills out a "voucher for material received." This voucher is handed to the purchasing department, who audits the invoice, and writes in the cost of the material, after which the voucher is returned to the stores department, where the price is transferred to the stock sheets.

There is one feature of the system that differs quite radically from many we have seen, which is that none of the foremen are called upon to do clerical work of any kind. The system is carried through the works entirely independent of the foremen, giving them all of their time to attend to their work as foremen, and leaves the clerical work to others who are better fitted for the work, and who, as a general thing, can be hired for less money. We are aware of the fact that a large number of manufacturers question the wisdom of going to the expense incurred by a satisfactory stores department and cost system, but the Heald Machine Co. claims that a very simple and inexpensive system, like that in force, will save any firm many times the actual cost of the system. Probably the greatest difficulty with those who question the wisdom of a cost system has been that the systems they have seen in force, or been in contact with, have been so loaded down with "forms" and "red tape" that the system became a burden rather than a help.

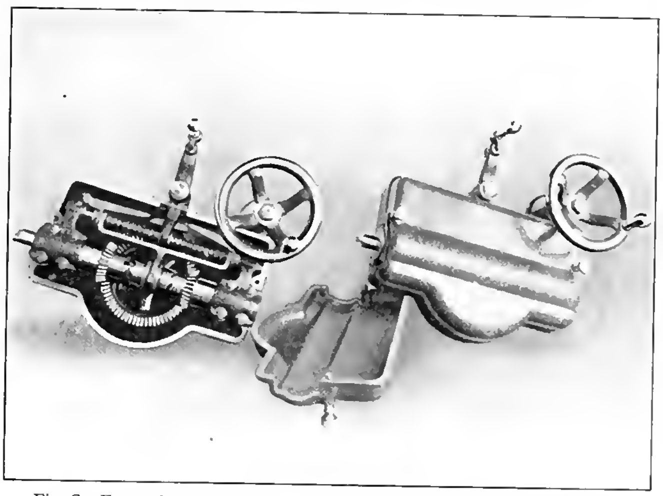


Fig. 6. Example showing Principle of Unit Construction followed in the Design of the Heald Co.'s Machines.

In preparing this article we are indebted to Mr. Heald and to his superintendent, Mr. Cowan, for much of the material.

* * *

MACHINE SHOP PROVERBS.

Hell hath no fury like a loose pulley scorned.

A fair exterior may be but a whited sepulchre for prick-punch fits.

A rusty nut will hang as plumb as a mercury bob.

The right thing in the right place—lard oil for the tap, black strap for the spindle.

"Were there "putting-on tools," then would be one man as good as another.

Better the mote in another's eye than the emery in one's own.

Lathe tail-centers were made before center reamers,—but be civilized.

That a man is a tool-maker does not make him a Joshua Rose.

* * *

In the February issue of MACHINERY reference was made to the new railway ferry connection proposed between Sweden and Germany, which will be the most remarkable railway ferry connection for both passenger and freight service in the world. The bill for the establishment of the ferry service has now passed the Swedish parliament. Four ferry boats are to be built, and direct communication will thus be provided between the government railroads of Sweden and Germany. The cost for the establishment of this ferry connection is about $2,500,000.

DROP AND STAMPED FORGINGS.*

JOSEPH HORNER.†

Joseph Horner.‡

The employment of drop forgings and stampings increases constantly and rapidly. Several firms are now equipped wholly for this class of work, and supply enormous numbers of forgings to the metal working trades. Drop forgings or stampings bear the same relation to the work of the blacksmith shop that machine-molded castings bear to that of the foundry. In each case the skilled labor of the craftsman is dispensed with, yet good wages are earned by men working by the piece. In each case the cheaper product has the advantage of much greater accuracy, and uniformity in shapes and dimensions. The numbers turned out from the dies or stamps, as from the molding machines, are often twenty or thirty times as great as those which can be produced by hand by skilled men. In each case, too, the question of machining is often inseparable from that of the methods of production adopted, because accuracy of shape, and uniformity of dimensions in forgings and casting alike are favorable to the most economical machining, since allowances which are either insufficient or excessive for the machines are equally undesirable and troublesome. The smith working at the anvil, even with the aids afforded by templets and gap gages, is unable to produce two pieces, to say nothing of twenty intricate and elaborate pieces, absolutely alike, unless at an enormous expenditure of time. It is cheaper therefore, and is the practice to "leave plenty on" to insure that the work shall "finish" all over when machined, otherwise the final corrections would occupy much more time than the actual formative work of the forging. But forgings which are stamped, all come out exactly alike from the dies, without any extra care or time spent on the part of the workman. Moreover, since the allowance left is small in amount and regular, pickling can be more usefully practiced than when allowances are excessive.

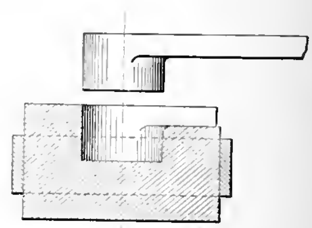


Fig. 1. Die used for Correcting or Finishing End of Lever.

The accuracy of stampings, however, is further advantageous in the fact that a considerable amount of machining is often avoided altogether. The smooth, glossy, polished and accurate surfaces left from the dies are often good enough for handles, lever webs, and bossed parts. Or, if they are required to be bright for good appearance, then a polished surface imparted by an emery wheel and buff are sufficient, without any machining in the lathe, shaper, or milling machine. Punched holes may be simply lapped, instead of being drilled

* The following articles on this and kindred subjects have previously appeared in MACHINERY: The Manufacture of Dies and Drop Forgings, March, 1900; Making Drop Forging Dies, January, 1905.

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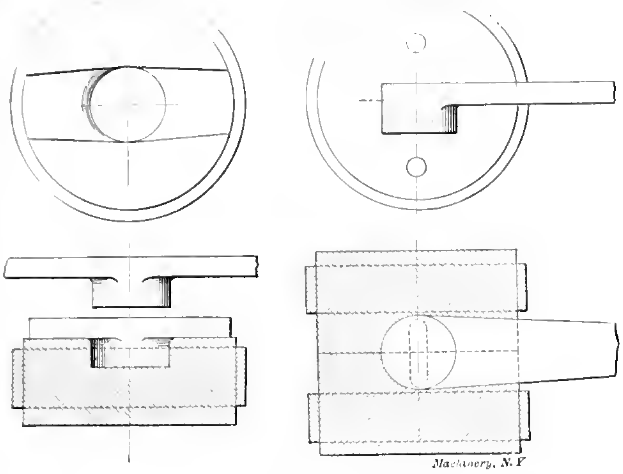
‡ JOSEPH G. HORNER was born in Bristol, England, in 1847. His early technical training was acquired in serving an apprenticeship of seven years with Stothert & Pitt, Ltd., Bath, England, and by attending technical evening classes. After having finished his apprenticeship, he remained in the employ of Stothert & Pitt, where he worked, in all, considerably more than thirty years, of these, fifteen years as foreman. His training, gathered here, was most thorough, because the works, although now specializing chiefly in hoisting machinery, has, at different periods, handled many classes of manufacture. His duties as foreman kept him in close touch with all branches of mechanical work. For the last thirteen years he has been wholly occupied with technical literary work, and besides having contributed to a number of technical publications, including *Engineering*, the *Mechanical World*, the *American Machinist*, *Foundry*, *Cassier's Magazine*, etc., he was written a number of books, of which may be mentioned "Pattern Making," "Practical Iron Founding," "Toothed Gearing," "Helical Gears," "Plating and Boiler Making," "Dictionary of Engineering Terms," "Hoisting Machinery," "Tools for Engineers and Wood Workers," "Practical Metal Turning," "Milling Machines," "The Principles of Fittings," etc. He is also editor of the "Encyclopedia of Engineering."

and reamed, the locations of the holes being fixed with accuracy by the dies.

Development of Stamping Processes.

The history of die stamping goes back fifty years or more in the Black Country, and Birmingham district, England. In the blacksmith shops a limited amount of work had been done previously in dies for as long a period, but only or chiefly as a device for imparting a final finish to work which had been already prepared and nearly completed at the anvil. This practice arose out of the fact that only in this way was uniformity in a number of similar forgings economically possible. Such uniformity could only be produced on the



Figs. 2 and 3. Other Examples of Dies used for Finishing, but not for Rough Forging, Bossed Levers.

anvil with flatters and swages, at the sacrifice of much time and labor. Hence, long before the practice of *producing* forgings by stamping existed in the blacksmith shops, the practice had grown of *correcting* and *finishing* anvil-made forgings in dies under the power hammer. The dies were often of a sectional form, as they are still to-day when heavy forgings are in question. Thus, a die or pair of dies would include a boss only, on a lever, Figs. 1, 2 and 3; the lever ends standing out beyond the dies; or a die would be used to punch a hole, and correct the boss at the same time, Fig. 4. Lever ends, either forked or solid, are suitable objects for

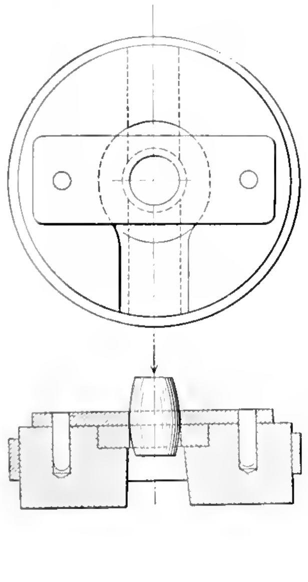


Fig. 4. Die used for Punching Hole through Boss, correcting Shape of Boss at the same Time.

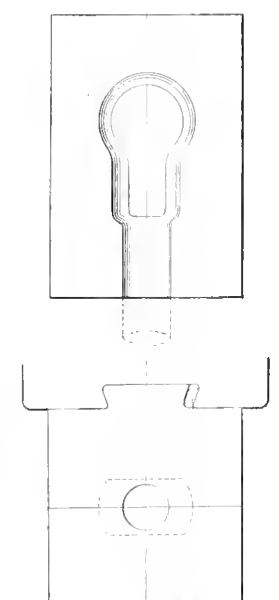


Fig. 5. Die for Finishing the End of a Connecting-rod.

finishing in this way. So are the ends of connecting-rods, Fig. 5, the eyes of the tie rods, and the bridles or loops of slide valves. In the old practice, as to a large extent now, these were made of wrought iron, bent, and welded. These operations were done at the anvil, and the correction and finish done at another heat in dies. These dies were and are made of cast iron from a pattern. Later, cast steel has been often used with a view either to increase the strength, or to lessen the weight.

Even on the anvil, in little shops where there was not as yet a steam hammer, the old Oliver was utilized in finishing the heads of bolts in dies, and the writer remembers seeing these

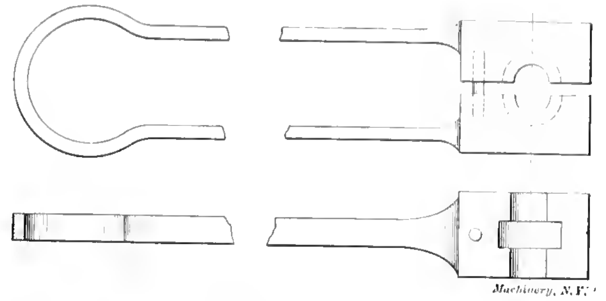


Fig. 6. Device for Shaping Bosses on Work, made on the Principle of the Spring Swage.

in operation. And on the anvil, little devices were rigged up for finishing bosses, and punching holes, the type of which was the spring swage, Fig. 6, the jaws of which were fashioned independently of aid from the machine shop, by a process of *typing*, or *hubbing*, from a dummy, or a duplicate forging. Very many simple forms can be and are done in this way still as a legitimate and suitable method. Light swages are used on the anvil, just as the heavier ones are operated under the steam or drop hammer.

The sectional dies are used very extensively now in the blacksmith shop for the purpose of final correction and finishing only. But along with the use of these, there has grown the practice of stamping wholly, either as a sub-department of the shop, or carried on in a distinct shop. Generally, however, the merely corrective dies are used for the

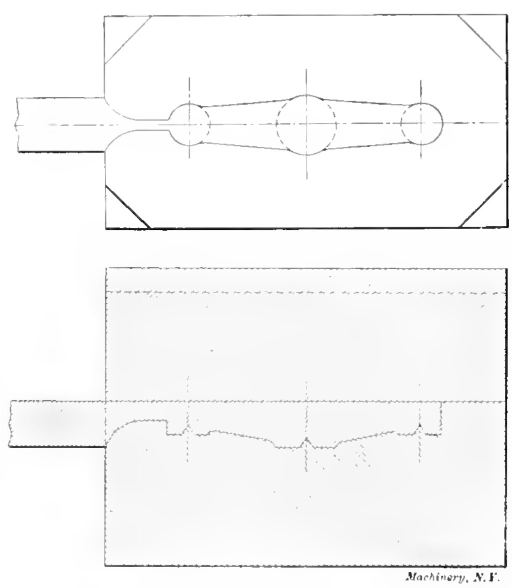


Fig. 7 Example of Forging Die, forming Center Holes in the Bosses of the Work.

heavier forgings, and the regular stamps for the smaller class, as in Figs. 7 to 10. To make the larger forgings entirely by stamping operations would often require heavier hammers and appliances than most shops are equipped with, and the numbers wanted of the large forgings might not be sufficient to render heavier installation remunerative. But a heavy forging may be corrected in dies when it would not be practicable to produce it entirely from a rude lump. Among work of this kind may be instanced large tie-rod eyes, large bossed levers, Figs. 1 and 2, rings, pillars, and such like. Some of these are too long to be embraced wholly in a single die. A long two- or three-bossed lever, for example, is then corrected only on its bosses, and for an inch or two away therefrom. A pillar for handrailing would have its bossed portions corrected separately, and the body corrected by swaging at the anvil, or in other dies.

Materials Used for Dies.

The number of similar castings required is often insufficient to justify a large outlay for cut steel dies. But dies made in cast iron are not costly, and therefore they are frequently made when only half a dozen or a dozen of similar articles are required. They may, of course, be kept for future use, and should be, when a job is likely to be repeated, but, apart from that, a very small number of forgings will pay the cost of cast dies.

The growth of stamping has been gradual and natural. The mere fact of having cast dies lying by from previous jobs

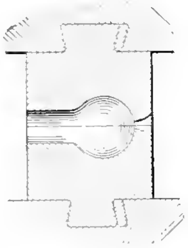


Fig. 8. Type of Die for Forming the End of a Ball Crank.

Fig. 9. Forging made in Dies from a Bar.

has been the cause of their utilization for pieces of work which might not otherwise have been thought to justify the expense of new dies. But being in stock, slight and unimportant alterations in some dimensions in new jobs would often render the dies available. In this way the beginnings of standardization arose. For as the dies began to accumulate, one pair or set was made to do duty for work for which it was not originally intended. Thus, the difference of half a ton or a ton of crane power was not allowed to involve the making of minute differences in the forged work for the cranes, but one standard set was used for both. So in engine and pump work the same standard sets came to be used for powers and sizes of mechanisms that were not very dis-

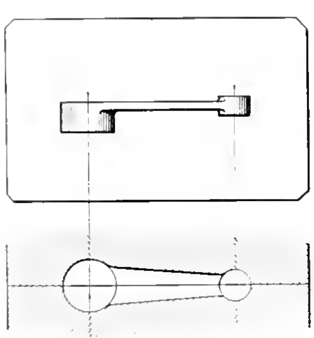


Fig. 10. Dies for a Lever with Hubs at Both Ends.

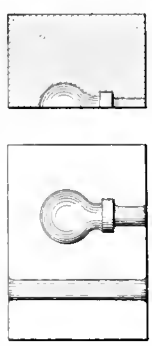


Fig. 11. Dies for Forging an Eye-bolt.

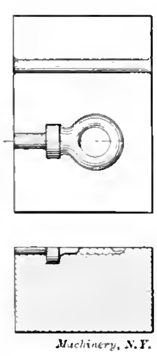


Fig. 12. Dies for Finishing the Eye-bolt.

similar, and when the difference of 1/4 inch, or so, in dimensions could make no possible difference in the proper operation or strength of the forged details.

Principles of Drop Forging and Stamping.

Comparatively few articles can be produced in one pair of dies, and those are chiefly circular forms, the diameters of which at different sections do not vary greatly. If they do vary, some preliminary reduction or "breaking down" is necessary. And if a portion of the article takes the form of an eye, or a boss, three or four successive operations may be necessary to produce the forging, as in the eye-bolt produced in Figs. 11 and 12. The die maker has then to settle how the work shall be done, whether in one or more pairs of dies, and whether under one hammer or two. As a rule, to which there are exceptions, it is desirable to do all the work at a single heat. Then, if several operations are required they must be done either in one set of dies, or in separate dies. For small forgings it is easy to get three or four recesses in one pair of dies, for roughing down, for formation, and for cutting off, or nicking for breaking off. In larger pieces it is necessary to have two hammers adjacent, so that the stamper can use them both without walking away from either. But a few hammers are made double headed, with two anvils, and tups to facilitate such work. When two heats are necessary, then it may be convenient to perform the earlier operations on a large number of similar pieces, and then change the dies for the subsequent work. This, perhaps, is more often done in the regular machine shops than in the stamping works, in which the work is divided between two adjacent hammers.

Though the smith working at the anvil endeavors to gage by a very rough mental estimation the amount of material

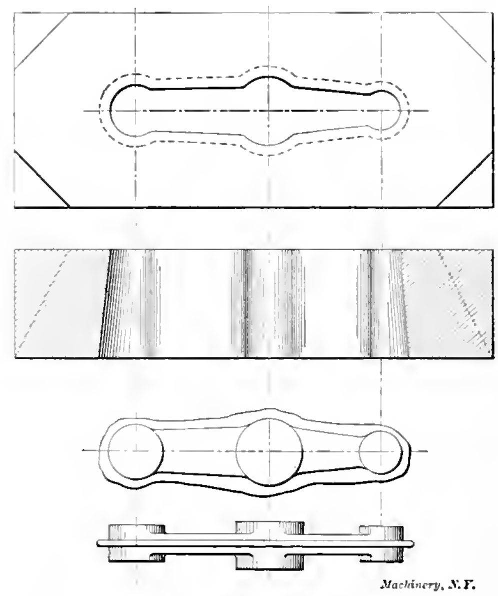
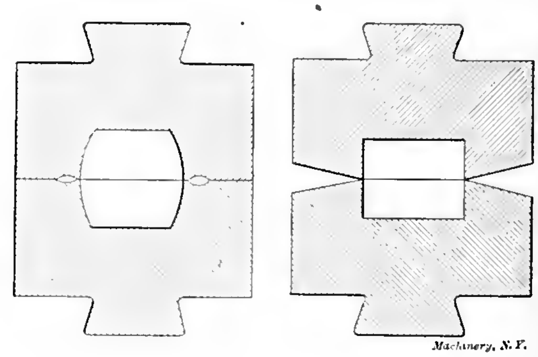


Fig. 13. Stripping Die for Removing Fin produced by Forging Process, and Work for which it is used.

which is required for a forging, in order to lessen labor, the stamper may be comparatively indifferent to that consideration. He will not, of course, have much excess of metal if it can be avoided, yet he is much in the same position as the anvil smith who has a steam or drop hammer available adjacent to the anvil. The power hammer is often resorted to for roughing down an odd lump quickly, in place of taking a smaller section, which would involve the alternative of upsetting, or of welding. The shapeless lump is simply roughed down rapidly in far less time than would be occupied in fullering on the anvil, or in performing the alternative operations of upsetting, or welding. In this way, too, very many odds and ends, cropped from iron or steel bars are utilized, which would otherwise go to swell the scrap heap.

The case of stamping is analogous. Though forgings having considerable differences in cross-sectional areas, are, as a general rule, broken down in one or more operations, preliminary

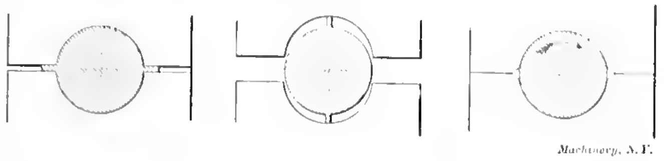


Figs. 14 and 15. Dies provided with Space for Receiving the Fin.

to finishing, yet a great deal of work is done without this step-by-step process. A cubical lump is taken and put into the dies and reduced. A large amount of fin being squeezed out in the process, this is removed in an adjacent stripping die, Fig. 13, and the forging put back, and finished in the first, or in another, recess, followed sometimes by a final stripping. This heavy reduction is only possible, first, because the lump is raised to a high temperature, and second, because the mechanical work done on it maintains the heat until the reduction is completed. At the anvil, two or three heats would often be required to accomplish the same amount of work which is done in one heat in stamps.

Removal of Fin Produced in Drop Forging.

The formation of fin, it will be noted, is peculiar to stamping; it does not occur in anvil work. Sometimes dies are cut like Figs. 14 and 15 to receive the fin. In Fig. 14 a wide and shallow groove is cut all around the recess to receive the fin. In Fig. 15 the faces are sloped away with the same object. Work which is of cylindrical form does not neces-



Figs. 16 and 17. Showing how Fin produced on Round Work is forged into the Bar by rotating it.

Fig. 18. Die with Rounded Edges to receive Fin.

sarily involve the formation of permanent fin, because it can be rotated, as the reduction is going on, and such excess of metal which is squeezed out laterally is removed at once when a partial rotation is given to the piece, as in Figs. 16 and 17. In Fig. 16 the fin is shown squeezed out; in Fig. 17 it is being driven into the forging again. Such being the case, Fig. 18 is the shape given to circular dies in cases where the circular form is not hampered by the proximity of shapes which would interfere with rotation. When the work can be rotated, the result is a fine, smooth, polished surface, which in many classes of work renders any subsequent machining unnecessary, or, if finish is essential, a little grinding may suffice. In some forgings a portion only, a stem or shank, can be so treated, the remainder consisting of an eye, or a flattened portion, or a square shape.

Difference between Treatment of Steel and Wrought Iron.

In the blacksmith shop, wrought iron is still used as extensively as steel for common forgings. But many forms when made of wrought iron must not be stamped from a solid lump

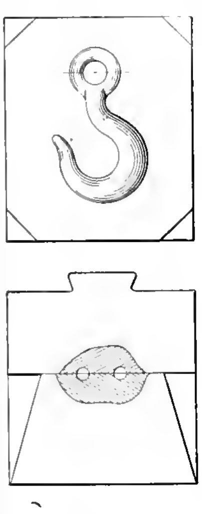


Fig. 19. Dies for Crane Hook.

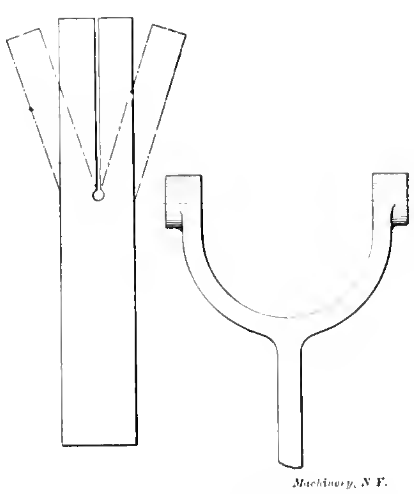


Fig. 20. Fork Lever, and Wrought Iron Bar from which it is made.

because of the loss of strength which occurs across the grain Large thin rings and curves of light section should always be bent. But if these are made of steel, no such reason exists, because steel has practically no difference in strength with or across the direction of rolling. The partial substitution of steel for wrought iron has therefore been favorable to the development of stamping. Many jobs are now stamped from a solid bar, or lump of steel, which were formerly made from wrought iron by bending and welding. Hence, while wrought iron is still extensively used for anvil made forgings, steel is employed much more for stampings. The crane hook, Fig. 19, when made of wrought iron, is always bent from bar before being finished in the dies. Made from steel, it is stamped from a solid lump. For the forked end, Fig. 20, if made of wrought iron, a bar is slit, and opened out, and bent over a form, and finished in dies. When made of steel, it may be stamped from a solid mass. The flange, Fig. 21, is stamped in steel from a solid chunk, handled by a porter bar temporarily.

Work with Holes Forged through it.

The old method of punching holes is that shown in Fig. 4, in which the punch is guided by a plate doweled on the body of the die. This is suitable for large holes. Frequently, for small holes, the punch is separate, and driven through a hole in an upper die as in Fig. 22; in Fig. 23, a hole without its punch is shown. But punches are also often included solidly in the die, as in Fig. 26, half in top, and half in bottom, and not quite meeting at the center. In a shallow boss the punch may be in one half of the die only, as for a forging like Fig. 24. The metal becomes squeezed into the boss, and is improved by consolidation. Often, when holes are left to be drilled, the centers are stamped by small conical projections

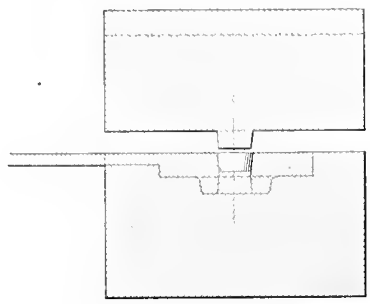


Fig. 21. Dies for a Circular Loose Hub.

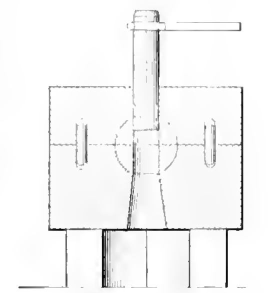


Fig. 22. Punching a Small Hole through the Work in the Dies.

in the dies which serve as accurate guides to the driller. Sometimes holes are punched only through a portion of the metal, Fig. 25, when the central part has to be bored out subsequently, as indicated by the dotted lines.

Methods of Applying Impact or Pressure on Dies.

Formerly all die work was done with hammer blows. As the demand grew for an extension of the system to heavier forgings, and to articles involving the bending of plates and sheets, the steam and drop hammers were not able to deal so well with these. The demand was met by the presses, which are actuated by hydraulic power or by gears, cranks, and toggle levers. These will easily deal with dies and articles of several feet in length, many of which are too intricate to be dealt with by hammers, even if their dimensions did not set a limit to such treatment. They are practicable on the hydraulic presses, because two rams can be utilized, one acting in the vertical, the other in the horizontal direction, so working at right angles with each other. This is utilized for bending, welding, and punching, for closing up joints, for dealing with undercut designs, and with hollow spaces formed

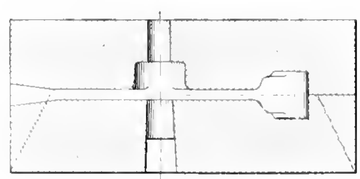


Fig. 23

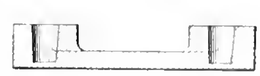


Fig. 24

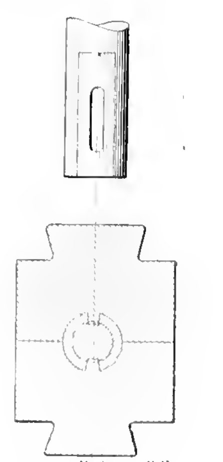


Fig. 23. Dies for Punching Holes through Bosses. Fig. 24. Holes punched by Punches Integral with Die.

Fig. 25. Method of Forging the Slots in Collets

by bending and welding, or by stamping. Typical of much work of this class is the die and punch used for stamping the rings for uptakes of vertical boilers and the man-hole and mud-hole seatings for boilers, Fig. 27, from a plain piece of steel plate. Fig. 28 shows the dies for forging a crank by pressure. A large amount of work of this kind is done in the railway car shops.

Stamped forgings thus diverge into two great groups, according as they are produced by hammer blows, or by grad-

nal pressure. Broadly, the first group includes articles of small and medium dimensions, the latter those of a massive character, and all large work done in plates. This is now a generally accepted division, and one which harmonizes with the difference in hammer blows delivered on comparatively small masses, and of pressure on thicker bodies. Where mass is the condition present, slow pressure is more penetrating than impact, just as it is in large shafts and forgings. Moreover, the blows delivered from a very heavy hammer are

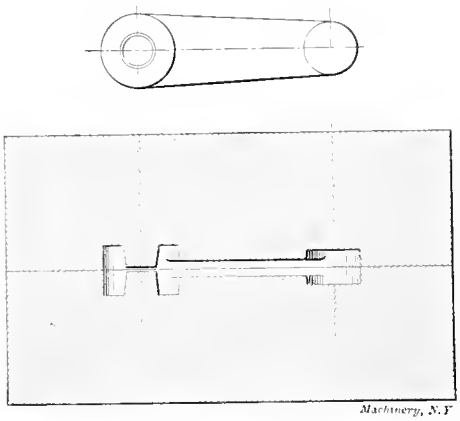


Fig 26. Construction of Die for Forging a Hole through a Boss.

destructive to dies, and if they are made massive enough to withstand these blows, then they are too heavy for convenient handling. Massive dies are, of course, required to resist pressure, but that is not nearly so destructive as the violent, incessant jarring action of a hammer.

Methods Used for Making Dies.

The stamps or dies used are as varied in their details and cost as the forgings themselves are. A great advantage of stamping dies is, that like machine molding, they are as readily adaptable to the demands for a very few identical articles, say ten or a dozen, as to hundreds or thousands. But the amount of work put into the dies, and the patterns and the materials used for them have to bear a definite relation to the number of pieces required. Hence, we have at extremes, dies of cast iron made cheaply, and those of mild steel cut out with care and hardened. Except in name and function,

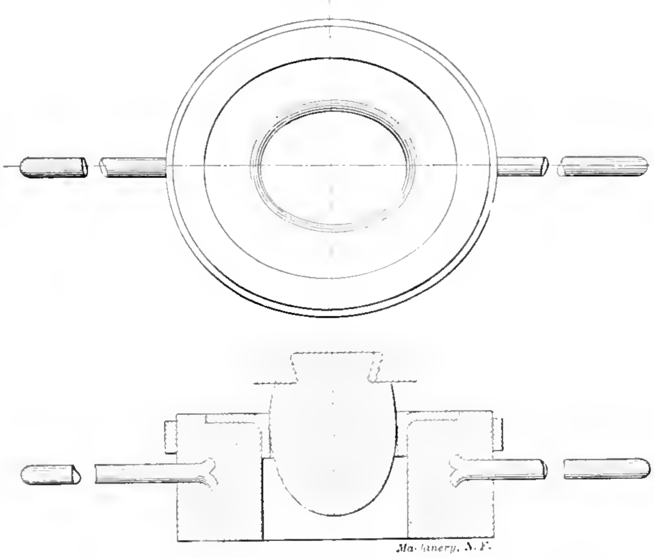


Fig 27. Die used for Forging and Bending Man-hole Seatings.

the examples at each extreme have little in common. They are not made in the same way, and the periods of their service are much less in the first than in the second case.

The cast dies are molded from suitable patterns. They may have to be cleaned up a little by the machinist. As they are liable to fracture, unless made very massive, they are frequently encircled with bands of wrought iron, shrunk on, as in Figs. 1 and 4. They are, when small, lifted with circular tongs, Fig. 29, or by the hands, but larger dies have handles cast in for lifting them, Fig. 27. Or, alternatively, holes are cast in for the insertion of rods for the same purpose. Some cast dies will endure long service, others fracture soon. Dies of cast steel are stronger, but are more liable to inaccuracy.

Dies of forged steel are marked out on their faces, and recessed by various machine tools, and by hand work. All the aids afforded by machine tools are utilized, as boring, slotting, milling, and shaping. But often very much is left for the chisel and file to complete. There are several special machines designed wholly or chiefly for the use of die sinkers, but much can be done by the ordinary tools in the shops. Templets are used to check the progress of the work, including those of sheet metal for local sections, and those which represent the actual forgings which have to be stamped. These are made of lead, or tin, or a first sample forging is prepared. Contact is insured by the transference of red lead from the templet to the recesses which are being cut.

Reference has been made to the typing or hubbing process. It bears an essential resemblance to the operation of stamping medals and coins by a hard blow. Only the operation is reversed, the die itself being produced by stamping it, while white hot, from a cold forging. It has the advantage of being cheaper than cutting dies, and in circular outlines is accurate enough, but is not well adapted for intricate shapes. The spring swages are frequently made in this way. In

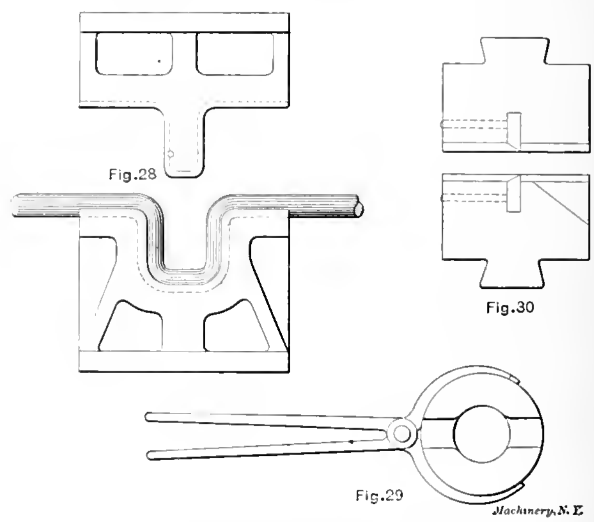


Fig. 28. Die for forging Crank. Fig. 29. Tong for Holding Dies. Fig. 30. Cutters for Nicking the Stock, fitted at the End of the Dies.

obtaining circular shapes thus, the hub or type is rotated between each successive blow, so correcting any inaccuracies that might form. The edges are of necessity produced with a slight convexity, Fig. 18. But this is an advantage in producing circular forgings which are rotated in the dies. It is not necessary to have complete circles in such a case, because metal squeezed out laterally, and what would soon form a fin, becomes obliterated by the next blow when the rotation into a new position takes place.

In one of the illustrations, Fig. 3, dowels are shown, which are inserted to serve as guides to secure the alignment of top and bottom dies. These are only used when the dies are not attached in any way to the anvil below, and tup above, as is often the practice in heavy dies. But generally the dies are secured by dovetails and keys, as in Fig. 5. In some cases locating screws are used on the anvil for dies cut at the corners, like Figs. 13 and 19, and the dovetail is only on the tup. The locating screws permit of making slight adjustments.

Forgings are often included wholly in their dies, and are knocked out by a kicker device, or are pried out, or pushed out. Often a porter bar is used, generally the plain length of the bar from which the forgings are being stamped, as in Figs. 7 and 9. Then the forging is easily nicked off by reducing the eye at the neck, as shown in Figs. 7 and 9; or a pair of cutters is fitted at the end of the dies, as in Fig. 30.

The foregoing is an outline of the methods of stamping in use, from which it is seen that the practice is divisible into three great groups; that done under hammers, and that in presses, and a further subdivision between the methods of the general shops, and the drop forgers who work for the trade.

THE SETTING UP AND OPERATION OF THE POTTER & JOHNSTON AUTOMATIC CHUCKING MACHINE—2.

This installment completes the article relating to the setting up and operation of the Potter & Johnston automatic chucking machine. Owing to the frequent unavoidable references to Figs. 1 to 7, it should be read in connection with the first installment, published in the April issue of MACHINERY.

As explained, the third turret face is empty, the cutting off of the collar being done during this portion of the cycle of operations. It has been taken for granted, of course, that in setting the turret slide for position, room has been left between it and the chuck for the cross slide. The cross slide is clamped in a convenient longitudinal position on the bed for the cutting-off operation, which will be done with a tool in the rear tool-post, so as to leave the front unobstructed for the operator. Where forming and cutting-off are to be done, forming is generally done at the front and cutting-off at the back, since heavier and more accurate forming work can be done with the work revolving downward toward a tool in the front tool-post, than with a tool at the back which is subjected to a lifting action.

The layout of the cross-slide cams is shown in Fig. 5. The rear feed cam is the one we have to use. Since this cutting-off operation is a short one, it may be done during the return of the turret for face No. 3. The cam drum is therefore rotated by hand until the turret for face No. 3 has begun to return. The cross-slide cams are loosened and the rear feed cam swung around to just touch the roller, the cross slide having been adjusted out to nearly the limit of its forward travel for cutting off, leaving approximately enough motion for cutting down the rear face of the collar and through the shell. The rear feed cam is then clamped in this position. A cutting-off tool is next placed in the rear tool-post at the proper height. The rear tool-post slide is adjusted to bring the point of the cutting-off tool up to the work, and the cam drum is revolved by hand until the piece is cut off. The cross-slide tool is, of course, set in the proper position to make a collar of the desired thickness.

Stopping the hand feeding when the roll is on the point of the cam, the cutting-off tool slide is permanently set on the cross slide so that the point of the cutting-off tool enters the bore just barely enough to completely sever the collar from the bushing. The motion of the cam drum is continued by hand until the roll is over the point of the feed cam. The cross slide is then pushed back by hand until the cam and roll are again in contact, when the rear return cam is brought up and clamped in position, so that there is just room for the roll between the feed cam and the return cam. The rear return cam, as the hand feed of the cam drum is continued, brings the cross slide back to its central position. Since there is no front tool used in the final layout of operations (Fig. 2 to the contrary, notwithstanding) the first feed and return cams are allowed to remain wherever they happen to be. These cam adjustments can all be made from the front of the machine.

Continuing the feeding of the turret slide, we next make sure that the cutting-off tool is returned to its normal position before the next face of the turret is presented for its operation, and then we proceed to set the recessing tool. This recessing tool, which is shown diagrammatically in Fig. 8, is a model of simplicity of design and action, as compared with the somewhat complex operation it has to perform. It may be said, in the first place, that this recess is for clearance only, and accurate dimensions and fine finish are not necessary. Assuming this, it will be seen that the operation of this recessing tool should be eminently satisfactory. The device consists simply of a slender boring-bar held in the turret, carrying a cutter suitably located about midway of the bar, the forward end of which is adapted to enter a bell-mouthed bushing held in the chuck. This boring-bar is bent to one side far enough so that the cutter clears the hole as the bar enters, but is forced into the work as the bell-mouth of the bushing engages the end of the bar and deflects it into its working position. The upper diagram shows the condition of the bar as it enters the hole, and the lower one its condition after it has entered the bushing and is engaged in turning the recess. This bar being properly designed as to its length, the position of the cutter with relation to the length of the recess in the work, and the location of the work with relation to the bell-mouthed bushing, it has merely to be set in the turret so that at the extreme forward travel of the turret slide the cutter is the same distance from the face of the chuck that the rear end of the completed recess will be when made to the desired dimensions. The cutter, of course, has been set out to give the recess the required diameter.

The final facing of the bushing by cam and turret face No. 5, so far as the setting of the tool is concerned, is merely a repetition of the facing operation on turret face and cam No. 1. This completes the setting of the cutting tools.

Making the Adjustments for Speeds, Feeds, Etc.

We have now to set the machine to perform automatically the desired changes of spindle speed, and fast and slow cam movements. Placing a new piece of work in the machine (the first one having been completed in the setting-up operations) the cam-shaft is revolved by hand until the turning tool in turret face No. 1 is just about to commence its cut. Hand-wheel D (Fig. 6) is now rotated in its normal direction until its next graduation marked "slow" is in line with the index mark on the base casting of the machine. Then the nearest pin M (see also Fig. 12) is moved up until it bears against

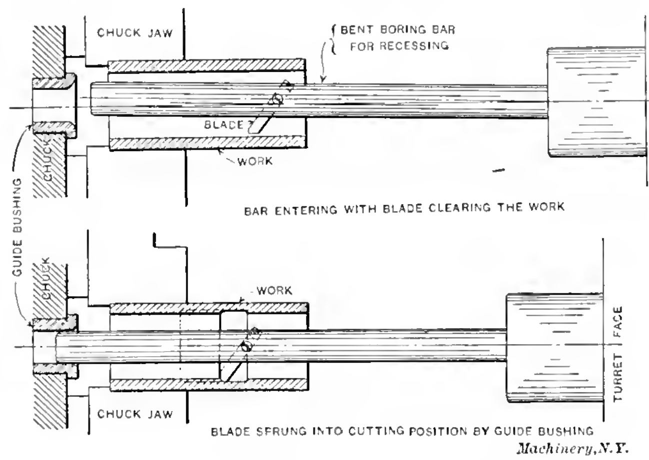


Fig. 8. The Tool used for Recessing the Work; shown also in Fig. 3.

the teeth of the star-wheel, when it is clamped in position. This should set it properly. To see if it is so set, return the cam-shaft by hand and throw in the automatic feed by moving lever H to the right, and watch the cut. The drum should slow down just before the tool commences to work. If it does not do this, the pin may be adjusted a little either way, as may be required. (In going over a piece for the first time, it is best to have the feed set to the smallest rate; that is to say, feed change handle K should be in position No. 1.)

After the cut has been completed and the turret feed cam roll is on the high point of the cam, the power feed may again be stopped, and the hand-wheel revolved until the next graduation mark "fast" is opposite the index mark. The next stop-pin is then moved up until it just touches the star-wheel, where it is clamped in position. The feed being again thrown in, the turret will be rapidly returned, indexed and moved forward for the second operation. Stopping the automatic movement, the pins are set for this face, and so on for all the operations, including that in which the cross slide is used for cutting off.

Operations 1, 2, and 3, being done on large diameters, should be done at the slow speed, handle J (Fig. 6) being set to give that speed. While, however, the turret slide is being returned between operations 3 and 4, one of the spindle speed changing dogs N should be clamped to the rim of disk D so as to change the spindle speed to the fast movement. This is continued until the last operation is completed, when a second dog of this kind is clamped in place to again throw in the slow movement.

The feed knock-off dog should also be clamped in place on the disk to stop the machine at the completion of the fifth operation, when the turret is in its rear position.

This completes the setting up of the machine. It is best for the operator to watch the operation the first time it is done automatically. If, as was the case with the parts shown, the feed is finer than is necessary, the feed change was found possible to use No. 3. If at any time the tools show signs of distress, the feed may be lowered instantly by changing this handle; or if the work seems to be done without distress, it may be increased as easily.

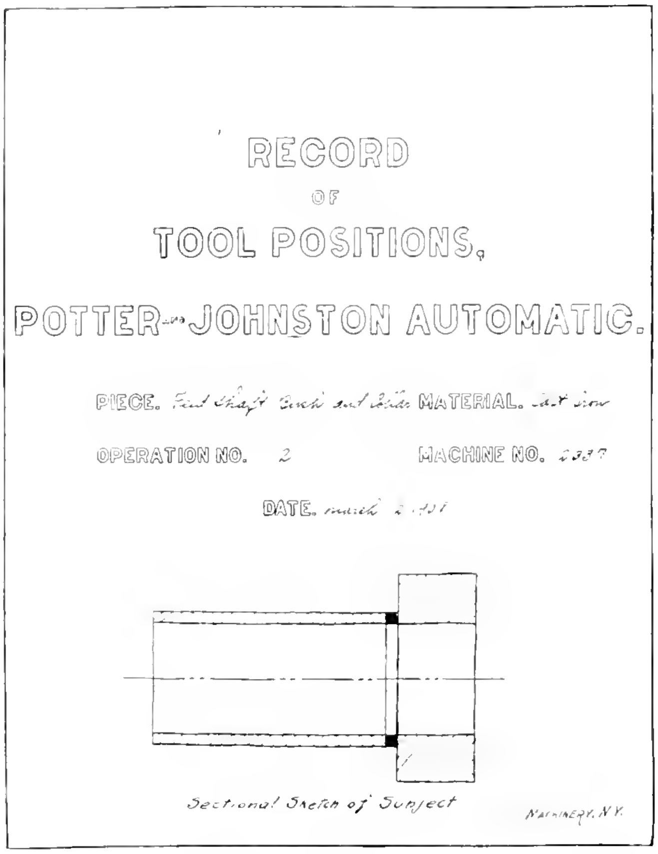


Fig. 9. The First Page of the Tool Record Sheet for Recording the Operations shown in Figs. 2 and 3.

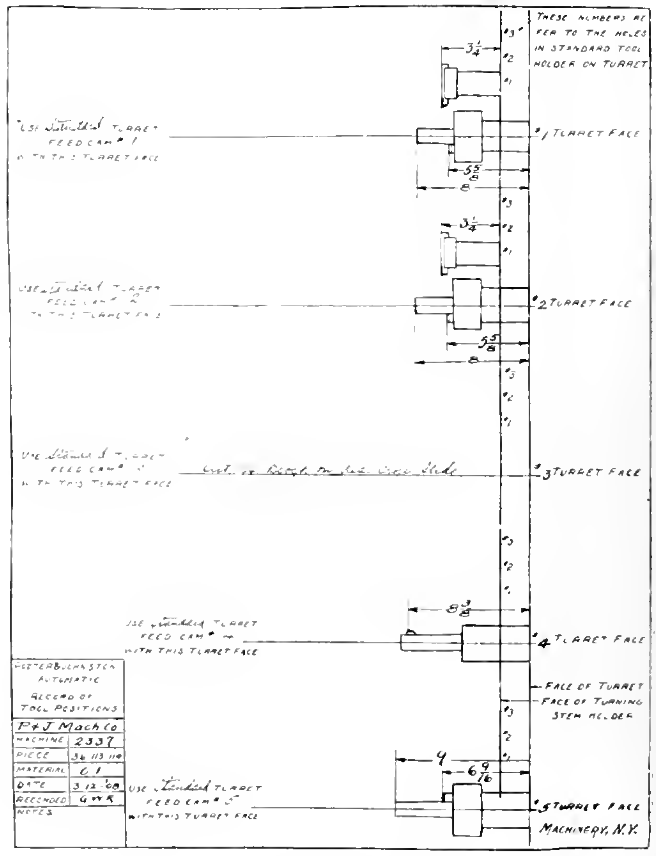


Fig. 10. Second Page of Tool Record, giving the Setting of Cutting Blades.

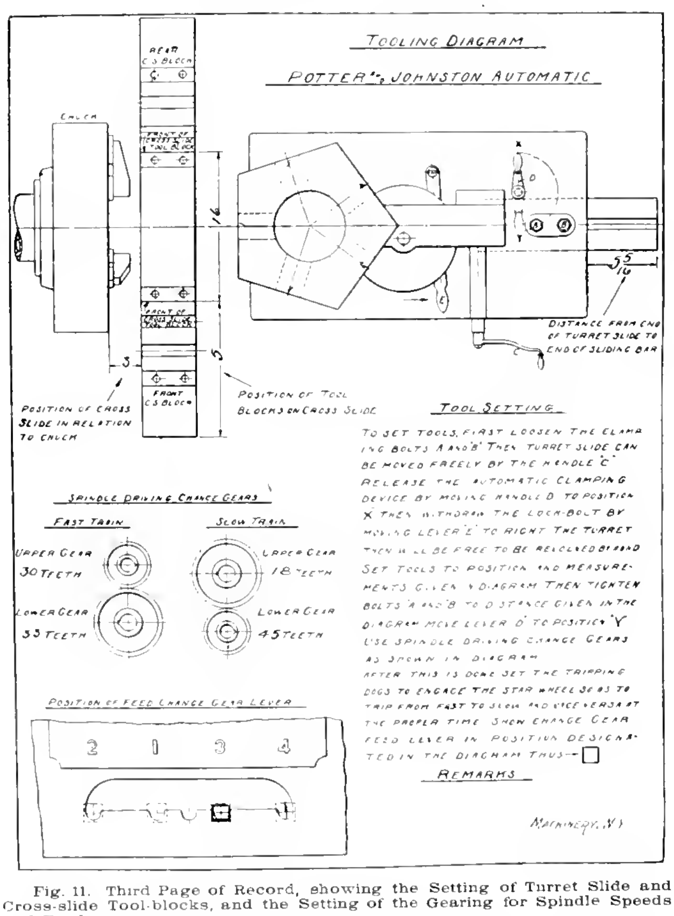


Fig. 11. Third Page of Record, showing the Setting of Turret Slide and Cross-slide Tool-blocks, and the Setting of the Gearing for Spindle Speeds and Feeds.

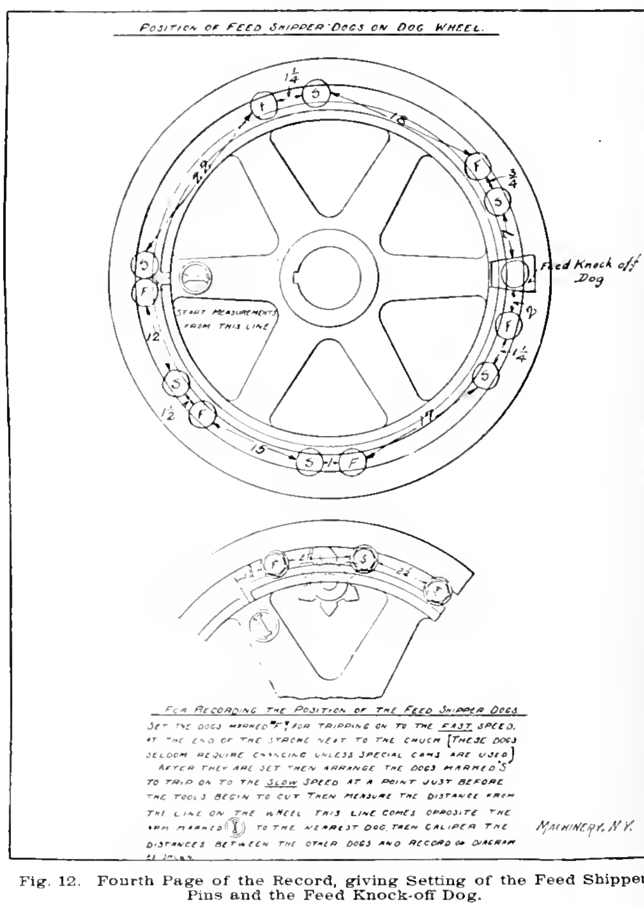


Fig. 12. Fourth Page of the Record, giving Setting of the Feed Shipper Pins and the Feed Knock-off Dog.

handle may be moved to the position which will give the greatest feed which it is possible to use with the work in hand. In the present case, as shown in Figs. 6 and 11, it

It has taken some little time to describe the setting up of the machines for this simple operation. In reality, however, in the hands of a competent operator, the setting up takes

little, if any, more time than the setting of a single piece in the lathe. There are no more tool settings to make than with the ordinary type of turret lathe, and the extra changes, such as the setting of the pins and dogs for the speed and feed changes, are made so quickly as to consume little time in comparison with the cutting movements. With the exception of the recessing tool, which is of simple construction, all the tools are a part of the regular equipment of the machine.

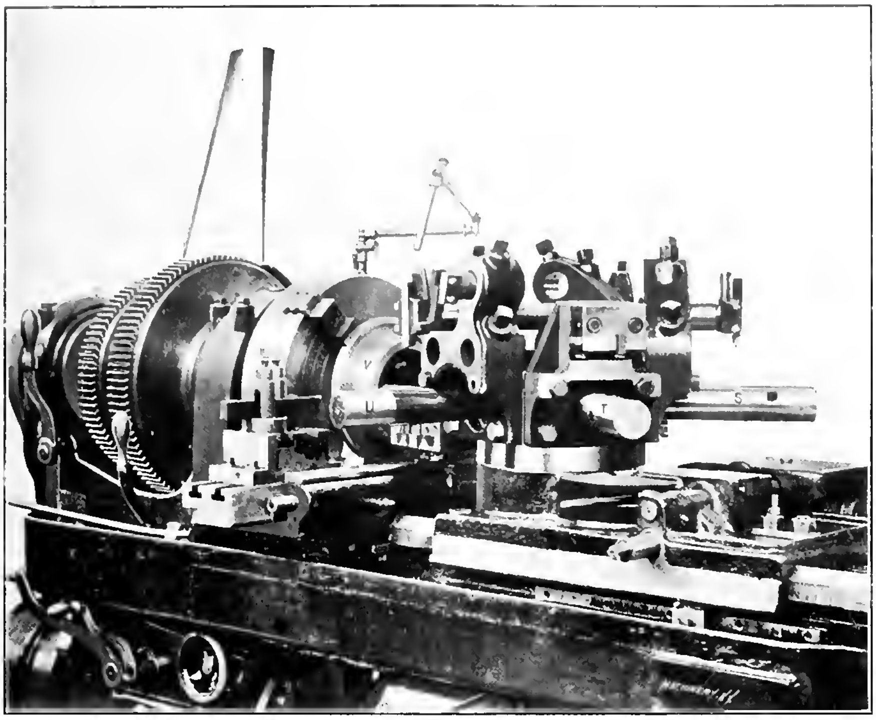


Fig. 13. Front View of Machine engaged in Finishing a Flanged Sleeve, made from a Steel Casting.

Tool Record Sheet.

The builders of this machine furnish a convenient form for recording the settings of a piece of work after they have once been obtained. We show the four pages of one of these records in Figs. 9, 10, 11, and 12, made out for the piece whose machining we have just described. It is printed in ink resembling India ink, in which the blanks are filled out by hand. The first page, as shown, gives the name of the piece, the material and the number of operations performed—this being a second operation, as previously explained. The number of the machine is also given for convenience in identifying it with the following operations. The fact that the part is cut in two to make two pieces of work, is plainly shown in the sketch.

The second page is taken up with sketches of the various tool-holders and cutting tools used. The distance of each of the cutting edges from the face of the turret or the face of the tool-holder is given. The tool-holder may thus be set at once without going through the trial settings we have mentioned as being necessary the first time the work is done. Tools held in the standard tool-holder have their distances measured from the face of the holder, while tools held in the face of the turret have their cutting edges located by the turret face. The feed cam used for each of the operations is also indicated. In recording work on which special cams might have to be used, the number of the cam employed for a given operation would be indicated in place of the word "standard," which we have for all five operations in this case.

On the third page of the pamphlet are shown diagrams giving the measurements for the setting of the cross slide longitudinally of the bed with relation to the chuck, and for the setting of the turret slide with relation to the cam roll. The latter measurement is taken, as indicated, from the end of the turret slide to the end of the sliding bar. The setting of the cross-slide blocks and cross slide is also given. The change gears for the fast and slow trains are recorded as shown, as well as the position of the feed change gear lever which was found the most suitable for the work. General instructions for tool setting are also given.

The last page of the record is occupied by a diagram in which the settings of the feed shipper pins are noted. These settings are obtained by using inside calipers in measuring the distance between consecutive pins. These distances, after being recorded, may be used in again setting pins for new work, thus making unnecessary the trial operations we have described. In actual practice, however, with competent workmen, this page of the record is not ordinarily filled out, it being as simple a matter to set the pins by trial as to measure them. For workmen not used to the machine, however, this record will be found very helpful. Regular use of the other features of these records will be found to save considerable time on work which has to be done repeatedly.

The Tools and Operations for a More Complicated Job.

The operations we have just shown are comparatively simple. In Figs. 13 and 14 are shown front and rear views of another machine in operation at the time of the writer's visit, in which many more tools are used, and in which much greater accuracy is required.

The machine is of the same type as the one shown in Figs. 1, 2, and 3, though of a somewhat older design. The part being machined is made from a steel casting. It is intended to be a sleeve for use in holding bushings in the chucks of the automatic machine for guiding the pilot bars of tools held in the turret. The face of the chuck which carries the sleeve is recessed, like the one shown in Figs. 13 and 14 holding the work, though a smaller sized sleeve would be used with that chuck. The lip on the flange of the sleeve enters this recess, in which it must be carefully fitted. The body of the sleeve is also very carefully fitted to the bore of the chuck. It will be seen that this sleeve ties the sections of the chuck together, so that on large, heavy work the clamp-

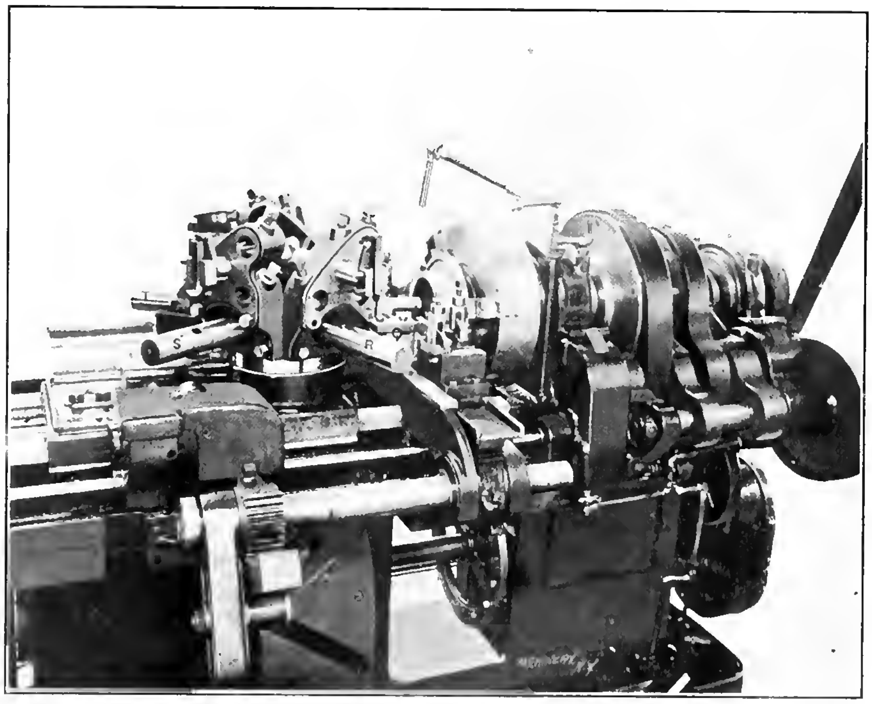


Fig. 14. Rear View of the Machine, set up as shown in Fig. 13

ing of the jaws down on the work will not spring the body of the chuck so as to distort it, and cause the pilot bushing within the sleeve to run out of true.

The first operation is performed by the turret face shown at *U*. It consists in rounding the corner of the large diameter of the flange, rough turning the outside diameter of the body, and facing the outer end of the body. This operation, like all the others, is steadied by the pilot bar shown, which is supported by a bushing in the chuck. The tool for facing the end of the body is not plainly shown in the engraving. The second operation, on turret face *T*, recesses the flange to form the lip, using a facing tool held in a special tool-holder, as shown. The third operation on face *S* finish turns the outside diameter of the body. The fourth operation, on turret face *U*, finish turns the inner side of the lip to the exact diameter desired. In the last operation, the hole is bored by a taper attachment *Q*, as will be explained, and the lip is finish faced by a tool held in the cross slide.

The bore of the sleeve is tapered, and one of the most interesting of the tools is that used in the final operation for boring this taper. It is shown in action in the two views of the machine given, but is best seen in Fig. 14. It consists simply of a cross slide carried by the turret, and provided

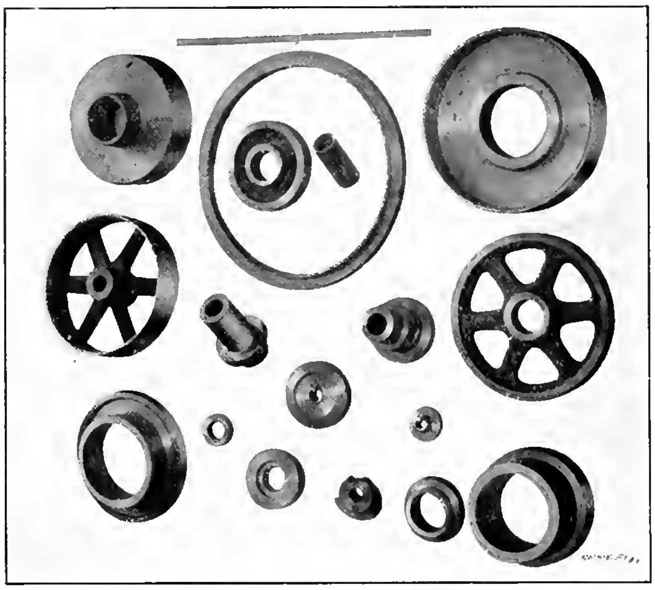


Fig 15. Group of Parts, showing the Variety in a Typical Day's Work, as done on the Machines in the Builders' Shops.

with a spring which tends to keep it forced toward a stop at the rear end of its travel. In the T-slots of the cross slide on the back end is clamped a hardened plate *Q*, with a ground straight-edge which is set to the desired taper. The end of a tool in the tool-post held in the rear cross-slide block is brought up against the edge of this plate by the cross-slide cam. The cross slide remains in this position throughout the operation. During the forward feeding of the turret, the action of the shank of this tool on the tapered plate forces the cross slide toward the front slowly, in such a way as to reproduce the taper of the plate in the bore of the hole. This simple arrangement produces tapers of a high grade of accuracy, as revealed by the usual test of finding the bearing in the hole produced, of the standard taper plug to which it has to be fitted.

The operation on this part takes something like three-quarters of an hour to perform, as compared with the very few minutes required for machining the bushing and collar shown in the first series of operations.

Range of Work for which the Machine is Fitted.

The wide range of work for which the machine is suited may be realized by referring to Fig. 15, which shows the work being done on the machines at the time of the writer's visit. The two upper parts at the right and left are cast iron, being clutch bodies for the spindle clutches of the chucking machines. The large cast iron ring shown is of a diameter that nearly taxes the machine to the limit of its swing. Inside the ring are shown a cast iron gear blank and the recessed bushing whose making we have described. The collar of this bushing is shown near the bottom of the group. The steel sleeve whose making is shown in Figs. 13 and 14 is at the lower left-hand corner of the group. A bevel gear blank and a cam are also shown, as well as a pulley and several miscellaneous pieces.

This group gives a favorable idea of the variety of the work possible on the machine, but it does not include any bar work or any work on composition metals, like brass and bronze, for both of which the machine is successfully used. For brass and bronze, the spindle is usually driven directly, instead of through gearing, to give the higher rotative speeds required.

Among the operations possible on the machine by the use of tools which have not been described, may be mentioned tapping, for instance, which may be done either right- or left-hand without reversing the spindle. Another device with which the machine may be provided is the "back facing" attachment, which is operated from a separate cam, applied to the cam-shaft, acting through levers on a back facing bar, which passes through a hole in the spindle, in a position to act on the rear face of the work inside the chuck jaws. In this may be mounted drills, cutters, facing tools, etc. Where extreme accuracy is required, a double back facing attachment may be used, arranged with cutters for taking both roughing and finishing cuts. A large proportion of the machines sent out by the builders are fitted with this attachment, whose use, in the general run of chucking work, will usually save a second operation.

Bar work up to 6 inches in diameter is also handled to good advantage, floor stands being provided for supporting the outer end. For bar work, as well as for steel castings and forgings, in which the holes are not cored, an oiling arrangement is provided for the turret, which forces the oil through the drill under heavy pressure to the cutting point. The oil flows only through the hole in the turret, which may be at the moment presented to the work.

Other such special arrangements as cam turning devices, two-position chucks, etc., will be provided as may be required by the purchaser. A large field of complicated operations is opened up by employing these, many of the combinations possible being of great ingenuity. The builders have developed a thriving business in the design of special tools for special operations. The possibilities of the machine with regular equipment, however, are evidently very great in the ordinary run of machine shop work.

It is not unusual to see as many as ten cutting tools in simultaneous operation on a piece, being carried by the turret, cross slide, and back facing holder. When such a tooling arrangement can be employed, it will be understood that the machine will show a saving over the ordinary type of hand lathe.

* * *

An interesting method for reproducing drawings, maps, etc., is mentioned in *Teknisk Tidskrift*. This method is termed "helios printing," and by the use of this method it is possible to take copies from drawings on any kind of white drawing paper, if the lines are simply drawn heavy enough so as to give resistance to the light. Not only is it possible to make copies from drawings on any kind of paper, but it is also possible to reproduce these copies on any kind of paper, as for instance, on tracing paper, white Whatman paper, ordinary yellow drawing paper, tracing cloth, etc. It appears that a great number of copies can be produced in a very short time. The method by means of which the work is carried out, however, is kept secret by the concern in Stockholm, Sweden, which makes a business of printing from other firms' drawings. It is stated that the price charged at the present time is about 20 cents a square yard for copies reproduced on good white paper, when several copies are ordered from the same drawing.

* * *

In the course of a lecture on the drive of machine tools, presented before the Pomeranian section of the Society of German Engineers, it was mentioned that for high speed cutting steel the proper cutting speed for cast iron is 66 feet; for machine steel 82 feet; for tool steel and steel castings 59 feet, and for nickel steel from 10 to 33 feet.

MONNET & MOYNE MACHINE FOR BENDING TUBING.

In bending a tube by the usual process, it is filled with sand or some similar substance, after which the ends are capped to hold the material in place; the bending is then performed by any suitable means, generally around forms of suitable radius to give the desired curve. The filling with sand is done to prevent buckling or flattening of the tube while it is being bent. The fact that the ends of the pipe are capped, maintains the pressure of the sand, and prevents such decrease of the interior volume as is necessary for flattening or buckling.

Messrs. Monnet & Moyne, of 11 Rue Torricelli, Paris, have recently perfected a machine for bending tubing which performs the operation satisfactorily without flattening, buckling or other deformation of the work, and without requiring the usual filling with sand. This interesting machine we show in diagrammatic form in the accompanying line engraving. Fig. 1 shows a vertical section through the column of one of the smaller machines. Fig. 2 shows a plan view of the top of the machine and Fig. 3 shows the operation in progress. The same reference letters apply to each of the three diagrams.

To the top of the column is clamped a bracket *A*, carrying at its outer end a fixed pivot *B*, and provided with a slide and adjusting and clamping screws for locating a second pivot *C*, at any desired distance from pivot *B*. Pivot *C* carries a rectangular block *D*, having semi-cylindrical grooves in its face, made to the radius of the pipe it is desired to bend. Above and below it, about the same pivot, are mounted bars *E*, which extend out to the side of the machine, where they are pivoted to a brace *F*, which is clamped in a swivel *G* at the top of the column of the machine.

Pivot *B* has mounted on it a former *H*, provided with a lever *J* for swinging it about its center in the forming operation. This former is turned to the radius to which it is desired to bend the tubing, the groove provided being of a circular section to match the diameter of the work. Attached to *H* is a clamp *K*, formed of a stirrup and thumb-screw,

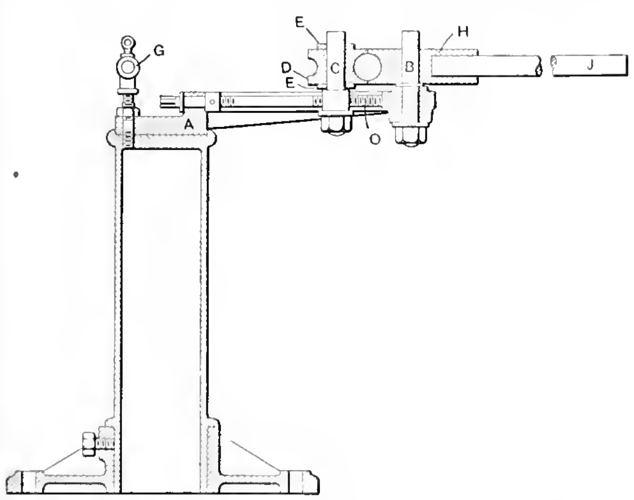


Fig. 1. Vertical Section of Monnet & Moyne Tube Bending Machine.

which clamp together serrated jaws, adapted to firmly hold the pipe and apply the pressure to it from all sides, so that it is not deformed. At the outer end of the frame-work (formed by bars *E* and brace *F*) is a support *L* for a bolt *M*, which is threaded into the right-hand end of the mandrel *N*.

In the peculiar construction of mandrel *N* lies the novelty of this bending process. As may be seen in Figs. 2 and 3, it has a solid body, but its left-hand end is composed of three articulated sections, forming a flexible extension of the full diameter of the hole in the pipe, so joined together as to be able to follow a curve of the shortest radius to which the tube can be bent. This is most plainly shown in Fig. 3.

The method of operation is as follows: The interior of the tube *P* is first cleaned with a wire brush. The tube is next placed in the groove of former *H*, and gripped tightly in the jaws of the holding clamp *K*. Mandrel *N* is next oiled and inserted inside of the tube, its position being so adjusted by the nut at the end of bolt *M* that the extremity of the solid body of the mandrel lines up with axis *X Y* of former *H*, as shown in Fig. 2. Guide block *D* is next adjusted by

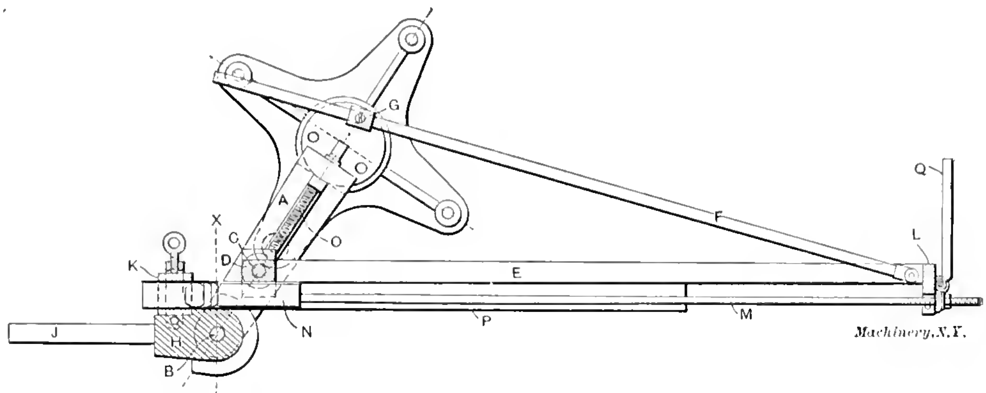


Fig. 2. Plan View of Machine, showing Forming Dies and Method of Holding the Articulated Mandrel.

means of a screw *O* to such a position that the distance from its face to the axis *X Y*, when it is brought in contact with the work, is equal to the diameter of the tube. This being done, pivot *C* and screw *G* are tightened, rigidly securing the framework formed by base *A* and members *E* and *F*.

The tube is now bent to the angle required, by operating handle *J*, which may be lengthened, as required, by the use of a piece of pipe of suitable diameter. When the tube has been bent to the required angle, the mandrel is withdrawn, being started by pressing on lever *Q*, after which it may be easily removed. The vise *K* is then loosened and the jaws removed, when the work can be taken out of the machine. The position of the mandrel during the bending is shown in Fig. 3.

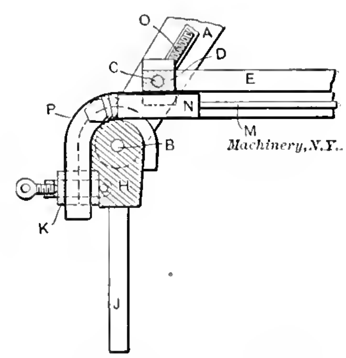


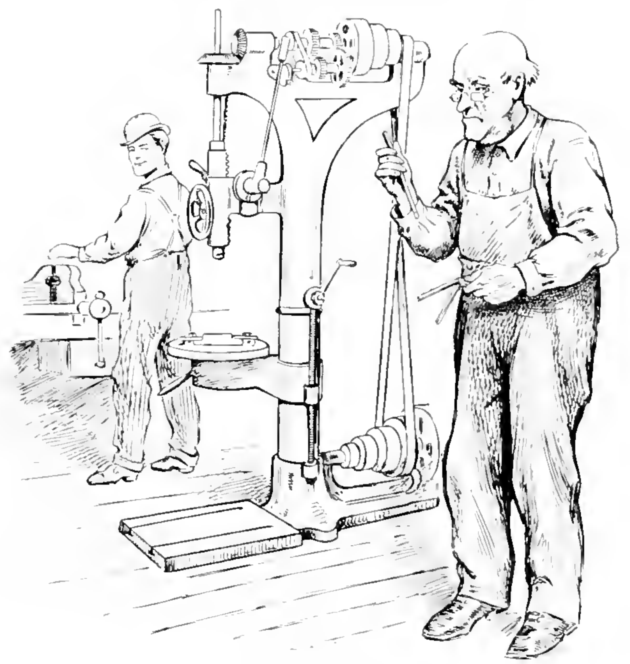
Fig. 3. Action of the Articulated Supporting Mandrel during the Bending Operation.

After the device has once been set up, it is only necessary to brush out the tube, clamp it into place, oil and insert the mandrel, and oil the guide, after which the work is bent and removed as previously described. Two operations per minute are easily possible on work of medium size. This, it will be seen, is a great saving over the old method in which it was required that the tube be filled with sand previous to bending. Even very thin tubes may be curved with this device, since the flexible mandrel prevents all possibility of the collapsing of the walls. The action is that of a drawing out of the fibers on the outside radius of the curve, combined, possibly, with a slight compression of those on the other side. Owing to the flow of metal which takes place, the material is hardened appreciably, thus increasing its resistance to deformation.

Different formers *H* are required for different radii of curvature and for different diameters of pipe. Special formers have sometimes to be provided for tubes curved in two places. Guide *D* may be used on all radii of curvature within the range of the machine, but must be changed for different diameters of pipe. The machine is made in five sizes, for the following maximum diameters: $\frac{3}{4}$, $1\frac{1}{2}$, $2\frac{3}{8}$, 4 and 6 inches, respectively. The smaller sizes are hand operated, as is the case with the $1\frac{1}{2}$-inch machine, of which we show diagrams. Larger sizes are operated by power. This machine is said to have found extensive application in automobile, boiler and railway shops in England and on the Continent.

HOW BILLY CAME TO USE TWIST DRILLS.

It was mighty difficult for old Billy Brown to give up his belief that a well forged and ground flat drill was not superior to a twist drill. He had been using flat drills for 40 or 50 years, beginning, in fact, long before the twist drills were originated, and when the younger hands came up and began to talk to him about some improvements of this or that kind, Billy Brown would smile in a superior way and explain to them that he was experienced in the business long before they were born. In particular, the flat drill was one of Billy Brown's hobbies, and unless the force of circumstances prevailed, he would never consent to use a fluted twist drill. Billy had been working in this same shop for so many years that he had become something of an old inventory, and the boss did not care much about Billy's queer ideas, particularly as he was a pretty good tool-maker, notwithstanding his opposition to new wrinkles. Billy's favorite boast was that no one in the whole shop could grind a flat drill just as he did it, as none of the others had the experience, because of using



"What ails the d—— thing?"

these new-fangled drills. Billy's boasting finally led to his downfall, and as usual a shop "kid" was the cause.

It happened one day that Billy was going to drill a ¼-inch hole on the upright drill press, and while he was grinding his drill, young Jimmy Smith went up to Billy's machine and crossed the driving belt. Billy put his drill into the socket and started off drilling, but, to his dismay, he found that his drill would not cut. The reverse motion of the drill spindle was not very apparent, because of its high speed, and then, too, Billy's eyesight was not as good as it was once. He hardened his drill again, and ground it very carefully, put it in the drill press, and still it would not work. A thing like this had never happened to Billy before, and he began to worry about not being able to grind a flat drill so that it would cut. So sudden was the loss of a boasted ability that Billy might well be pardoned for getting a little flustered.

He finally hardened his drill for another trial, and ground it even more carefully than before to the angles that had never failed him before, but strange to say the drill still would not make any impression whatever on the piece of work. Then he tried the work with a file to see whether it was not hardened, but it was nothing but ordinary soft machine steel. Then he tried the drill with his file and found that it was just as hard as it could be, so the fault evidently must be with the grinding of the drill. Then Billy totally lost confidence in himself, and went up to one of the younger men, explaining to him his troubles. Jimmy, the innocent, who was always around when he was not wanted, came up and looked at Billy's drill, and said: "Why, Billy, of course that drill wouldn't cut. Don't you see you haven't ground to the right angles at all?"

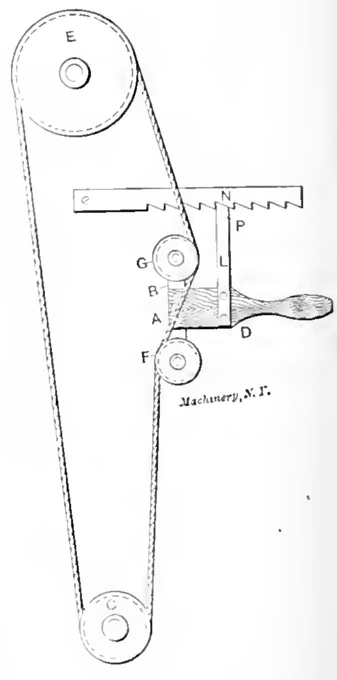
I won't try to repeat what Billy said to the apprentice, for that would not look good in print, but Jimmy, unabashed, snatched the drill from Billy and ran over to the grindstone, pretending that he was grinding the drill to its proper angles, while, of course, he left the cutting surfaces undisturbed. During this grinding operation, however, somebody kindly put the belt right again on the drill press, and Jimmy, placing the drill in the socket, fed it down and it cut through the piece of work as though it were butter. Billy stood dumbfounded, and that noon, he went up to the foreman and said: "I guess I am getting too old to work in the shop." The foreman, however, who by this time had heard the story of Billy's trouble with the drill, persuaded Billy that he could not spare him, and Billy, greatly gratified to hear that, concluded that thereafter he would use a twist drill, and now Billy thinks that twist drills are far superior to the old flat drills.

I often think of Billy and his flat drill hobby. We laugh at him and his ignorance or perversity, but aren't most of us about as foolish on some pet notion? We often need a jolt to knock out old delusions, so that new ideas can get in. Billy got a hard one, but the old man, after all, was more sensible than lots of young men would be.

* * *

A BELT TIGHTENER.

An interesting tightener for a small belt or rope drive is shown in the *Practical Engineer*. It often happens that it is desirable to arrange one or more machines, so that they can be conveniently stopped and started, without reference to the running of the rest of the machinery. Of course, this problem is usually solved with friction clutches, loose pulleys, etc., but there sometimes occur cases where a pulley is driven directly from the line shaft and there is no room to put in any of these extra appliances. In a problem of this kind, where it is desired to arrange a drive for the machine so that it could be stopped and started at any time, the arrangement shown in the accompanying illustration was devised. In the cut, *C* is the driving and *E* is the driven pulley. The pulley *E* may be started and stopped by means of the twin idlers *F* and *G*, which are mounted on a bar of iron, *B*, of suitable size, the pulleys running on studs, screwed into this bar. The bar *B*, in turn, is fastened to a wooden piece *D*, which, with the bar *B* is pivoted on a suitable stud at *A*. Thus it will be seen, that when the handle on the end of *D* is pressed down, it will tighten the belt without a very great swing of the idlers, and when the handle is lifted it will release the belt and allow it to hang free from the bottom pulley *C*. The belt is held at proper tension by means of the locking device shown, consisting of the iron bar *L*, attached to the block *D*, the upper end *P* of which engages in suitable notches in bar *N*, and holds the idler frame wherever set. This locking device is conveniently released by simply raising up bar *N*. It is evident of course that on a large belt, a certain amount of power is wasted by this arrangement, and it may not be advisable to use with large belts.



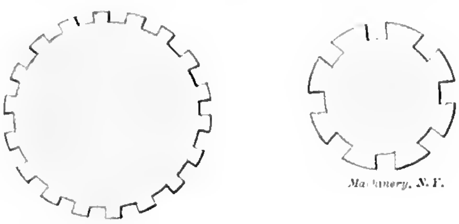
* * *

In almost every shop and factory in the country, men and women are just aching to be interested in the firm's welfare, if the employers would only let them. Any man or woman would rather be interested in his work than not be, for when the heart is in it, work is easy, and easy work is work done right.—*The Silent Partner*.

ITEMS OF MECHANICAL INTEREST.

GROOVED SHAFTS FOR MOTOR CARS.

The Lanchester Motor Co., Ltd., of Birmingham, England, employs a rather interesting means of securing driving parts of automobiles to their respective shafts. The principle employed is clearly illustrated by the two sections of shafts shown in the accompanying cut. The shafts are grooved as indicated, and the corresponding female parts are provided with grooves to fit. This system of connecting the shafts with the rotating parts was adopted by this company over eight years ago, and has stood the test of long time of service. In

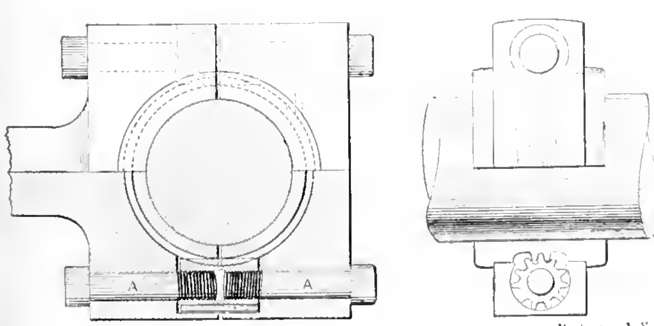


Grooved Motor Car Shafts over which Hubs with Corresponding Grooves Fit.

the first place, the use of this kind of shaft was restricted to cases where keys were awkward or difficult to arrange, but the results proved so satisfactory that in the modern Lanchester car this system of connecting shafts and rotating parts has been adopted almost exclusively for all cases where there was any reasonable gain from having the shaft and the rotating parts so firmly connected, and the system has also been adopted by several other British motor car firms. It would appear, on first sight, that this kind of joint would be rather expensive, but it is claimed that the shafts and the corresponding holes can be produced comparatively cheaply. The slots are cut to the necessary depth on a milling machine, with ordinary milling cutters, and the corresponding female part is cut with a series of broaches. The first cost of the broaches is, of course, rather high, but the amount of work they will perform before worn out is so considerable that the unit cost per each detail finished is very small. The actual fit of the parts takes place on the external diameter of the shaft. The grooves are so milled that they will provide for as close a fit as possible on their sides, but a small clearance is allowed in the bottom of the grooves.

TIGHTENING DEVICE FOR CONNECTING-ROD BRASSES.

An automatic device for connecting-rod brasses has recently been brought out by Messrs. Tangyes, Ltd., Smethwick, England. This device is shown in the accompanying cut, which is taken from the *Mechanical Engineer*, issue of February 28. The bearing brasses, instead of being fixed in the usual manner, are given freedom to rotate, when too loose, under the friction of the crank-shaft, and this rotation of the brasses is utilized to effect the tightening of the screws *A* in the con-



Rod Connection in which the Wear of the Brasses is Automatically taken up.

necting-rod end and its cap. On the outside circular surface of the bearing brasses a worm thread is cut as shown, and small worm-wheels are arranged in recesses in the cap and connecting-rod end. The holes through these worm-wheels are threaded right- and left-hand to engage with the tightening bolts *A* as shown. By this arrangement it is evident that if the brasses revolve slightly, they will cause a slight motion of the small worm-wheels, and this in turn will tighten up the cap of the connecting-rod against the end, by means of the right- and left-hand threads in the small worm-wheels. Should the bearing brasses be loose enough so that the friction between the crank-shaft and the brasses has a tendency to effect a rotation of the brasses, the pressure between the head and cap of the connecting-rod being insufficient to hold the brasses in place, a rotary motion of the brasses will take place and the worm-wheels will be rotated in the proper direction for drawing the screws inward, thereby tightening up the cap. When the pressure of the cap is sufficient to prevent the rotary motion of the brasses, these will remain stationary, and the crank-shaft will revolve as usual in its bearing. It will be seen that the bearing is thus automatically tightened whenever it becomes loose, and accident from the unfastening of the bearing is rendered impossible.

A SIMPLE CALCULATOR.

The accompanying cuts, reproduced from *Der praktische Maschinen-Konstrukteur* show a rather interesting and ingenious calculator of a simple and cheap design, intended for rapid multiplication. The construction is easily comprehended directly from the cuts. There are five stationary slides, provided with numbers from 1 to 99, and between each of these

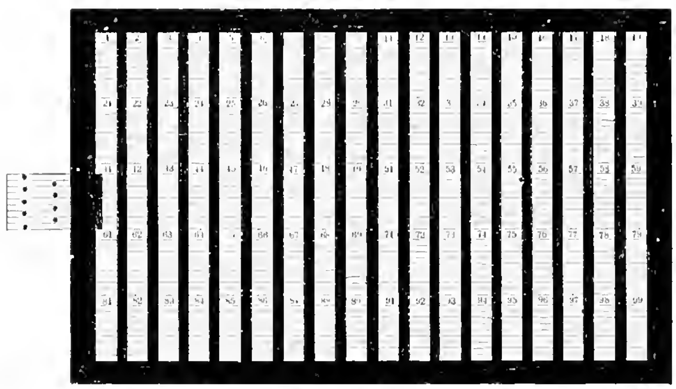


Fig. 1. Calculator for Rapid Multiplication.

rows of numbers there are nine movable slides which are numbered at the ends, 1, 2, 3, 4, etc. These movable slides are provided with figures, placed in a certain way, so that, by setting the slide, as indicated in Fig. 2, the product of the number on the stationary slide, and the number at the end of the movable slide can be read off at once; thus, for instance, 4×44 is 176. In the case in Fig. 2, the number 6,543 is to be multiplied with any of the numbers on the stationary slide. The product of each of the figures in 6, 5, 4 and 3 times 44 will be found directly under 44, as 132, 176, 220 and 264; the

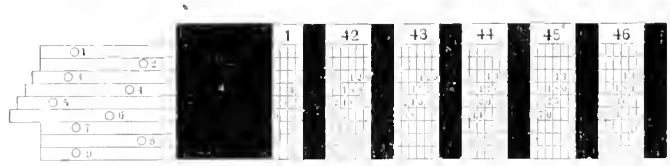


Fig. 2. Method of using the Calculator

movable slides being set in proper order, all that is necessary to get the multiplication is to add, the same as in ordinary multiplication, getting the product 287,892. It is, however, not necessary that the one number with which another is multiplied should have only two figures. It is possible to figure with factors having four figures a great deal easier than by ordinary multiplication. Take a case, for instance, of $6{,}543 \times 4{,}546$. In this case, 4,546 is divided up in two parts, 45 and 46, and we have:

$$6543 \times \,..46 = \quad 300978$$
$$6543 \times 45.. = 294435$$
$$\overline{29{,}744{,}478}$$

The products of each part of the number 4,546 with 6,543 are found directly on the scale in Fig. 2, by simple addition, and the time required for multiplication is but a fraction of that ordinarily necessary, if we multiply in the usual way. The instrument is made by the Rechenapparate-Fabrik Fr. Schneider, München, Germany.

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MAY, 1908.

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A FAULT OF HANDLING FOREIGN TRADE.

It is a more or less common fault of machinery dealers to become indifferent to the fate of machines sold, after they are once accepted and paid for. This applies with special force to foreign trade, and one very serious mistake made by a few of our American machine tool builders is their selection of indifferent foreign representatives. The builder of a machine tool should not forget that the ability to handle it so as to secure its maximum efficiency is fully as important as the design itself. Very often the fate of a new design depends as much on the way the first operator handles it as on the general design. In a foreign field, where conditions are quite different from those under which the machine was designed, it is specially desirable that prejudice be not aroused because of misunderstanding the various functions of a new machine. We were deeply impressed with this view by a letter lately received from a foreign subscriber who is trying to do deep-hole drilling with certain American equipment. He wrote, in part, as follows:

"We depend greatly on American machine tools in this country [Belgium], but we never get, during the first months, the full value of the machine we buy. Everybody has to go through costly experiments before he learns to use the machine to its best advantage. The agent will sell you everything you order, but he does not take the least interest in whether you get the right tool for your use or not. He rarely knows the machine sufficiently well to point out what you want to know. He will give you a catalogue *printed in English*, and that is all. Lucky is the man who understands this language!"

This man wrote to us for specific instruction on deep-hole drilling that would enable him to use the equipment he had purchased. Is it not a serious condition of affairs when a foreign buyer and user of an American product finds it necessary to write to an American trade journal for help rather than to appeal to the manufacturer himself? This man probably felt that there was little opportunity of getting help from that direction, because he dimly realized that his equipment was not well-suited to his work. But why was not the proper equipment sold to him? Simply because the agent did not know his business, or, if he did know it, he apparently did not care enough about future sales to help this man out of his predicament.

OVERTIME, A CASE OF MISDIRECTED ENERGY.

A few weeks ago there was some discussion in Great Britain regarding the practice of certain firms working their men overtime, while most firms were laying off help, not having been able to run full time. The trade unions contended that because of the number of unemployed, firms having a greater amount of work to do than could be performed by their regular workmen in the stipulated number of working hours, should employ additional help rather than work overtime. In a case like this it may be difficult to say whether or not the contention of the labor unions was reasonable, for the rush in the shops which were working overtime may have been only temporary, and it might have been inadvisable to hire new help only to lay off such men within a few weeks.

However, it cannot be disputed that our industrial system under which men work in the shops one year, say, for ten, twelve, and even thirteen hours a day, only to find themselves the next year either thrown out of employment altogether, or only working five days a week, seven to eight hours per day, is very unsatisfactory. It is greatly to be doubted if this way of conducting a manufacturing business is more profitable than if the work were divided more evenly over the times of prosperity and depression. The majority of well-established firms could, without injury to their business and without fear of the future, prepare somewhat more than is common in this country for the day when the orders come in faster than the facilities of the shop enable them to be filled. If this were done, there would be less feverish overtime work in prosperous times, and during times of depression the results all around would be less disastrous. The great sums paid out for overtime work could be partly saved, and the saving invested to good advantage in keeping things going at a more even pace all the time. It may be said that this proposition is impracticable, but if it were, the general uniform balance of industrial conditions which is maintained on the European continent would not be possible. We can learn a profitable lesson from the way that such conditions are handled across the water—a lesson that would be greatly to our advantage. It may be added, however, that there are some indications that certain Continental firms are on the verge of adopting our methods, and running their works on the hand-to-mouth plan, but they will, without doubt, find this policy a decidedly inferior one.

* * *

INATTENTION.

The writer has just returned from an auction sale of tickets where large signs were displayed stating that, in every case, bids were a premium to be paid in addition to the basic price of tickets. To make assurance doubly sure, the fact was announced and explained from the platform. In the face of all this, no less than three persons bid in seats, and prepared to pay for them only the specified amount of the premium. Such experiences are repeated everywhere and every day, in the shop, the office, the school. They seem to be almost chronic. It is hard to define the cause. Is it due to mere inattention, or heedlessness, or to real lack of comprehension, or what? At all events, its results are disastrous to the prospects of many a young man whose mind is not upon his work.

Attention to business is the first sound law of success. The boy who does not have to be told twice, who carries "the message to Garcia," and brings back what he was sent to get, is the one who counts. It would be interesting, though saddening, to discover the aggregate annual loss in the average shop through inattention: The things done over because the first attempt was wrong; the things done wrong because the workman was not attentive enough to learn how to do them right; the piece spoiled because the feed was jammed in too deep; the drawings ruined because of miscalculation or error in layout. It would be a sorry exhibit. We are all looking for the boy who thinks; for him there is a prospect, but he is scarce in these days of the multitude who seem to think that the world owes them a living. If our education is to accomplish anything of which we can boast, it must create a feeling of personal responsibility and an attitude of careful attention.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

Official statistics place the number of automobiles in use in Germany at a figure of 36,022. Of these nearly 1,800 are trucks. Of the vehicles intended for carrying passengers more than half were used for business purposes.

The Cunard steamer, *Mauretania*, crossed the ocean last March during an eastward voyage, at an average speed of 24.42 knots, which is the highest speed ever attained by any steamer across the Atlantic.

The imports of Austrian petroleum into Germany are constantly increasing, while the imports of petroleum from Russia have decreased considerably. In the year 1902 Germany imported 16,800 tons of petroleum from Austria, and in 1906 the figure was 59,800 tons, while during the first half of 1907 the imports exceeded 45,000 tons.

A Dutch scientist, Kamerlingh-Onnes, has succeeded in producing helium in solid form; in other words, in freezing helium. There is now not a single element known which cannot be transformed into solid form. The temperature at which helium will freeze is claimed to be —272 degrees C, which is only one degree C. over absolute zero.

In the *Consular and Trade Reports* for February 20, it is stated that the tariff duties on catalogues, price lists, and advertising matter of similar character, which, as we mentioned in a previous issue, have hitherto been imposed by the commonwealth of Australia, have been removed, and that matter of this character will hereafter be admitted to the country free of duty.

The Italian ambassador at Washington has given out official information to the Department of State regarding an international exposition, to be held at Rome and Turin, Italy, in 1911, in commemoration of the 50th anniversary of the proclamation of the kingdom of Italy. The exposition in Rome will include art and history, and the Turin exposition will be devoted to the productive industries.

A new motor record, according to the *Practical Engineer*, was established on the Brooklands motor tracks in England by a 60 H. P., 6-cylinder Napier car, which covered 50 miles in 35 minutes and 15 seconds, and 150 miles in one hour and 46 minutes. In two hours the space covered was 169 miles, the average speed for this time having been 84½ miles an hour. The previous best record was 151 miles in two hours.

The preliminary work for the electrification of portions of the main lines of the Swedish State railways, to which we have referred several times, has now progressed to the point where orders have been placed for some of the machinery for the power stations. To begin with, two water turbines, designed to deliver 12,500 H. P. each, have been ordered. These turbines will work with a head of 100 feet, and will deliver the required power at 187 revolutions per minute.

Flying machines built according to the same design as the Farman prize-winning aeroplane, fitted with 50-H.P. motors, can now be bought in England at a price of $6,000, or in America for $8,400, the latter figure including the import duty to this country of 40 per cent *ad valorem*. In this particular case the tariff seems to fill its place of protecting an infant industry, inasmuch as the manufacture of flying machines surely still is in its infancy in the United States.

We mentioned in our Engineering Review section last month that an international industrial exhibition is to be held this summer in Toulouse, France. According to *Industritidningen Norden*, the Permanent German Industrial Exposition Committee has pointed out that it does not seem advantageous for German manufacturers to take part in this exhibition. The reason is not given, although it may be assumed that the scope of the exhibition and its advertising value would not warrant the expense incurred by sending machinery for exhibition.

A radical departure along the line of making use of the surplus heat from electric generators will be made at the large electric power station at Trollhättan, Sweden. We have previously mentioned that the equipment will consist of generators which will carry a normal load of 10,000 H.P. The heat evolved from the generators, it is estimated, will be equivalent to 400 H.P. In order to prevent this heat from escaping into the engine room, a partition of iron has been placed within the machine, and each generator will be furnished with a fan so placed that it will draw cold air through a duct from the outside atmosphere. The air then passes through the generator, and will be driven in its heated state into various parts of the building where artificial heating is required. It is believed that sufficient heat can thus be supplied from the generators for heating all the adjoining rooms and buildings by hot air.

The growth of the ocean steamship continues. The *Lusitania* and *Mauretania* are not long to hold the palm for great size. The White Star Co. has made plans for two new ships 1,000 feet long and of 60,000 tons displacement. These new monsters, however, will not be ocean greyhounds. They will be comparatively slow boats, the promised speed rating being about 20 knots. The economy of the large vessel where plenty of business is assured is fully recognized, and the probabilities are that even larger boats than 1,000 feet length will be built within the next twenty years. Mr. Lewis Nixon, a naval expert of some reputation, prophesies ocean steamers a quarter of a mile long, driven by producer gas engines. The new White Star boats will be driven by reciprocating engines and turbines, the turbines being low pressure and driving screws in the center while the high pressure reciprocating engines are connected to side screws.

An interesting instance of the bending of a large steel pipe in a short time, by heating with an oil burner, is mentioned in the *Iron Trade Review*. The work was carried out in an eastern mining shop. A 10-inch steel pipe, 18 feet in length, was bent to right angles with a radius of 30 inches, without filling with sand or other material, in one hour and ten minutes. Three men were required for the work. One end of the pipe was fastened by wedges, and at the other end of the pipe a tackle was attached for pulling the pipe at the proper time. The burner was then applied to the pipe, at the point selected for the beginning of the bend, and a 20-inch section was heated, this operation requiring about six minutes. Then the pipe was pulled to the desired radius, the wedges were loosened, and the pipe was shifted for bending further down on the arc, until it was bent the required 90 degrees. With an air pressure of 60 pounds, the entire oil consumption was about 2½ gallons.

Fly-wheels with rims of reinforced concrete are a novelty which, according to *Industritidningen Norden*, has been introduced at a pumping station at Zwartkopjes in Transvaal, where ten pumps are installed, each having fly-wheels of a diameter of about 14 feet. These fly-wheels are provided with cast iron hubs, to which are screwed 16 spokes made of 4-inch pipe. The rim consists of a casing of sheet iron, in which is placed the actual rim of reinforced concrete, having a section 13 inches square. The concrete is reinforced with ¼-inch steel wire. The rim weighs about 6,000 pounds, and the whole fly-wheel weighs about 8,000 pounds. On the ten fly-wheels, this construction permitted a saving of nearly $10,000, most of which saving, however, is due to the enormously high transportation costs that would have been necessary to pay for the transport of fly-wheels of this size, if they had been made

entirely of cast iron, and shipped to the pumping works. Under the present conditions the rims, of course, were completed right at the pumping station.

A novel gas engine starter has been developed by the Oil City Gas Engine Co., consisting of a flash boiler furnishing superheated steam at high pressure which may be used in a gas engine in the same manner that compressed air is used for large engine units. According to a description in the *Engineering Record*, the boiler is of the coil type of small capacity, and is heated by a large gas burner. When in operation, the coil is heated to a red heat, and then a small quantity of water is injected by a hand pump. This water instantly flashes to steam of from 400 to 500 pounds pressure, and is then admitted to the engine cylinder. The first heating of the coil will furnish sufficient steam for turning the crank a number of revolutions, and if the engine then should fail to get in operation, a second heating of the coil will give another number of turns, and so on. A safety valve set at 500 pounds pressure protects the device from excessive pressure.

The extent of the automobile business in the United States can be comprehended from some figures which have been compiled by the Association of the Licensed Automobile Manufacturers for the year 1907. It is stated that the number of automobile factories amounts to more than 200, but it is extremely difficult to get any figures in this respect, as many so-called manufacturers of automobiles work on a very small scale, merely assembling a few machines from parts bought from part makers, and other factories, so far, only experiment. The number of employes in the factories is estimated at 58,000, the capital invested, $94,000,000, and the value of the product for the year mentioned, over $105,000,000. The increase in these last three years is remarkable. In 1904 the number of factories was given as 121, the number of employes as about 10,000, the capital invested as $20,500,000, and the value of the product as $26,650,000, approximately.

A writer in *Stahl und Eisen* states that China has enormous possibilities as an iron-producing country. Although as yet the country has not been thoroughly explored, enormous deposits of high grade ore are known to exist. It is estimated that the total ore resources are not much less than those of the United States. Coal is also available in fairly extensive quantities. The Chinese, however, have passed a law preventing foreign capital from being employed directly in mining operations in China. Foreign capital can be used only for the purchase of stock in Chinese companies. While this provision is by no means cheerfully accepted by foreign capitalists who see an opportunity for exploitation on a large scale in the newly-developed Chinese ore deposits, this provision may be a very wise one from the Chinese point of view. It is at least in harmony with the time-honored idea of protection, which the Chinese applied for many centuries before the western world conceived of this efficient means for the stifling of trade and the building up of monopolies.

On March 19, the two long cantilevers of the Blackwells Island Bridge across the East River, at New York City, were brought together above the middle of the stream. As regards capacity, this bridge will be the largest cantilever structure in the world, although there are some cantilever bridges that have a considerably longer span between the towers. The bridge will be double-decked and is 8,419 feet in length between terminals. The length of the main span is 1,182 feet (the span of the famous Forth Bridge in Scotland is 1,710 feet, and the span of the Quebec Bridge, one cantilever arm of which recently collapsed, is to be nearly 1,800 feet). On the Blackwells Island Bridge there will be a roadway wide enough for four three-horse teams to pass abreast. On each side of this roadway there will be two trolley tracks. The upper deck will carry two elevated railroad tracks, and two footbridges. The six tracks across the bridge are estimated to have a capacity of between 400,000 and 500,000 passengers a day. The total cost of the bridge, it is estimated, will be more than $20,000,000.

ELECTRIC TRANSMISSION OF PHOTOGRAPHS.

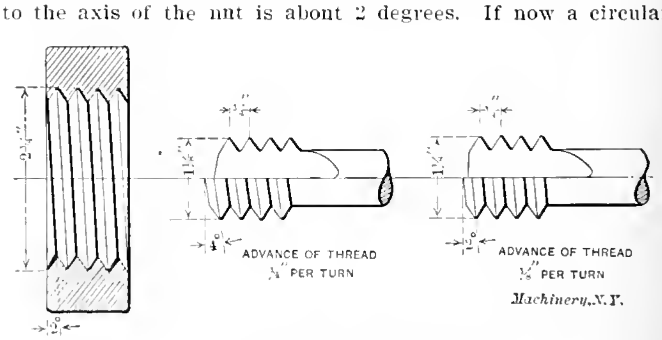
Electrical Engineering, January 2, 1908.

In the May, 1907, issue of MACHINERY, engineering edition, the principles of the Korn system of transmitting photographs by means of electricity, were explained. Another system for transmitting photographs electrically has been worked out by a Frenchman, Mr. Pascal Berjonneu. During experiments undertaken lately in Paris, wires were connected so that the photographs were transmitted through the line from Paris to Marseilles and back again to Paris, a distance of over one thousand miles. Pictures were successfully transmitted over this line. The apparatus was also connected to a wireless telegraph outfit, and the receiving apparatus placed in the same room as the transmitting apparatus, and the pictures were transmitted from the one to the other, wirelessly, this being the first time that this has been done. The new system differs from the Korn system in that use is not made of selenium. The principle of this system is that the picture to be sent is etched on a thin metal plate, which is rolled up to form a cylinder, and is mounted on a traveling drum, similar to that on a phonograph. An insulated platinum point is placed in front of the drum, so that it will come in contact with those portions of the cylinder only which stand in relief, that is, those portions which have not been influenced by the etching process. When the drum revolves, and contact is made between the metal plate and the platinum point, a current will pass through the transmitting wire for longer and shorter periods. The receiving apparatus consists of a film, sensitive to light, mounted on a cylinder, and a ray of light, controlled by a small shutter moved by a magnet through which the current passes, falls upon the film, thus reproducing the original picture. The reproduction, of course, consists of lines of dots and dashes corresponding to the etching.

CIRCULAR CHASERS FOR INTERNAL THREADING.

Mechanical Engineer, March 20, 1908.

Circular chasers for internal threading, such as shown in Fig. 2 of the accompanying cut, have been more or less used instead of ordinary inside thread tools, but when the difference in diameter between the hole to be threaded and the diameter of the chaser itself is considerable, there is a serious objection to the use of these internal chasers, particularly on coarse pitches. Referring to Figs. 1 and 2, it is evident that if the nut to be threaded is provided with four threads per inch, and the diameter of the thread equals 2¼ inches, then the actual angle of the thread with a line perpendicular to the axis of the nut is about 2 degrees. If now a circular



Figs. 1, 2 and 3. Section through Nut, Objectionable, and Improved Forms of Circular Chasers.

chaser is made, being 1¼ inch in diameter, and having four threads per inch, it will be seen that the angle of this thread with a line at right angles to the axis of the chaser is 4 degrees. It is plain that when such a chaser is used for cutting the thread in the nut shown, there will be an interference between the part of the thread in the chaser which is below the cutting edge and the thread already cut in the nut, the side of the thread in the chaser rubbing up against one side of the thread in the nut. In order to overcome this defect, and at the same time offer the advantages inherent in the chaser form of thread-cutting tool, S. N. Brayshaw, Mulberry Street, Hulme, Manchester, England, has brought out an improved form of circular chaser. For cutting a nut of the kind shown in Fig. 1, a chaser such as shown in Fig. 3 would be used. In this, the flute or notch in the chaser which provides the cutting edges, is milled first, before any threads

are cut, and then the threads are cut by a milling cutter in a thread-milling machine with such a lead that the angle of the thread in the chaser will be the same as the angle of the thread in the nut to be cut, the shape of the thread, of course, still remaining the same as before. The thread is not a continuous thread, but each thread simply extends around the chaser from one edge of the flute or groove to the other. By this means a chaser is provided which will cut the thread required without interference. It is clear, of course, that different chasers will have to be made for various internal diameters, but on fine pitches, in particular, each chaser can take in a considerable range of different diameters without meeting with the objections that would prevail if the chaser simply had a thread of the regular pitch cut continuously around it.

THE QUEBEC BRIDGE DISASTER.

The chief conclusions of the royal commission, appointed by the Canadian government to investigate the cause of the failure of the Quebec Bridge, which collapsed on August 29, 1907, have been submitted to the Canadian Parliament. The summary of the findings of the commission are as follows:

A. The collapse of the Quebec bridge resulted from the failure of the lower chords in the anchor arm near the main pier. The failure of the chords was due to their defective design.

B. Stresses that caused the failure were not due to abnormal weather conditions or accident, but were such as might be expected in the regular course of erection.

C. The design of the chords that failed was made by P. L. Szlapka, the designing engineer of the Phœnix Bridge Co.

D. This design was examined and officially approved by Mr. Theodore Cooper, consulting engineeer of the Quebec Bridge & Railway Co.

E. The failure cannot be attributed directly to any cause other than errors in judgment on the part of these two engineers.

F. These errors of judgment cannot be attributed either to lack of common professional knowledge, to neglect of duty or to a desire to economize. The ability of the two engineers was tried in one of the most difficult professional problems of the day and proved to be insufficient for the task.

G. We do not consider that the specifications for the work were satisfactory or sufficient, the unit stresses in particular being higher than any established by past practices. The specifications were accepted without protest by all interested.

H. A grave error was made in assuming the dead load in the calculations at too low a value and not afterwards revising this assumption. This error was of sufficient magnitude to have required the condemnation of the bridge even if the details of the lower chords had been of sufficient strength, because, if the bridge had been completed as designed, the actual stresses would have been considerably greater than those permitted by the specifications. This erroneous assumption was made by Mr. Szplaka and accepted by Mr. Cooper and tended to hasten the diaster.

I. We do not believe that the fall of the bridge could have been prevented by any action that might have been taken after August 27, 1907. Any effort to brace or take down the structure would have been impracticable, owing to the manifest risk of human life involved.

J. The loss of life in August, 1907, might have been prevented by the exercise of better judgment on the part of those in responsible charge of the work for the Quebec Bridge & Railway Company and for the Phœnix Bridge Company.

K. The failure on the part of the Quebec Bridge & Railway Company to appoint an experienced bridge engineer was a mistake. This resulted in a loose and inefficient supervision of all parts of the work on the part of the Quebec Bridge & Railway Company.

L. The work done by the Phœnix Bridge Company in making the detail drawings and in planning and carrying out the erection, and by the Phœnix Iron Company in fabricating the material was good, and the steel used was of good quality. The serious defects were fundamental errors in design.

M. No one connected with the general designing fully appreciated the magnitude of the work nor the insufficiency of the data upon which they were depending. The special experimental studies and investigations that were required to confirm the judgment of the designers were not made.

N. The professional knowledge of the present day concerning the action of steel columns under load is not sufficient to enable engineers to economically design such structures as the Quebec bridge. A bridge of the adopted span that will unquestionably be safe can be built, but in the present state of professional knowledge a considerably larger amount of metal would have to be used than might be required if our knowledge were more exact.

O. The professional record of Mr. Cooper was such that his selection for the authoritative position that he occupied was warranted, and the complete confidence that was placed in his judgment by the officials of the Dominion government and the Phœnix Bridge Company was deserved.

DIE SINKING AND ENGRAVING MACHINES.

The accompanying cuts, Figs. 1 and 2, show some interesting die-sinking and engraving machines, constructed by Messrs. Thomas Auty & Co., London, England. These machines are employed in a great variety of die-cutting work, and for engraving, and are used, to a great extent, in the British government shops for cutting the dies for various parts of rifles. The half-tone, Fig. 1, shows what is called the 42-inch Patent Die-sinking machine, which is the latest design brought out. The line cut, Fig. 2, shows exactly the same principle applied to a smaller machine, called the 27-inch die-sinking and engraving machine. The principle of these machines is that they copy from an enlarged former or model the form desired, reducing it by means of the pantograph arrangement shown.

The work to be operated upon is clamped to the table A under the head C. This head carries a milling cutter, constrained to follow the exact movement of the tracing-pin carried by head D along the form. The operating mechanism is carried on the table A, and consists of a pivoted arm B, the

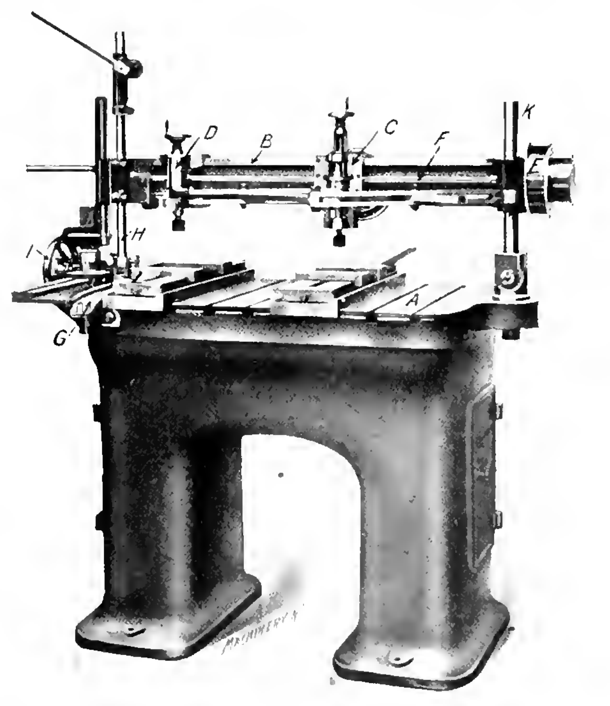


Fig. 1. Thomas Auty & Co.'s 42-inch Patent Die-sinking Machine.

end of which can be traversed in a horizontal plane around the axis of stud K. This arm is carried at its outer end by the roller L on the end of stud H, traveling along the circular path G of the machine table. The horizontal movement may be effected either directly by hand or mechanically through a pinion and rack, connecting with the hand-wheel I. As will be seen from the cut, at the right-hand end of the machine the arm B is carried by the stud K, which is, in turn, connected with the table by a universal joint, which permits the arm to rise and fall in a vertical plane, so as to accommodate itself to any irregular surfaces which there may be on the form, while, at the same time, the exact proportion between the cutter and the tracing-pin is maintained through the pantograph. By traversing the tracing head D longitudinally along the arm, a third movement is obtained, which imparts a relative, but reduced, motion to the cutting head C. The cutter spindle of head C is driven through a longitudinal shaft F, from the pulley E at the right-hand end of the machine. The drive in the head is through hardened steel helical gearing, carried in the slide itself. The arm B is secured to the stud K by means of a set-screw, the point of which

enters into a spline, as shown in the line cut, Fig. 2, so that the height of the arm may be varied according to the height of the work operated upon. The left-hand end of the arm is provided with a spring support on the end of rod H which takes the weight of the arm when vertical movements are required. This spring support is provided with the roller, as already mentioned. A thumb-screw is provided for preventing the spring from acting, thereby allowing the full weight of

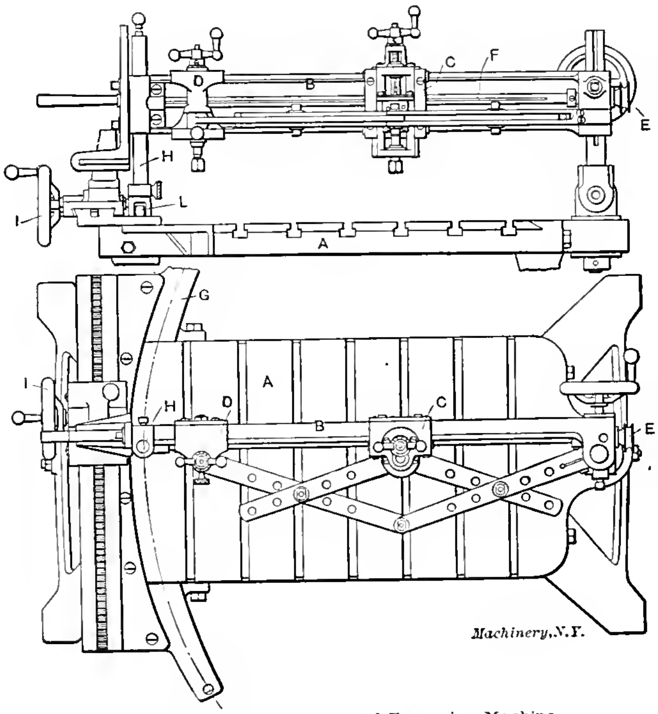


Fig. 2. 27-inch Die-sinking and Engraving Machine.

the arm to bear upon the work when necessary. In the machine in Fig. 1, reversible automatic feeds may be provided for both the longitudinal and transverse motion if required. The power is transmitted to the arm hand-wheel by a shaft in the back of the machine, driven through suitable gearing from the main shaft. The transverse movement is connected through a universal joint with the free end of the arm.

THE MANUFACTURE OF MACHINE TOOLS IN GERMANY.

Abstract of Report of Capt. Godfrey L. Carden, Special Agent of the Department of Commerce and Labor.

American manufacturers who have not heretofore attempted to analyze the European market, will find that German machine tool shops are turning out many machines that for practical shop work serve the purpose as well as the average American tool, and unless the German manufacturer can buy American machine tools cheaper than those made in his own country, he may be expected to patronize his own market. The majority of American manufacturers, however, can undersell the German tool manufacturers in German territory, despite the lower wages paid in Germany. This condition is due to the specializing and high standard of shop efficiency prevalent in America. Very few German establishments have attempted so far to confine themselves to a few lines of tools or to one type of machine, which specializing, of course, would greatly diminish the cost of production.

Many of the statements in the report are of a character that seems like the very rudiments of business requirements, but Capt. Carden says that he has been struck with the apparent ignorance on the part of many machine manufacturers in America, even men who are presidents of prominent concerns, of what constitutes the latest and most up-to-date practice in Europe. It is this very lack of knowledge which has probably had much to do with the failure of many American machine houses to accomplish more in the outside world. There is, however, some excuse for this, when we consider the great stress under which the home firms have been engaged during the last few years in the attempt to meet the enormous domestic demand. Under such conditions, there has been little incentive for many of our houses to study foreign markets.

The rate of wages has increased in German shops in recent years. The average wages paid at one large establishment is about 17 cents per man per hour. (In one large machine tool building firm in the United States the average wages paid per man per hour is 22 cents.—EDITOR.) The average working day is nine hours. The introduction of gages into Germany, as turned out by some of the best American firms, is serving as a potent factor in the development of the efficiency of the German workman. Measuring instruments are manufactured in Germany, but they are not recognized as equal to the best produced in America. There is very little competition in Germany on the part of English firms.

What concerns American manufacturers vitally is the fact that the Germans are putting more engineering thought into their designs than at any time in the history of tool construction. The mechanical skill still holds in favor of the Americans, and will probably remain to their credit in the case of those American firms which are paying close attention to the drafting-room. When tools from American firms are introduced into Germany, every feature of those tools will be the subject of close scrutiny, and if engineeering skill, backed up by careful mathematical deductions, make it possible to produce a better machine, the Germans will be among the first to discover the fact. The American firm need not, therefore, be surprised, if, in a very short time, there is found on the market a similar German tool, possibly American in its original idea, but essentially German in its improved form. It is therefore absolutely necessary for any American firm which proposes to hold its own in foreign competition, not to ignore technical education.

A visit to the A. Borsig plant, near Berlin, is referred to in the report. This plant employs about 5,000 men, and the managers have learned, to the highest degree, how to get the maximum work out of the machine tools. It would be surprising to many American manufacturers, says Capt. Carden, who believe that Americans alone understand shop efficiency, to take a walk through these shops, and he says that a glimpse of the workings of this particular plant would cause a realization of what there is ahead of America in foreign competition.

Practically one-half of the machinery production of Prussia is for export. The French have not been inclined for many years to patronize the German houses, but the merit of German production has forced itself even on the French buyer. On the whole, however, the Germans do not as yet understand in the great majority of cases how to operate the greatest number of machines with the least number of men, and the greatest improvement possible in German machine tool building is enhanced shop efficiency. The Germans, however, are learning fast in this respect, and if we propose to keep ahead in shop efficiency and in our ability to run a shop with the least possible number of men, there must be a thorough training of all those employed in the shop. In Germany, schools for apprentices are often established in the shops. These schools are presided over by men directly interested in the shop work. The apprentice works in the school-room either early in the morning, when he first comes to work, or at some other hour in the day, and the time devoted to the school-room is deducted from his wages. The education of the apprentice is carried along on carefully and well-thought-out lines, and always with the view of developing a highly skilled and technically trained man, developed, of course, particularly along the lines of work carried on by the firm employing him.

* * *

In a previous issue we referred, in a short note, to the tremendous volume of business done in the moving picture industry. The following additional information may be of interest, as indicating the proportions of the business. One of the largest French companies is employing about 1,000 people in its factories. For the production of moving pictures, two large theaters are in constant use, and a large park with artificial lakes, etc., is also included in the equipment. Outside of the employes in the factories, the company employs more than 300 actors for obtaining the scenes for the moving pictures.

MAXIMUM STRESSES—2.*

JOHN S. MYERS †

Moments in Two Planes; Crane and Telpher Girders.

In the design of crane, telpher, and similar runways, not housed, suitable provision should be made for lateral strength to resist wind loads. This, in conjunction with considerations of the buckling tendency of the compression flange, makes a single I-beam or a built-up girder of symmetrical section undesirable. The three types of section most commonly used for these purposes consist of: 1st, an I-beam for vertical strength with a channel riveted to the compression flange for lateral stiffness; 2d, the same construction with the addition of a smaller channel to the tension flange to increase the vertical strength; and, 3d, two I-beams, side by side, with a cover plate on the top flanges only. Tables V and VI in the supplement of the present issue give properties of these three varieties of built-up sections. Most of the combinations are made up of the minimum weight sections rolled, which are the most economic to use and most readily obtained.

For the purpose of illustrating the use of these two tables in conjunction with Table II and Diagram III in the supplement of the March issue, the following notation is assigned to the various quantities entering into the calculation of a girder acted upon by a moving load, dead load, and wind loads, the moving load being carried on two wheels equally loaded:

W_l = live load, *i. e.*, the sum of the two wheel loads.
W_d = dead load, *i. e.*, the weight of the girder.
W_w = wind load, one-half of which is carried by each wheel.
W_n = normal wind load on girder.
L = length of span in inches.
B = wheel-base (center to center of wheel).
Z_c = section modulus of upper chord about axis $a\ a$.
Z_t = section modulus of lower chord about axis $a\ a$.
Z_w = section modulus of upper chord about axis $b\ b$.

Z_c, Z_t, and Z_w are to be taken from Tables V and VI in the the supplement.

V_m = variable for determining the moment due to wheel loads. Use the maximum value given by Table II or diagram III in the March issue supplement.
V_{mu} = variable for determining the moment due to uniformly distributed loads. Use the value given by the top curve of diagram III, where the same vertical ordinate as used for V_m intersects. If using Table II, take the value given opposite $R = 1$ or over, and in the same vertical column from which the maximum value of V_m was taken.
M_l = moment due to live load W_l.
M_v = moment due to all vertical loads, W_l and W_d.
M_w = moment due to wind loads W_w and W_n.
S_t = tensile stress due to M_v.
S_c = compressive stress due to M_v.
S_w = stress in top chord due to M_w.
S_{mc} = maximum combined compressive stress.
S = assumed stress used for determining the size of a trial section.

Then $$M_l = W_l\ L\ V_m \tag{18}$$
$$M_v = L\ (W_l\ V_m + W_d\ V_{mu}) \tag{19}$$
$$M_w = L\ (W_w\ V_m + W_n\ V_{mu}) \tag{20}$$
$$Z_t = \frac{M_l}{S} \quad (21) \qquad S_t = \frac{M_v}{Z_t} \quad (22)$$
$$S_c = \frac{M_v}{Z_c} \quad (23) \qquad S_w = \frac{M_w}{Z_w} \quad (24)$$

If the structure is subjected to maximum wind while carrying full dead and live load, then

$$S_{mc} = S_c + S_w \tag{25}$$

but since unhoused cranes, telphers, etc., are not reasonably supposed to be in operation during a wind storm little short of a hurricane, it is more logical to assume but half the wind loads, when combining with the maximum stresses due to live and dead load; then

$$S_{mc} = S_c + \frac{S_w}{2} \tag{25a}$$

* Continued from the March issue.
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Example.—A girder, 30 feet span, supports 15,000 pounds on two wheels equally loaded. The wheel-base is 9 feet, the wind normal to the girder is taken at 30 pounds per square foot, and the area exposed to wind carried by the two wheels is 60 square feet. Find a suitable section, and state the maximum stress.

Solution.—L = 30 feet = 360 inches; B = 9 feet; $\frac{B}{L} = \frac{9}{30} = 0.3$; W_l = 15,000 pounds; $W_w = 60 \times 30 = 1800$ pounds.

From table II or diagram III (March issue supplement), the maximum value of $V_m = 0.1806$ for $\frac{B}{L} = 0.3$ or $B = 0.3\ L$, and for the uniformly distributed loads $V_{mu} = 0.1222$. For a trial section we have by formula (18) $M_l = W_l\ L\ V_m = 15{,}000 \times 360 \times 0.1806 = 975{,}240$ inch-pounds. Assuming the low fiber stress of 10,000 we have by formula (21)

$$Z_t = \frac{M_l}{S} = \frac{975{,}240}{10{,}000} = 97.5$$

From Table V, in the current supplement, the lightest weight girder having a section modulus Z_t in excess of this is seen to be composed of one 18 inch 55-pound I-beam with a 12-inch 20.5-pound channel on the top flange. For this section $Z_t = 99.11$, $Z_c = 161.57$, and $Z_w = 23.16$. The weight per foot is then $55 + 20.5 = 75.5$ and the total weight of girder is $W_d = 75.5 \times 30 = 2265$ pounds. By formula (19), $M_v = 360 \times (15{,}000 \times 0.1806 + 2265 \times 0.1222) = 1{,}074{,}882$ inch-pounds.

By formula (22)

$$S_t = \frac{M_v}{Z_t} = \frac{1{,}074{,}882}{99.11} = 10{,}820,$$

and by (23)

$$S_c = \frac{M_v}{Z_c} = \frac{1{,}074{,}882}{161.57} = 6660.$$

The depth of girder is 18 inches = 1.5 feet: the area exposed to wind is $1.5 \times 30 = 45$ square feet. Then

$$W_n = 45 \times 30 = 1350 \text{ pounds.}$$

By formula (20)

$$M_w = 360 \times (1800 \times 0.1806 + 1350 \times 0.1222) = 176{,}422.$$

Then by formula (24)

$$S_w = \frac{M_w}{Z_w} = \frac{176{,}422}{23.16} = 7610$$

The maximum stress is then, according to formula (25),

$$S_{mc} = 6660 + 7610 = 14{,}270 \text{ pounds per square inch,}$$

or, under the more logical assumptions of formula (25a),

$$S_{mc} = 6660 + \frac{7610}{2} = 10{,}465 \text{ pounds per square inch.}$$

Moments in Two Planes with Symmetrical Resisting Section.

The foregoing is an example of moments in planes at right angles to each other, but of such a special nature as to warrant classification under a specific heading. The most common case of moments in two places occurring in machine construction is that of shafting or pins supporting gears, drums, etc. In these cases the resisting section is round, and therefore symmetrical about any axis passing through the center of gravity. The stress in any particular plane is then proportional to the bending moment in that plane, and to find the maximum stress it is only necessary to find at what point the combined bending moment becomes a maximum, the moments in the various planes being susceptible of graphical combination in the same manner as forces. The point at which the combined moment is a maximum can generally be determined by an inspection of the problem, but when there is any doubt, the moments at the critical points should be calculated, and a scale diagram laid out for each plane in which moments occur. The ordinates of these diagrams can be combined for the various points where the maximum moment is liable to occur. To illustrate this method we will take an actual case.

Example.—The shaft shown in Fig. 4 is acted upon by the four forces P, P_1, P_2, and P_3, and by the two reactions. The forces P and P_1 are in the plane of line $E\ F$, and the moments they produce in this plane are represented by diagram A. The forces P_2 and P_3 are in the plane $G\ H$, their moments

being shown by diagram *B*. At *C* is shown the method of combining moments M_1 and M_5, producing the resultant moment M_{15}, which is the maximum moment occurring in the shaft at the point of application of the force P_1, the magnitude and direction of M_{15} being represented by the length and direction of the heavy line *c b*; *c a* is drawn parallel to *E F* and *a b* parallel to *G H*.

At *D* is shown the combination of M_2 and M_4 giving the resultant M_{24}, which is the maximum moment occurring at the point of application of force P_2. This resultant, M_{24}, exceeds in numerical value the moment at any other point of the shaft and is therefore the *maximum combined bending moment* for which it must be designed.

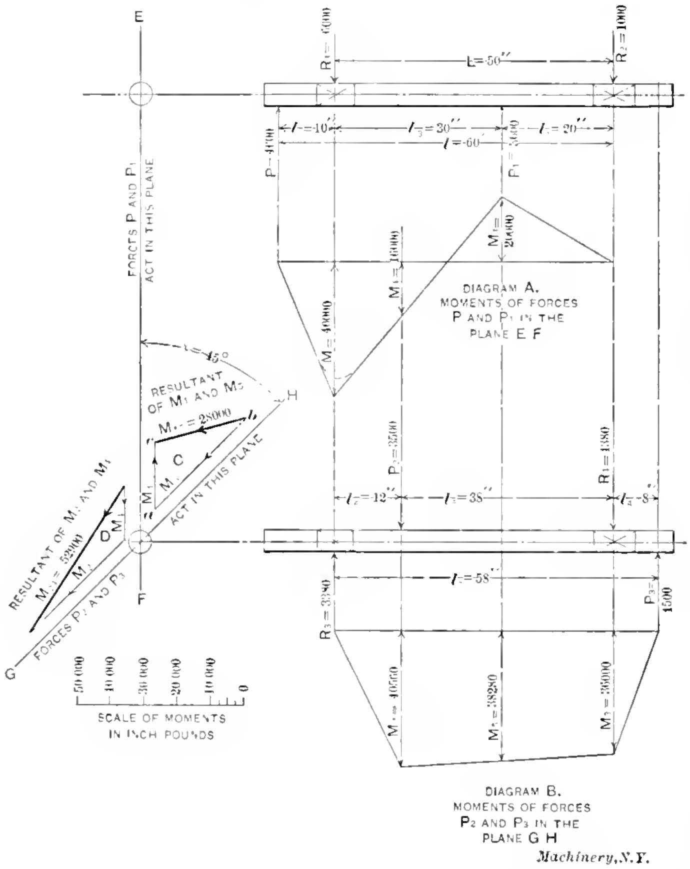


Fig. 4.

The method of calculating the reactions and moments at the various points used in making the diagrams of Fig. 4 is as follows:

$$R_1 = \frac{Pl + P_1 l_1}{L} = \frac{4000 \times 60 + 3000 \times 20}{50} = 6000 \text{ pounds.}$$

$$R_2 = \frac{P_1 l_3 - P l_2}{L} = \frac{3000 \times 30 - 4000 \times 10}{50} = 1000 \text{ pounds.}$$

$$M = Pl_2 = 4000 \times 10 = 40,000 \text{ inch-pounds.}$$

$$M_1 = R_2 l_1 = 1000 \times 20 = 20,000 \text{ inch-pounds.}$$

$$R_3 = \frac{P_3 l_4 + P_2 l_5}{L} = \frac{4500 \times 8 + 3500 \times 38}{50} = 3380 \text{ pounds.}$$

$$R_4 = \frac{P_3 l_7 - P_2 l_6}{L} = \frac{4500 \times 58 - 3500 \times 12}{50} = 4380 \text{ pounds.}$$

$$M_2 = R_3 l_6 = 3380 \times 12 = 40,560 \text{ inch-pounds.}$$

$$M_3 = P_3 l_4 = 4500 \times 8 = 36,000 \text{ inch-pounds.}$$

After laying out diagrams *A* and *B* from the above values, M_4 and M_5 may be scaled off, diagrams *C* and *D* constructed, and the final results M_{15} and M_{24} scaled off with sufficient accuracy for all practical purposes. If desired, they may be calculated. For this particular case

$$M_4 = M - \frac{M + M_1}{l_3} l_6 = 40,000 - \frac{40,000+20,000}{30} \times 12 = 16,000,$$

and

$$M_5 = \frac{M_2 + M_3}{2} = \frac{40,560 + 36,000}{2} = 38,280.$$

$$M_{24} = \sqrt{(M_4 \sin a)^2 + (M_2 + M_4 \cos a)^2} =$$
$$\sqrt{(16,000 \times 0.7)^2 + (40,560 + 16,000 \times 0.7)^2} = 52,900.$$

This latter is an unnecessary refinement which in practice would seldom, if ever, be resorted to, but is inserted here for purposes of illustration.

It will be noticed in the above solution that the forces were considered to be concentrated, no account being taken of the distributing action of the bearings. While this is quite customary, on account of simplifying the calculations, the error is sometimes considerable. In diagram *A* of Fig. 4, if the length of bearing *B* at the reaction R_1 is 7 inches, then the actual moment $M = P l_2 - \frac{R_1}{2} \times \frac{B}{4} = 34,750$. The diagram instead of coming to a sharp point should actually be rounded off as indicated by the dotted line.

Moments in Three Planes.

Fig. 5 is an illustration of moments in three planes, the proposition there presented being this: A shaft carries three drums, *A*, *A′* and *C*. *A* and *A′* are each acted upon by a rope whose load is represented by the force *F* at an angle of 30 degrees with the horizontal. An additional force F_1, due to the gears *B* and *B′*, acts at an angle of 90 degrees with the horizontal. Drum *C* carries a rope load F_2 on each side, and a gear load F_3 in the center, their direction being indicated by the dotted lines in the diagram.

The problem is to find the maximum combined bending moment.

Solution.—Force *F* is distributed over two bearings, their respective loads being *P* and P_1. $P = \frac{25,000 \times 7}{15} \cong 11,700$ and $P_1 = \frac{25,000 \times 8}{15} \cong 13,300$. The reaction due to *P* and P_1 is $R = 25,000$. The maximum moment in the plane of these forces is

$$M_0 = R\,(l + l_2) - P\,(l_1 + l_2) - P_1 l_2 = R\,l - P\,l_1 + l_2\,(R - P - P_1),$$

but since $R - P - P_1 = 0$, we have $M_0 = R\,l - P\,l_1$.

This shows that the moment for this case is the same in value as though the loads were concentrated at the center of the bearing, the only difference being that in the case of concentrated loads the moment would become maximum at point *H*, whereas with the load uniformly distributed over the bearing, the point of maximum moment shifts to *J* (see Fig. 5, diagram *D*). From the above may be stated the general principle that *for all cases of equal, symmetrically disposed loads acting in the same direction the maximum moment is the same in value whether the loads be concentrated at the center of bearings or distributed over their full length.* Then $M_0 = 25,000 \times 25 - 11,700 \times 15 \cong 449,500$ = maximum moment in the plane of *F*.

The force F_1, being central with a bearing, is all carried by that bearing. By the principle above stated its maximum moment is $M_1 = R_1 l = 18,100 \times 25 = 452,500$.

The forces F_2 and F_3 acting on drum *C* may be combined as in the diagram showing the direction of forces. This gives the resultant load $P_2 = 13,000$ pounds on each bearing of the drum. The maximum moment of P_2 in its plane is $M_2 = R_2 l_3 = 13,000 \times 35 = 455,000$.

Diagram *K* of Fig. 5 shows the combination of moments M_0, M_1 and M_2, giving the resultant *maximum combined bending moment* $M_{012} = 880,000$ inch-pounds, which is the moment for which the shaft must be designed.

Use of Table VII in the Supplement.

After the maximum moment to which a shaft is subjected has been found, the next step is to find what size must be used to withstand this and not exceed a safe fiber stress. By formula (8) in the March issue $Z = \frac{M}{S_b}$, where Z = section modulus, M = moment, and S_b = stress. Table VII in the supplement gives the value of *Z* for diameters ranging from 1/16 inch to 10 inches. It also gives the moment of inertia *I* for use when investigating for deflection. Formulas for

deflection covering various cases are given on data sheet No. 48 of the September, 1905 issue.

The values given in the supplement, Table VII, should be used for bending moments only. For torsional moments, the polar moment of inertia and section modulus should be used; but since these quantities are just double those for a rectangular axis, multiply the values in the table by 2.

The use of this table can best be illustrated by actual problems.

Example.—In the case shown by Fig. 4 the maximum combined bending moment was 52,900 inch-pounds. Using a fiber stress not exceeding 10,000 pounds per square inch, what size should the shaft be?

Solution.—By formula (8) the required section modulus is

$Z = \dfrac{52{,}900}{10{,}000} = 5.29.$ Referring to Table VII in the supplement, it is seen that for a 3 13/16-inch shaft $Z = 5.44$, which satisfies the conditions of the problem.

Example.—In the case illustrated by Fig. 5, the maximum moment was 880,000 inch-pounds. Allowing 25 per cent for

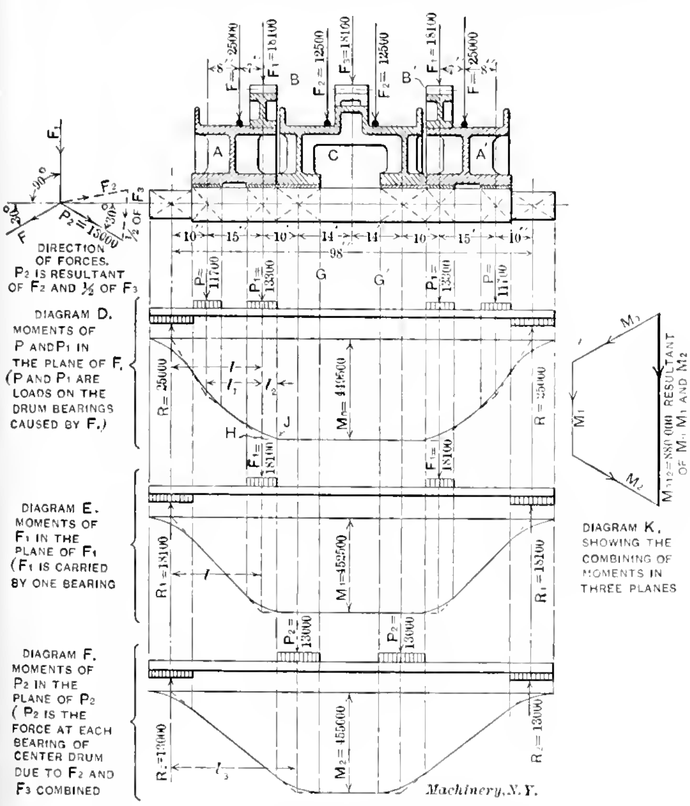


Fig. 5.

impact, what diameter of shaft may be used without exceeding a maximum stress of 15,000 pounds per square inch?

Solution.—25 per cent of 880,000 = 220,000.

$M = 880{,}000 + 220{,}000 = 1{,}100{,}000.$

$Z = \dfrac{1{,}100{,}000}{15{,}000} = 73.33.$ Referring to the supplement for 9-inch diameter. $Z = 71.57$ and for 9¼ inch diameter $Z = 77.7$; a 9⅛-inch shaft would then answer the purpose.

Example.—A shaft resists 50,000 inch-pounds torsional moment, what should be its diameter for a fiber stress of 8,000 pounds per square inch?

Solution.—Polar section modulus $= \dfrac{50{,}000}{8{,}000} = 6.25.$ Value in table $= \frac{1}{2} \times 6.25 = 3.125.$ For a 3⅛-inch shaft, the table gives $Z = 2.996$, and for 3 3/16-inch shaft $Z = 3.179$. Either of these sizes would be sufficiently near to satisfy the conditions.

Example.—What is the deflection of an 8¾-inch shaft loaded as shown in Fig. 6, taking the coefficient of elasticity at $E =$ 30,000,000?

Solution.—Referring to data sheet No. 18, September, 1905, deflection $f = \dfrac{W a}{24 E I}(3l^2 - 4a^2)$. For this problem $W = 26{,}000$, $l = 96$, $a = 34$.

From Table VII in the supplement of this issue $I = 287.7$ for an 8¾-inch shaft. Then the deflection $f =$

$$\frac{26{,}000 \times 34}{24 \times 30{,}000{,}000 \times 287.7} \times (3 \times 96^2 - 4 \times 34^2) = 0.098 \text{ inch.}$$

Example.—If in the last problem it is required to reduce the deflection to 1/16 = 0.0625 inch and use a coefficient of elasticity $E = 28{,}000{,}000$, what should be the shaft diameter?

Solution.—Let I, E and f be the values under the first condition, and I', E' and f' the corresponding values under the second condition. The deflection is inversely proportional to the moment of inertia and the coefficient of elasticity, then the required moment of inertia

$$I' = \frac{I f E}{f' E'} = \frac{287.7 \times 0.098 \times 30{,}000{,}000}{0.0625 \times 28{,}000{,}000} \cong 483.$$

Referring to the supplement, it is seen that for a 10-inch shaft $I = 490$. Ten inches is then the required size under these conditions.

Combining Shear with Tension or Compression. Table VIII.

The usual formulas given for the combination of shear with tension or compression are:

$$S_m = \sqrt{S^2 + \left(\frac{t}{2}\right)^2} \qquad (26)$$

and

$$t_m = \frac{t}{2} + \sqrt{S^2 + \left(\frac{t}{2}\right)^2} \qquad (27)$$

in which the letters have the following values:

S = unit shearing stress if acting alone.

t = unit tensile or compressive stress if acting alone.

S_m = maximum combined shear.

t_m = maximum combined tension or compression.

Both the above formulas, involving as they do the square and square root, are rather awkward to apply. Equation (26) may be expressed

$$S_m = S\sqrt{1 + \left(\frac{1}{2}\frac{t}{S}\right)^2} = S\,y \qquad (26a)$$

in which

$$y = \sqrt{1 + \left(\frac{1}{2}\frac{t}{S}\right)^2}$$

and formula (27) may be written

$$t_m = t\left[\frac{1}{2} + \frac{1}{2}\sqrt{\left(2\frac{S}{t}\right)^2 + 1}\right] = t\,x \qquad (27a)$$

in which

$$x = \frac{1}{2} + \frac{1}{2}\sqrt{\left(2\frac{S}{t}\right)^2 + 1}.$$

The value x then represents a factor by which to multiply the tension and arrive at the maximum combined tension, while y represents a similar factor by which to multiply the shear when the maximum combined shearing stress is desired. Table VIII in the supplement gives values of x and y for values of $\frac{S}{t}$ and $\frac{t}{S}$ ranging from 0.05 to 1.5.

To make the significance of these values clear, refer to the table, and note that for $\frac{S}{t} = 0.75$, $x = 1.40$, which means that if the shear is 75 per cent of the tension, the maximum combined tension is 1.40 times what it would be if there were no shear or an increase of 40 per cent. For the same value of $\frac{S}{t} = 0.75$, $y = 1.20$, which indicates that the maximum combined shear is 1.20 times what it would be if there were no tension or an increase of 20 per cent. Again, referring to the table for $\frac{t}{S} = 0.75$, $y = 1.07$ and $x = 1.92$ approximately, which shows that when the tension is 75 per cent of the shear the maximum combined shear is only 7 per cent greater than if there were no tension, but the maximum combined tension is 92 per cent in excess of what it would be if acting alone.

The combination of shearing stresses, produced by torsion, with tension or compression stresses due to bending, will be taken up in a later issue.

Stresses Due to Torsional Deformation.

When a machine element or member is subjected to a known torsional moment, an angular deformation occurs, or, if deformed torsionally a known amount a resultant shearing stress is produced. The following notation and formulas express the relations of the various quantities involved:

L = length of member in inches.

C_p = distance from polar axis of the section to the extreme fiber in inches.

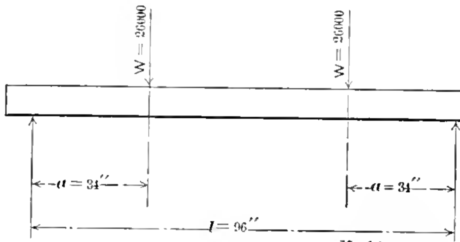


Fig. 6.

S = the shearing stress in pounds per square inch.

M_t = the torsional moment in inch pounds.

I_p = the polar moment of inertia.

E_s = the modulus of elasticity for shear (given by Reuleaux as 0.4 of that for tension).

ϕ = torsional angle in radians.

α = torsional angle in degrees.

$$\text{Then } \phi = \frac{M_t\, L}{I_p\, E_s} = \frac{S\, L}{E_s\, C_p} \qquad (28)$$

$$\alpha = 57.296\,\frac{M_t\, L}{I_p\, E_s} = 57.296\,\frac{S\, L}{E_s\, C_p} \qquad (29)$$

$$S = \frac{\phi\, E_s\, C_p}{L} = 0.01745\,\frac{\alpha\, E_s\, C_p}{L} \qquad (30)$$

Eye bars are sometimes used for supporting a load, while at the same time subjected to a torsional deformation. An example of this is seen in some bridge tramways where one end of the bridge is supported by a number of bars, permitting the bridge to slew through an angle of several degrees by twisting the bars.

Example.—A 4 × ¾-inch bar 24 feet long, sustaining a load of 21,000 pounds, is twisted through an angle of 5 degrees. What are the maximum stresses?

Solution.—$L = 24 \times 12 = 288$ inches.

$C_p = \sqrt{2^2 + 0.375^2} = 2.03$ inches. $\alpha = 5$ degrees.
$E_s\ 0.4 \times 27{,}000{,}000 = 10{,}800{,}000$. By formula (30)

$$S = \frac{0.01745 \times 5 \times 10{,}800{,}000 \times 2.03}{288} \cong 6650.$$

The direct tensiou is

$$\frac{\text{load}}{\text{area}} = \frac{21{,}000}{4 \times 0.75} = 7000. \qquad \frac{S}{t} = \frac{6650}{7000} = 0.95.$$

Referring to Table VIII in supplement, it is seen that the tension factor $x = 1.573$, and shear factor $y = 1.130$. Then by formula (27a) maximum tension $t_m = tx = 7{,}000 \times 1.573 \cong 11{,}010$. By formula (26a) the maximum shear $S_m = Sy = 6650 \times 1.130 \cong 7{,}510$.

As an example of bending, direct tension, and shear, also illustrating the method of determining moment of inertia of unsymmetrical sections, take the corner section on a C-frame, as illustrated in Fig. 7. This section is subjected to a bending moment equal to WL, where W equals 360,000 pounds, and L is the perpendicular distance from the line of action of the force to the center of gravity of the section. In addition to the bending moment, there is acting upon this section a force P, which is equal to $W \cos \alpha$ and is uniformly distributed over the section as tension; the other component P_1, which is equal to $W \sin \alpha$, is uniformly distributed over the section as shear.

In order to find the magnitude of the various stresses it is first necessary to find the area, center of gravity and moment of inertia of the section. Proceeding to find the center of gravity, take moments of the elementary areas of which the section is composed about some assumed line of reference, as $x\ x$, and divide the algebraic sum of the moments by the total area; the quotient is the distance from this line to the center of gravity. The operations are as follows:

	Areas.	Moments.
10×4	$= 40.000$	$\times\ 2.00 = 80.00$
1.25×13.5	$= 16.875$	$\times\ 10.75 = 181.41$
6×2.5	$= 15.000$	$\times\ 18.75 = 281.25$
A = total area	$= 71.875$	Sum of moments $= 542.66$

$$\frac{542.66}{71.875} \cong 7.55 \text{ inches to center of gravity of section} = C_t \text{ for}$$

tension flange; $20 - 7.55 = 12.45$ inches $= C_c$ for compression flange.

To get the moment of inertia, multiply each area by the square of its distance from the center of gravity of the entire section and add to each its moment of inertia about its own center of gravity. The moment of inertia of a rectangle being $\frac{b\,h^3}{12}$, the problem becomes:

$$40 \times 5.55^2 + \frac{10 \times 4^3}{12} = \begin{cases} 1232.10 \\ 53.33 \end{cases}$$

$$16.875 \times 3.2^2 + \frac{1.25 \times 13.5^3}{12} = \begin{cases} 172.80 \\ 256.29 \end{cases}$$

$$15 \times 11.2^2 + \frac{6 \times 2.5^3}{12} = \begin{cases} 1881.60 \\ 7.81 \end{cases}$$

$$I_r = 3603.93$$

The moment $M = WL = 360{,}000 \times 14.25 = 5{,}130{,}000$ inch-pounds. The tension is, $S_t = \frac{M\,C_t}{I}$ and the compression is

$$S_c = \frac{M\,C_c}{I}.$$

$$\text{Then } S_t = \frac{5{,}130{,}000 \times 7.55}{3603.93} = 10{,}747, \text{ and}$$

$$S_c = \frac{5{,}130{,}000 \times 12.45}{3603.93} = 17{,}722.$$

In this case the tension due to P and the shear due to P_1 are equal since sin 45 deg. = cos 45 deg. The value of these stresses is then

$$\frac{W \sin \alpha}{A} = \frac{360{,}000 \times 0.707}{71.875} = 3542.$$

Adding this to the stress in the tension flange, since this is also tension, and subtracting it from the stress in the compression flange we have: $10.747 + 3{,}542 = 14{,}289$ pounds per square inch tension, and $17{,}722 - 3{,}542 = 14{,}180$ pounds per square inch compression. Combining with the shear by formula (27) we have for the maximum combined tension

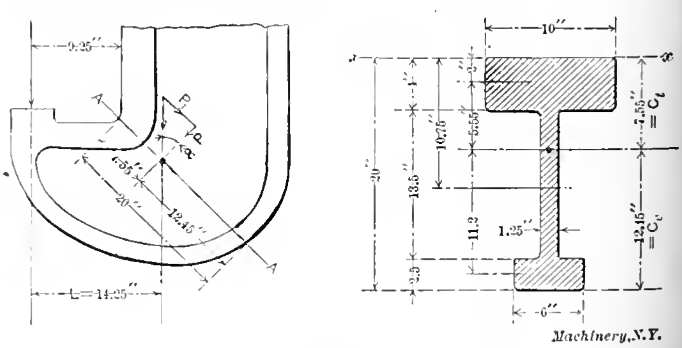


Fig. 7.

$$t_m = \frac{14{,}289}{2} + \sqrt{3542^2 + \left(\frac{14{,}289}{2}\right)^2} = 15{,}122 \text{ pounds per sq. in.}$$

The compression is so nearly the same value as the tension that it will be unnecessary to combine the shearing stresses in this case by separate calculation.

JIGS AND FIXTURES—2.

EINAR MORIN *

GUIDING THE DRILL.

The guides for the cutting tools in a drill jig take the form of concentric steel bushings, which are hardened and ground and placed in the jig body in proper positions. The bushings may be either stationary or removable, which latter, in the shop, are usually termed loose bushings. The most common, and the preferable form for the stationary bushing is shown in Fig. 5. This bushing is straight both on the inside and on the outside, excepting that the upper corners *A* on the inside are given a liberal radius, so as to allow the drill to enter the hole easily, while the corners *B* at the lower end of the outside are slightly rounded for the purpose of making it easier to drive the bushing into the hole, when making the jig, and also to prevent the sharp corner on the bushing from cutting the metal in the hole into which the bushing is driven.

When removable bushings are used, they should never be placed directly in the jig body except if the jig be used only a few times, but this should always be provided with a lining bushing. This lining bushing is always made of the form shown in Fig. 5. If the hole bored in the jig body receives the loose or removable bushing directly, the inserting and removing the bushing, if the jig is frequently used, would soon wear the walls of the hole in the jig body, and after a while the jig would have to be replaced, or at least the hole would have to be bored out, and a new removable bushing made to fit the larger-sized hole resulting. In order to overcome this, the hole in the jig body is bored out large enough to receive the lining bushing referred to, which is driven in place. This

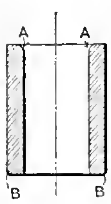


Fig. 5.

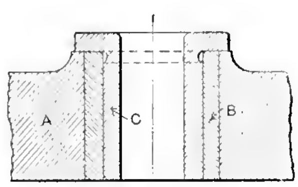
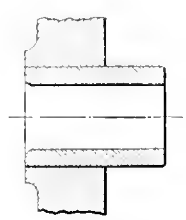


Fig. 6.



Machinery,N.Y.
Fig. 7.

Guide and Lining Bushings for Drill Jigs.

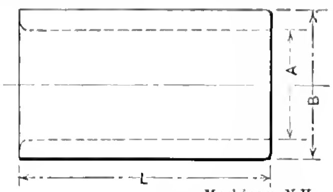
lining bushing then, in turn, receives the loose bushings, the outside diameter of which closely fits the inside diameter of the lining bushing, as shown in Fig. 6, in which *A* is the jig body, *B* the lining bushing, and *C* the loose bushing. Both of these bushings are hardened and ground so that they will stand constant use and wear for some length of time. When no removable bushings are required, the lining bushing itself becomes the drill bushing or reamer bushing, and the inside diameter of the lining bushing will then fit the cutting tool used. The bushing shown in Fig. 5 is cheaper to make, and will work fully as well when driven in place in the hole receiving it, as do bushings having a shoulder at the upper end, as has the loose bushing shown in Fig. 6. It was the practice some years ago to make all bushings with a shoulder, but this is entirely unnecessary, and simply increases the cost of making the bushing.

Dimensions of Jig Bushings.

It is rather difficult to give any standard dimensions for jig bushings as these depend, in most cases, on the different conditions of the various classes of jigs in which the bushings are inserted. As a rule the common practice is to make the length of the bushing twice the inside diameter of the hole in the bushing for stationary drill bushings. On very small bushings, however, say 1/4 inch diameter hole and less, the length of the bushing will have to be made longer than twice the diameter, while on very large bushings the length may be made somewhat less than twice the diameter. The accompanying Table I gives proportions of stationary drill bushings. The dimensions, as here given, will be found suitable in all cases where no special conditions demand deviation from ordinary practice. If the jig wall is thin, the bushing may project out as shown in Fig. 7, so as to give the cutting tool the proper guiding and support as close to the work as possible. In Table II are given dimensions for lining bushings, not intended to directly guide the drill, but to hold removable bushings, which in turn, guide the cutting tools. The dimensions given in Tables I and II are for bushings made from tool steel or machine steel.

While it may be, in some cases, difficult to draw a distinct line between stationary drill bushings and lining bushings, it may be said in general, that the bushings in Table I are

TABLE I. DIMENSIONS OF STATIONARY DRILL BUSHINGS.



Machinery,N.Y.

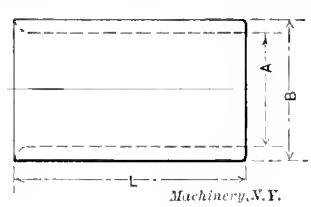
A	B	L	A	B	L	A	B	L	A	B	L
1/16	3/16	3/8	9/16	13/16	1 1/8	1 1/16	1 7/16	2	1 9/16	1 15/16	2 3/4
1/8	1/4	1/2	5/8	7/8	1 1/4	1 1/8	1 1/2	2 1/8	1 5/8	2	2 7/8
3/16	5/16	1/2	11/16	15/16	1 3/8	1 3/16	1 9/16	2 1/8	1 11/16	2 1/8	2 7/8
1/4	3/8	5/8	3/4	1	1 1/2	1 1/4	1 5/8	2 1/4	1 3/4	2 1/4	3
5/16	1/2	5/8	13/16	1 1/8	1 1/2	1 5/16	1 11/16	2 1/4	1 13/16	2 5/16	3 1/8
3/8	9/16	3/4	7/8	1 3/16	1 5/8	1 3/8	1 3/4	2 3/8	1 7/8	2 3/8	3 1/4
7/16	5/8	3/4	15/16	1 1/4	1 3/4	1 7/16	1 13/16	2 1/2	1 15/16	2 7/16	3 3/8
1/2	11/16	1	1	1 3/8	1 7/8	1 1/2	1 7/8	2 5/8	2	2 5/8	3 1/2

used for guiding the drills when drilling holes directly, either with a full-sized drill, when the hole is not required to be very smooth or accurate, or, if greater accuracy is required, for guiding a spotting drill which fits the bushing exactly, after which the hole is drilled out with a so-called reamer drill which is 0.010 inch or less under the size of the finished hole, and finally reamed out with a reamer fitting exactly the hole in the bushing. These bushings are thus, in general, used when no tapping or counterboring would be required. The lining bushing in Table II again may guide one of the tools for the holes to be finished directly, and then removable bushings are inserted to guide the other tools used.

Miscellaneous Types of Drill Bushings.

As already mentioned, it was, some years ago, always the practice to provide even stationary bushings with a shoulder or head, as shown in bushing *C*, Fig. 6. This will prevent

TABLE II. DIMENSIONS OF LINING BUSHINGS.



Machinery,N.Y.

A	B	L	A	B	L	A	B	L
5/16	1/2	1/2	1 1/8	1 1/2	1 1/2	2 1/8	2 5/8	2 5/8
3/8	9/16	1/2	1 1/4	1 5/8	1 5/8	2 3/16	2 11/16	2 3/4
7/16	5/8	5/8	1 5/16	1 11/16	1 3/4	2 1/4	2 3/4	2 7/8
9/16	13/16	5/8	1 3/8	1 3/4	1 7/8	2 5/16	2 7/8	2 7/8
5/8	7/8	3/4	1 7/16	1 13/16	2	2 3/8	3	3
11/16	15/16	7/8	1 9/16	1 15/16	2 1/8	2 9/16	3 3/16	3 1/8
3/4	1	1	1 5/8	2	2 1/8	2 5/8	3 1/4	3 1/4
13/16	1 1/8	1 1/8	1 3/4	2 1/4	2 1/4	2 11/16	3 5/16	3 3/8
15/16	1 1/4	1 1/4	1 13/16	2 5/16	2 1/4	2 3/4	3 3/8	3 1/2
1	1 3/8	1 3/8	1 7/8	2 3/8	2 3/8	...	...	...
1 1/16	1 7/16	1 1/2	1 15/16	2 7/16	2 1/2	...	...	...

the bushing from being pushed through the jig by the cutting tool, but this seldom occurs if the bushings are made to fit the tool correctly. Sometimes the shoulder is used to take the thrust of a stop collar, which is clamped on the drill, to allow it to go down to a certain depth, as shown in Fig. 8, in which *C* is the stop collar, *D* the wall of the jig, and *E* the stationary bushing, *F* being the piece worked upon. In such a case, a shoulder on the bushing may be in place.

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If the work to be drilled is located against a finished seat or boss on the wall of the jig, and the wall is not thick enough to take a bushing of standard length, then it is common practice to make a bushing having a long head, as shown in Fig. 9. The length A of the head can be extended as far as necessary to get the proper bearing. As the bushing is driven in place, and the shoulder of the head bears

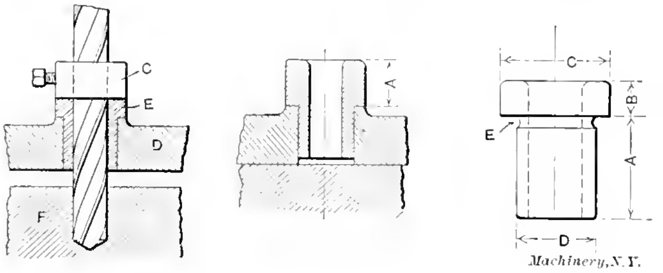


Fig. 8. Fig. 9. Fig. 10.
Types of Drill Jig Bushings for Different Purposes.

against the finished surface of a boss on the jig, it will give the cutting tool almost as rigid a bearing as if the jig metal surrounded the bushing all the way up.

Stationary or fixed drill bushings are almost invariably made from tool steel, but machine steel bushings, case-hardened and ground, give good service and wherever it seems necessary to save in the expense of the jig, machine steel will serve the purpose well enough for any jig that is not in constant use. For large bushings in particular, the difference becomes quite considerable, and, therefore, a great many prominent firms have made it a rule to make all larger bushings and, in particular, all lining bushings of machine steel.

Removable bushings are frequently used for work which must be drilled, reamed, and tapped, there then being one bushing for each of the cuttting tools. They are also used when different parts of the same hole are to be drilled out to different diameters, or when the upper portion of the hole is counterbored, or when a lug has to be faced off. In this case, each tool, of course, has its own guiding bushing. The common design of removable bushing is as shown in Fig. 10. The outside is made to fit the inside of the lining bushing with a nice, sliding fit, so that it can be gently pressed into the lining bushing by the hand. The distance A under the head of the bushing should be the same length or longer than the guiding bushing; in the latter case for the purpose of getting close to the work. The thickness B of the head varies, of course, according to the size of the bushing. The diameter C of the head should be from 1/4 to 1/2 inch larger than the diameter D of the bushing. A groove E, 1/8 to 1/4 inch wide, is cut immediately under the head, so that the emery wheel can pass clear over the part being ground.

Means for Preventing Loose Bushings from Turning.

In order to prevent the bushings from turning, in some shops a collar, with a projecting tail, as shown in Fig. 11, is forced over the head of the bushing. This arrangement also

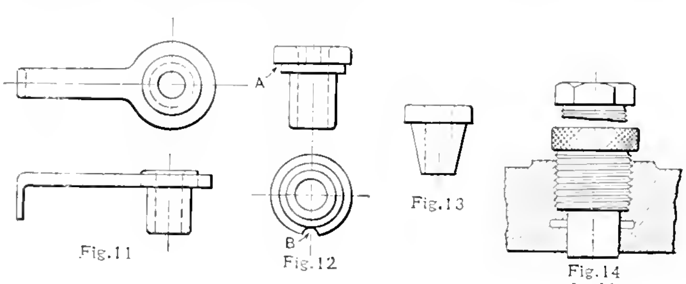
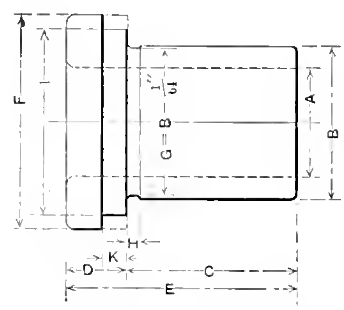


Fig. 11 Fig. 12 Fig. 13 Fig. 14
Means for Preventing Drill Bushings from Turning, Taper Bushing, and Screw Bushing.

makes it easy to remove the bushing. The dog, as it is commonly called, is usually bent at the end of the tail, as shown in the cut, one end resting against some part of the jig, the proportions of which the dog must suit. Sometimes the bent end is left straight, if there is a possibility for the tail to strike against some lug in the same plane. The making of such dogs involves some extra expense, but it is very effective in avoiding troubles with bushings turning and working their way out of the holes. In some cases simply a hole is drilled in the shoulder of the bushing at the edge, and a corresponding pin is driven into the jig body. This serves the same purpose as the dog. It is probably cheaper, but it does not add the convenient means for removing the bushing as does the dog. To make such a bushing more easily removable, the arrangement shown in Fig. 12 is probably the most common. A step A is turned down on the head, which, in this case, will have to be a trifle larger in diameter. This step permits some kind of a tool—a screw driver, for instance—to be put underneath, and with a jerk the bushing may be lifted enough to get a good hold on it. The half-round slot at B is milled or filed in the periphery of the head, and fits over a pin or screw which is fastened in the jig body, as mentioned before. There are, of course, a number of other devices for preventing drill bushings from turning, but the ones shown will serve the purpose of plainly exhibiting the principles.

In Table III are given dimensions for removable bushings of the type shown in Fig. 12. As will be seen in the engraving above the table, dotted lines have been shown, indicating a

TABLE III. DIMENSIONS OF REMOVABLE DRILL BUSHINGS.



A	B	C	D	E	F	H	I*	K*
1/8	5/16	1/2	1/8	5/8	5/8	1/8	1/2	1/32
3/16	3/8	1/2	1/8	5/8	5/8	1/8	1/2	1/32
1/4	7/16	5/8	1/8	3/4	3/4	1/8	5/8	1/32
5/16	9/16	5/8	1/8	3/4	3/4	1/8	5/8	1/32
3/8	5/8	3/4	1/8	7/8	7/8	1/8	3/4	1/32
7/16	11/16	7/8	1/8	1	1	1/8	3/4	1/32
1/2	3/4	1	1/8	1 1/8	1	1/8	7/8	1/32
9/16	13/16	1 1/8	1/8	1 1/4	1 1/8	1/8	1	1/32
5/8	15/16	1 1/4	3/16	1 7/16	1 1/4	1/8	1 1/8	1/32
11/16	1	1 3/8	3/16	1 9/16	1 1/4	1/8	1 1/8	1/16
3/4	1 1/16	1 1/2	3/16	1 11/16	1 3/8	1/8	1 1/4	1/16
13/16	1 1/8	1 1/2	3/16	1 11/16	1 3/8	1/8	1 1/4	1/16
7/8	1 1/4	1 5/8	3/16	1 13/16	1 1/2	1/8	1 3/8	1/16
15/16	1 5/16	1 3/4	3/16	1 15/16	1 5/8	1/8	1 1/2	1/16
1	1 3/8	1 7/8	1/4	2 1/8	1 3/4	3/16	1 5/8	1/16
1 1/16	1 7/16	2	1/4	2 1/4	1 7/8	3/16	1 3/4	3/32
1 1/8	1 9/16	2 1/8	1/4	2 3/8	2	3/16	1 13/16	3/32
1 3/16	1 5/8	2 1/8	1/4	2 3/8	2	3/16	1 13/16	3/32
1 1/4	1 3/4	2 1/4	5/16	2 9/16	2 1/8	3/16	1 15/16	3/32
1 5/16	1 13/16	2 1/4	5/16	2 9/16	2 1/4	3/16	2 1/16	1/8
1 3/8	1 7/8	2 3/8	5/16	2 11/16	2 1/4	3/16	2 1/16	1/8
1 7/16	1 15/16	2 3/8	3/8	2 13/16	2 3/8	3/16	2 3/16	1/8
1 1/2	2 1/8	2 1/2	3/8	3	2 1/2	3/16	2 5/16	1/8
1 9/16	2 3/16	2 5/8	3/8	3 1/8	2 5/8	3/16	2 7/16	1/8
1 5/8	2 1/4	2 3/4	3/8	3 1/4	2 5/8	3/16	2 7/16	1/8
1 11/16	2 5/16	2 7/8	3/8	3 1/4	2 3/4	3/16	2 9/16	1/8
1 3/4	2 3/8	3	3/8	3 3/8	2 3/4	3/16	2 9/16	1/8
1 13/16	2 9/16	3 1/8	1/2	3 5/8	3	1/4	2 13/16	5/32
1 7/8	2 5/8	3 1/4	1/2	3 3/4	3 1/8	1/4	2 15/16	5/32
1 15/16	2 11/16	3 3/8	1/2	3 7/8	3 1/8	1/4	2 15/16	5/32
2	2 3/4	3 1/2	1/2	4	3 1/4	1/4	3 1/16	5/32

* When using dogs as illustrated in Fig. 11, the dimensions in these columns are omitted.

shoulder without any recess of the kind shown at A, Fig. 12. The dimensions for such a shoulder as would be the result if the head of the bushings were made to the dotted lines apply to such bushings as are used with a dog, as shown in Fig. 11. In this case the dimensions in columns I and K in the table are omitted.

Table IV gives dimensions for bushings for holes which are reamed with a rose chucking reamer, after having first been drilled with a drill 1/16 inch smaller than the diameter of the reamer with which the hole is finally reamed out. The bushing to the extreme right, over the table, is the lining bushing, which is made of machine steel, case-hardened and ground. The bushing to the extreme left is the bushing for the rose

chucking reamer. It is made of cast iron and ground. The bushing in the center is the drill bushing which is made from tool steel, hardened and ground, or in cases where it does not seem warranted to make the bushing of tool steel, of machine steel, case-hardened and ground

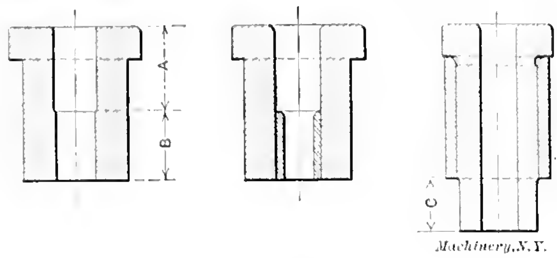


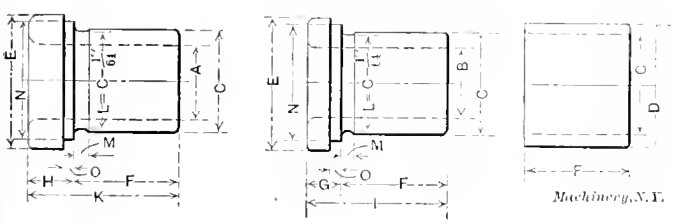
Fig. 15 Fig. 16 Fig. 17
Special Types of Drill Jig Bushings.

The tapered removable bushing shown in Fig. 13 is objectionable on account of being expensive to make, and also on account of its liability to be thrown out of true by chips, etc., getting in between the outside of the bushing and the hole.

Screw Bushings.

Sometimes removable bushings are threaded on the outside and made to fit a tapped hole in the jig, as shown in Fig. 14. The lower part of the bushing is usually turned straight, and ground, in order to center the bushing perfectly in the hole in the jig. The head of the bushing is either knurled, or milled hexagon for a wrench. When these bushings are used they are, as a rule, not used for the single purpose of guiding the cutting tool, but combine with this the purposes of

TABLE IV. BUSHINGS FOR HOLES REAMED WITH ROSE CHUCKING REAMERS.



A	B	C	D	E	F	G	H	I	K	M	N*	O*
3/4	11/16	1 1/4	1 5/8	1 1/2	1 1/4	3/16	1/4	1 7/16	1 1/2	1/8	1 3/8	1/16
13/16	3/4	1 5/16	1 11/16	1 5/8	1 5/16	3/16	1/4	1 1/2	1 9/16	1/8	1 1/2	1/16
7/8	13/16	1 3/8	1 3/4	1 5/8	1 3/8	3/16	1/4	1 9/16	1 5/8	1/8	1 1/2	1/16
15/16	7/8	1 7/16	1 13/16	1 3/4	1 7/16	3/16	1/4	1 5/8	1 11/16	1/8	1 5/8	1/16
1	15/16	1 1/2	1 7/8	1 3/4	1 1/2	1/4	5/16	1 3/4	1 13/16	3/16	1 5/8	1/8
1 1/16	1	1 9/16	1 15/16	1 7/8	1 5/8	1/4	5/16	1 7/8	1 15/16	3/16	1 3/4	1/8
1 1/8	1 1/16	1 5/8	2	1 7/8	1 11/16	1/4	5/16	1 15/16	2	3/16	1 3/4	1/8
1 3/16	1 1/8	1 11/16	2 1/8	2	1 3/4	1/4	5/16	2	2 1/16	3/16	1 7/8	1/8
1 1/4	1 3/16	1 13/16	2 5/16	2 1/8	1 7/8	5/16	3/8	2 3/16	2 1/4	3/16	2	1/8
1 5/16	1 1/4	1 15/16	2 7/16	2 1/4	2	5/16	3/8	2 5/16	2 3/8	3/16	2 1/8	1/8
1 3/8	1 5/16	2	2 1/2	2 1/4	2 1/8	5/16	3/8	2 7/16	2 1/2	3/16	2 1/8	1/8
1 7/16	1 3/8	2 1/16	2 9/16	2 3/8	2 1/4	5/16	3/8	2 9/16	2 5/8	3/16	2 1/4	1/8
1 1/2	1 7/16	2 1/8	2 5/8	2 3/8	2 3/8	5/16	3/8	2 11/16	2 3/4	3/16	2 1/4	1/8
1 9/16	1 1/2	2 3/16	2 11/16	2 1/2	2 1/2	3/8	7/16	2 7/8	2 15/16	3/16	2 3/8	1/8
1 5/8	1 9/16	2 3/8	3	2 5/8	2 5/8	3/8	7/16	3	3 1/16	3/16	2 1/2	1/8
1 11/16	1 5/8	2 7/16	3 1/16	2 3/4	2 3/4	3/8	7/16	3 1/8	3 3/16	3/16	2 5/8	1/8
1 3/4	1 11/16	2 1/2	3 1/8	2 7/8	2 7/8	3/8	7/16	3 1/4	3 5/16	3/16	2 3/4	1/8
1 13/16	1 3/4	2 9/16	3 3/16	3	3	7/16	1/2	3 7/16	3 1/2	1/4	2 13/16	3/16
1 7/8	1 13/16	2 5/8	3 1/4	3	3 1/8	7/16	1/2	3 9/16	3 5/8	1/4	2 13/16	3/16
1 15/16	1 7/8	2 11/16	3 5/16	3 1/8	3 1/4	7/16	1/2	3 11/16	3 3/4	1/4	2 15/16	3/16
2	1 15/16	2 3/4	3 3/8	3 1/8	3 3/8	7/16	1/2	3 13/16	3 7/8	1/4	2 15/16	3/16
2 1/16	2	2 15/16	3 9/16	3 1/2	3 1/2	1/2	5/8	4	4 1/8	1/4	3 1/4	3/16
2 1/8	2 1/16	3	3 5/8	3 1/2	3 1/2	1/2	5/8	4	4 1/8	1/4	3 1/4	3/16
2 3/16	2 1/8	3 1/16	3 13/16	3 5/8	3 5/8	1/2	5/8	4 1/8	4 1/4	1/4	3 3/8	3/16
2 1/4	2 3/16	3 1/8	3 7/8	3 5/8	3 3/4	1/2	5/8	4 1/4	4 3/8	1/4	3 3/8	3/16
2 3/8	2 5/16	3 3/8	4 1/8	3 7/8	3 7/8	1/2	5/8	4 3/8	4 1/2	1/4	3 1/2	3/16
2 1/2	2 7/16	3 1/2	4 1/4	4	4	1/2	5/8	4 1/2	4 5/8	1/4	3 3/4	3/16
2 5/8	2 9/16	3 5/8	4 3/8	4 1/8	4 1/8	1/2	5/8	4 5/8	4 3/4	1/4	3 7/8	3/16
2 3/4	2 11/16	3 3/4	4 1/2	4 1/4	4 1/4	1/2	5/8	4 3/4	4 7/8	1/4	4	3/16

* When dogs illustrated in Fig. 11 are used, dimensions in these columns are omitted.

locating and clamping the work. For such purposes they are quite frequently used. These bushings are not commonly used as removable bushings, as it would take considerable time to unscrew, and to again insert a bushing of this type into the jig body.

Sometimes bushings for guiding the tools may be made of cast iron, but only in such cases when the cutting tool is of such a design that it does not have any cutting edges in the bushing itself, as, for instance, in the case of guiding the smooth surface of a boring-bar, or the shank of a reamer or a rose reamer, but hardened steel bushings must always be used when the cutting tool is liable to cut the bushing, as, for instance, in the case of drills and reamers, guided on their flutes, taps, etc.

Special Designs of Guide Bushings.

When the guide bushings are very long, and consequently would cause unnecessary friction in their contact with the cutting tools, they may be recessed, as shown in Fig. 15. The distance *A*, of the hole in the bushing, is recessed enough wider than the diameter of the tool, so as not to bear on it. The length *B*, being about twice the diameter of the hole, gives sufficiently long guiding surfaces for the cutting tool, to prevent its running out. If the outside diameter of the bushing is very large, as compared with the diameter of the cutting tool, as indicated in Fig. 16, the expense of making the bushings may be reduced by making the outside bushing of cast iron, inserting into this a hardened tool steel bushing, driven in place. The steel bushing is then given dimensions according to Table I for stationary bushings. The reason why there may be a necessity of a bushing having so large an outside diameter and so small a hole, may be that the bushing is required to be removed for counterboring part of the small hole being drilled, by a counterbore of large diameter, in which case the hole in the jig body has to be large enough to accommodate the larger sized counterbore.

If a loose or removable bushing is longer than the lining bushing, as illustrated in Fig. 17, it will prove advantageous to have the diameter of the projecting portion of the bushing about 1/32 inch smaller in diameter than the part of the loose bushing which fits the lining bushing. This lessens the amount of surface which has to be ground, and, at the same time, makes it easier to insert the bushing, giving it, so to say, a point, which will first enter the lining bushing, and it interferes in no way with the proper qualities of the bushing as a guide for the cutting tool.

In some cases, the holes in the piece to be drilled are so close to one another that it is impossible to find space for lining bushings in the jig. In such a case, it will be necessary to make a leaf, or a loose wall, or the whole jig of machine steel or tool steel, hardening a portion or the whole jig thus made.

* * *

MACHINE SHOP PRACTICE.

MACHINING A FIXTURE CASTING.*

MACHINERY'S articles on shop practice aim to supply, in a comprehensive way, definite, practical information about the various methods and operations chiefly comprising the work of the machinist; and while such instructions are always necessarily more or less elementary in character, and intended primarily for the apprentice, they are invariably interesting and valuable to the more advanced workman. We select, as examples, those operations which are general in character and best serve to teach the methods employed in actual practice, and the underlying principles of machine shop work; and in following this policy the information is of the greatest value to the largest number.

In Fig. 1 is shown a drawing of a milling machine fixture casting which is to be machined as indicated by the finish marks *f*. In this article we shall only discuss the planing operations, the boring and milling work being reserved for the next installment. In the Shop Operation Supplement accompanying this issue we have given condensed instructions for performing the planing operations, together with diagrams showing how the work is set up on the machine. Before setting this casting up on the table of the machine, it is first necessary to determine which of these surfaces shall be machined first. In general, when there are several surfaces on a piece of work to be machined, the shape of the work, and the relation of the finished surfaces to each other, must be considered in determining which part of the work is to be machined first. The fixture casting which we have selected as an example of

* With Shop Operation Sheet Supplement.

planing, boring, and milling work, is to have the bearing planed, which includes facing the top, planing the pillow-block cap fitting and facing the ends; the base with its tongue-piece, which is to be at right angles to the pillow-block cap fitting, planed; the top surface of the arm *H* planed; a T-slot milled in it, and the bearing bored. The T-slot *C* is to be parallel with the tongue-piece *B*, and the finished surface of the arm parallel with the base. Either the bearing or the base might be planed first in this case, but it is preferable to begin with the bearing, as the casting can be supported better on the rough base than on the unplaned bearing end. The first illustration on the Shop Operation Supplement shows the work set up for the first planing operation. Small parallel pieces were inserted beneath each corner of the base, as shown, in order to get a better bearing by preventing the casting from bearing on any high spot. If the base of the casting, because of its roughness, does not rest on all four parallels, liners of brass or tin should be inserted. In order that the base be of uniform thickness, its top surface should be set parallel with the table by using a surface gage. As the first planing operation consists of facing the top of the bearing and planing the fitting *G* for the pillow-block cap, and as this bearing is to be at right angles to the long side of the base and the T-slot *C* in the arm *H*, it will be necessary to set the casting with reference to these points. Inasmuch as the arm *H* is

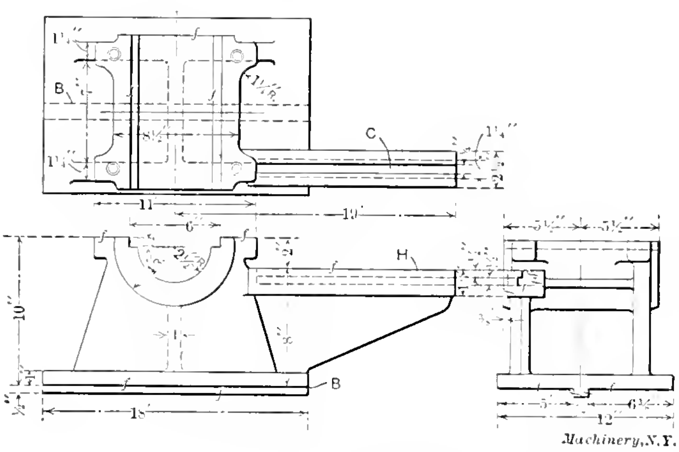


Fig. 1. Elevations and Plan of Milling Machine Fixture Casting.

considerably above the base, a straight-edge *A* is first set at right angles to the side of the table, as shown in the Supplement, and clamped in position. When the base is set parallel with the straight-edge, the cored slot in the arm may be tested by placing a square against the straight-edge and measuring from the blade of the square to the T-slot *C* at two points as far apart as possible. If the T-slot is not parallel, the casting should be shifted slightly so that both T-slot and base are as near parallel with the straight-edge as possible. The tongue-piece *B*, which is to be at right angles to the bearing, should also be approximately parallel with the straight-edge, so that when the casting is turned over and the base planed, the tongue-piece will true up. It is well to remember that in setting up any piece of work having a number of surfaces to be machined, that it should be so set that all surfaces can be finished in their proper relation to one another. After the casting is set it should be clamped firmly to the table, and set-screw plugs or other suitable stops set against it to prevent it from shifting when taking a cut. When planing the top surface *F* of the casting, the amount of metal to be removed will depend upon the distance between this surface and the base, and the required thickness of the base.

By locating the center *c* of the boss and the arcs *d*, and then working to these lines when planing the cap fitting, the fitting is made central with the boss. Obviously, the projection on the cap should also be planed central with its boss, so that when the cap is bolted in place the bosses and lugs on both castings will match each other.

When planing the base, the casting is inverted, as shown in Operation Sheet No. 62. As the tongue-piece *B* and the cap fitting are to be at right angles to each other, set the cap fitting at right angles to the side of the planer table by using a square as shown. As it is somewhat difficult to see the square blade when it is against the fitting, a piece of paper inserted between the square blade and fitting at each end of the fitting will aid in determining when the work is correctly set, as then both paper strips will be pinched by the square blade. When planing the base, roughing and finishing tools, similar to those shown at *A* and *B*, Fig. 2, may be used. The importance of removing the right amount of metal when plan-

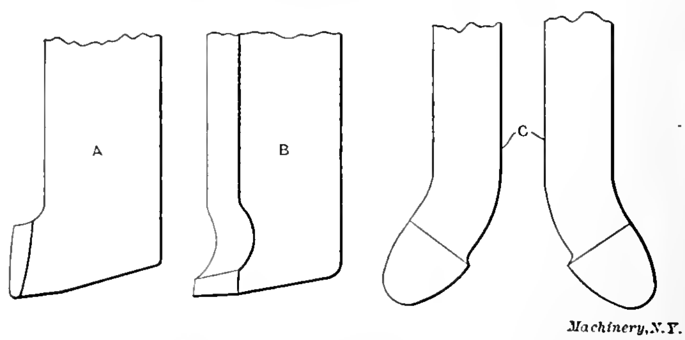


Fig. 2. Roughing, Finishing, and Right- and Left-hand Tools for Vertical Cuts.

ing the top of the bearing, will now be understood; if too much metal be removed, the casting will not finish to the dimension *H*, while if too little be removed, the flange of the base will be made too thin when the casting is machined to this dimension.

Before planing the ends of the bearing, the drilling and tapping for the cap bolts should be done, and the cap bolted in place. The casting is then set up on the planer table, as shown in Operation Sheet No. 63, with the tongue-piece ***B*** against one side of a T-slot. In this way the casting is set so that the finished ends of the bearing will be parallel with the tongue-piece. Before taking a vertical cut on a planer, the nuts *D* (Fig. 3) should be loosened, and the top of the apron *E* swung away from the plane of the surface to be planed, so that when the tool rises on the return stroke, instead of rubbing against the surface of the work, it will swing away from it or in a plane indicated by the line *F*—*G*. Of course, when planing the opposite end of the bearing, the apron must be swung in the opposite direction. Right and left round-nose tools for facing the ends of the bearing are shown at *C*, Fig. 3. When clamping the tools in place for these vertical cuts, they should be set so that a continuous cut can be taken over the entire surface to be planed.

When it is desired to plane surfaces at an angle to a line perpendicular to the platen, the bolts *H* are loosened, and the planer head *J*, which is mounted on a swiveling base *K*, is set

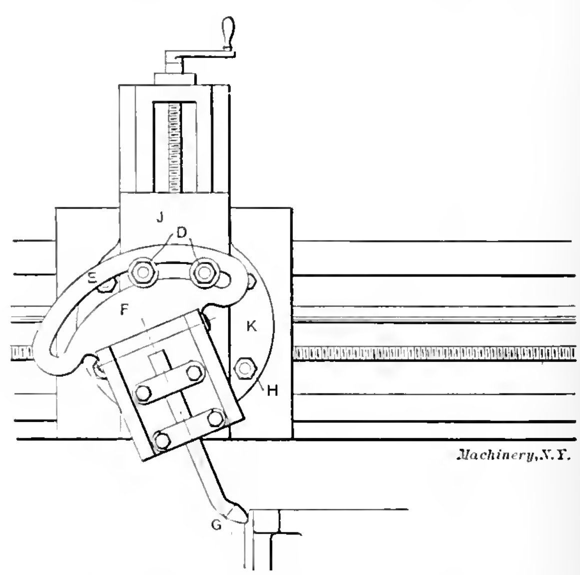


Fig. 3. The Planer Tool-block set for Taking Vertical Cuts.

to the required angle by the graduations provided. In this case, as the ends of the bearing are to be at right angles to the base, the head is set to the zero mark. If the planer has been in use for a considerable time the zero mark may not be absolutely correct, and it is advisable to test the accuracy of the work by the use of a square.

LETTERS UPON PRACTICAL SUBJECTS.

TWO-JAWED LATHE CHUCKS.

The accompanying engravings illustrate the best two-jawed chuck for general use that the writer has ever seen. It has been made by the Mueller Mfg. Co. Decatur, Ill., exclusively for this company's own use. The chuck was designed by Edward Mareille and patented as long ago as January, 1889, but as the original patent has now run out, and as the Mueller Mfg. Co. does not make these chucks for the market but simply for shop use, a description of them and the manner in which they are made, may be of interest and value to the readers of MACHINERY. About fifty of these chucks

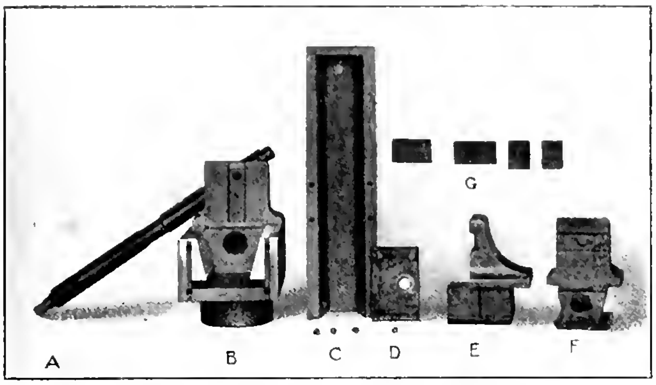


Fig. 1. Details of the Two-jawed Lathe Chuck.

are in use in the factory mentioned. Ten are used in the tool-room and about forty in the brass working shop. As a tool-room chuck, this design is unsurpassed for many jobs which formerly were done on the face-plate or on an angle plate. This is especially true in the case of core box work, where small metal core boxes are made for brass valve cores.

Some of these chucks, which have been continually in use for seven years, were recently overhauled, and showed very

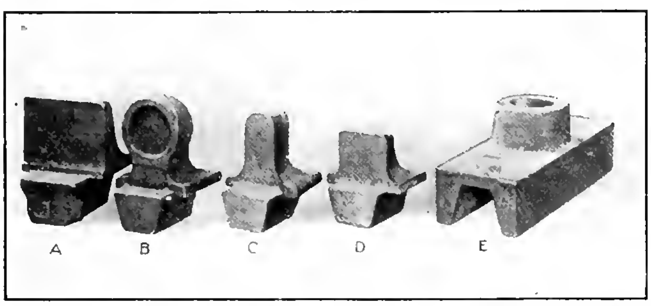


Fig. 2. Rough Castings used in making the Two-jawed Chuck.

little indication of the rough usage to which they had been subjected. The details of the chucks taken apart are shown in Fig. 1, in which *A* represents the chuck screw, threaded right- and left-hand, as usual. At *B* is shown an end view of the chuck, with the end-plate removed and one jaw in place. The part shown at *C* is a front view of the chuck body with everything removed, excepting one end-plate, the other end-plate being shown at *D*. A side view of the chuck jaws is

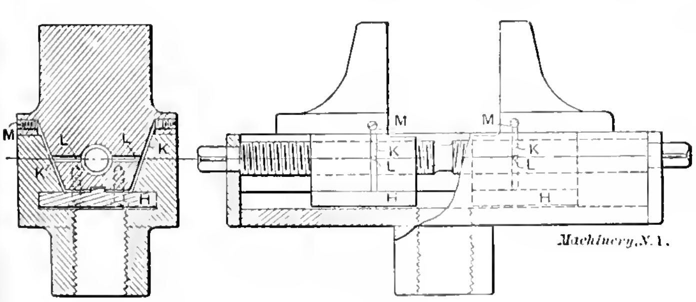


Fig. 3. Section and Side Elevation of the Chuck

shown at *E*, and a front view is shown at *F*. It will be noted that these two jaws are grooved on their faces differently from the one shown at *B*. This is done in order to permit the holding of special false jaws, but most of the chuck jaws are grooved lengthwise of the jaw face. Finally, at *G* are shown small metal plates used to protect the chuck screw from chips and dirt.

In Fig. 2 is shown a group of the rough castings used for making these chucks. The castings shown at *A* and *D* are for regular jaws of different sizes while those shown at *B*

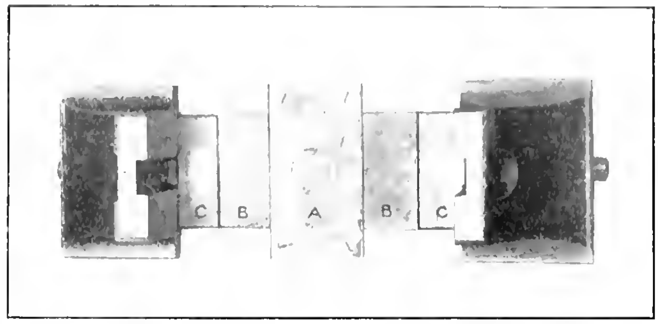


Fig. 4. View of Chuck with Jaws opened to Maximum Capacity.

and *C* are for special chucks. The casting for the chuck body itself is shown at *E*. The engraving Fig. 3 shows a section and a side elevation of the chuck. The section is taken at such a place as to illustrate the way in which the chuck is oiled, and the manner in which the jaws are set into the body and held. A plate *H* is screwed to the bottom of the

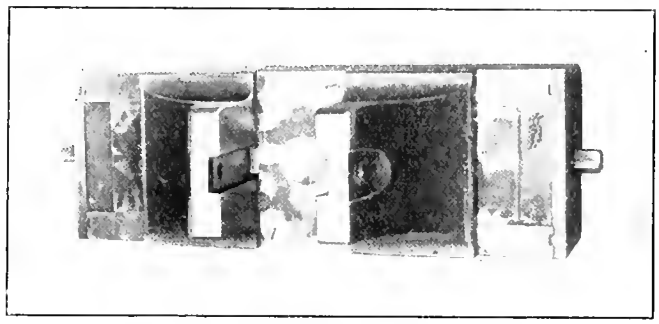


Fig. 5. View of Chuck with Jaws closed.

jaw, and fits into slots in the chuck body as shown. In regard to the oiling arrangement, oil grooves leading down the sides of the jaw are shown at *K*, while oil holes running in to the chuck screw nut are shown at *L*. At *M* are shown small screws for plugging up the oil holes. In the side elevation, part of the chuck is shown in section, to show the oiling arrangement. The half-tone Fig. 4 shows the chuck with the jaws open to their maximum capacity, and illustrates the

Fig. 6. Several Forms of Cast False Jaws used with the Chuck.

way in which the plates shown at *G* in Fig. 1 slide in and out and thus keep the chuck screw covered, excluding chips in a most effective manner. The plate *A* is stationary, and is held in place by screws. The plates *B* are made to slide in small grooves cut in the sides of the chuck body, and telescope in and out with the movement of the jaws by means of small pins working in the slots. The circular spot in the middle of plate *A* is an "accident." The parts *C* are projections of the jaws. In Fig. 5 the jaws are shown closed, and it is seen how the sliding plates at the back of the jaws are working, covering up the chuck screw in the same manner as the sliding plates in the front of the jaws.

As will be readily seen, these chucks are all intended to be used with false jaws, and an inspection of the construction will show how simple the chuck is, and how easy it is to take up the wear, on account of the beveled slot in the body,

and how rigid the long bearing of the jaws permits them to be. The location of the oil holes and grooves keep the working parts thoroughly oiled, being so placed that it is only necessary to take out the plug set-screws and inject some oil, the centrifugal force taking care of the rest. In the toolroom, flat false jaws are usually employed, but in the factory

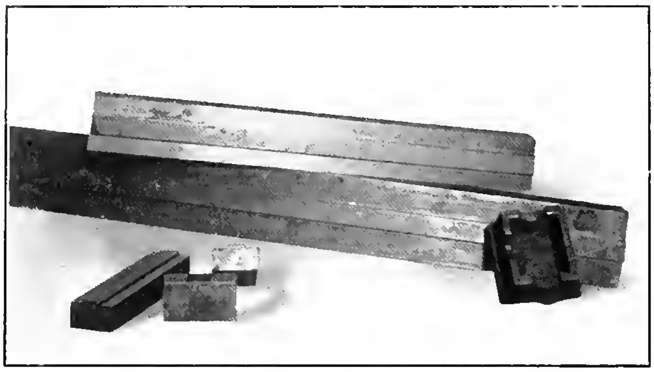


Fig. 7. Steel Bars from which Pieces are cut for making False Jaws.

special shapes are made for holding the different forms and sizes of valves being machined. The false jaws are made to fit the groove in the chuck jaws, and are held by a strong screw, and are interchangeable for any chuck of a given size. In Fig. 6 are shown groups of castings for several forms of false jaws, but most of the false jaws are made from machine steel bars and case-hardened. The bars are planed in long

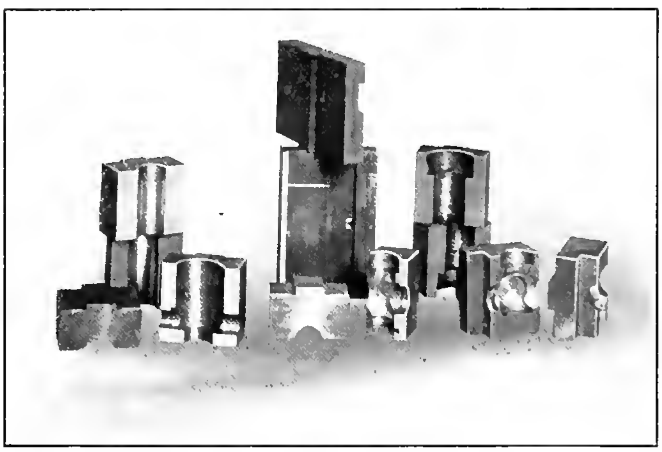


Fig 8. Partly Finished False Jaws which were cut from the Pieces shown in Fig. 7.

sections, as shown in Fig. 7, and the pieces are cut off when needed and machined to whatever shape is required. In Fig. 8 some of these false jaws made from machine steel, and partly finished, are shown.

Special angle plate clamps, which are used to hold the chuck jaws when performing the various operations through which they pass on the shaper, are shown in Fig. 9. These

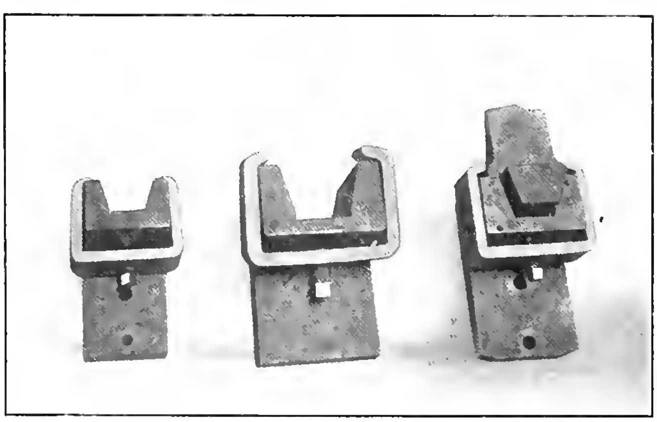


Fig. 9 Special Angle Plate Clamps used for Holding the Chuck Jaws when machining them.

appliances are also used on the lathe face-plate, to hold the jaw while the thread is being cut for the chuck screw. Finally, in Fig. 10 is shown a square block screwed onto the lathe spindle, and the chuck jaws screwed up to it. After the chuck jaws and all working parts have been carefully scraped and fitted into place, the assembled chuck is clamped by means of its jaws onto this block, and the threads in the body cut and the boss finished. These angle plates and the block mentioned are the only jigs or special tools used for making these chucks. ETHAN VIALL.

Decatur, Ill.

TO MAKE ACCURATE ARBORS.

An arbor, to be an efficient tool, should have a true cylindrical surface, and have center holes that are exactly coincident with the axis, round, true as to angle, and perfectly smooth. The most important of these requirements is the center hole, as it is easily deranged. An arbor can be very easily ruined in a few seconds by letting one of the center holes get dry and roughen. The shape or design of a center hole is a

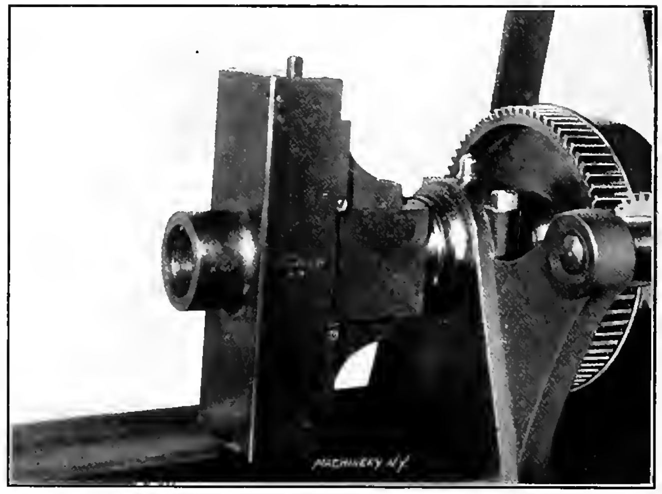


Fig. 10. The Way in which the Chuck is held when cutting the Thread and finishing the Boss.

factor that must not be looked upon as unimportant, though it is largely a matter of choice. The center shown in Fig. 1 is reamed to standard angle and the corner is rounded off at the mouth, while the center illustrated in Fig. 2 is reamed to standard angle and the end of the arbor counterbored. The advantages claimed for the latter are, protection of the center hole, and that it will stand considerable driving without spoiling the center hole, but then, driving is rather a barbaric practice. If by chance the arbor shown in Fig. 2 should get caught by the lathe center near the center hole, the point of the center is liable to raise a small burr, or chip out a small piece at the edge of the center hole. With the center shown in Fig. 1, this is prevented by the center striking the curved edge of the hole, and sliding into place. If the point strikes back of the curve it will be too far from the center hole to do any damage.

When making arbors the stock is cut first to length, and then carefully centered so that there will be a uniform amount of stock removed from all sides of the piece. This is important because of the difference of density caused by the rolling operations. After taking a roughing cut over the pieces, it is advisable to pack anneal them. This is to give any internal strains which were caused by the stock being straightened cold after being rolled, a chance to adjust themselves. After annealing they may be turned down, leaving the part *A* (Fig. 1) large enough to allow for grinding. This allowance will depend upon the length and size of the arbor. The possible spring of the stock in hardening must also be considered. The part *B*, with the curved edge *C*, may be turned to size and polished. Hold one end of the arbor in a true universal chuck, and run the other end in a steady rest. The curved edge of the center hole is now finished with a hand graver, and the end polished. The arbor is now ready for milling the flat places on the part *B* upon which the lathe dog is to be clamped. Procure a drill the size of the teat of the center drill used, and drill the center hole to the depth of about $\frac{1}{2}$ inch. This is to make a reservoir for the storage of oil to lubricate the center when in use.

We are now ready to ream the center holes. This is a very important operation, and one that cannot be rushed, for much

depends upon this part of the work. We will need a 60-degree center reamer, one having several flutes preferred. These flutes should be honed so that they have smooth, keen edges. Grip the center reamer in a chuck so that it runs absolutely true and block the lathe spindle. Now flood one center hole of the arbor with lard oil, and support the other end on the tail center which has been carefully lined up with the live spindle. Ream out the center hole by slowly turning the

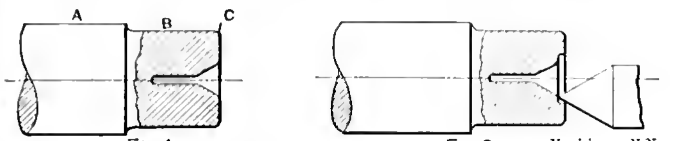


Fig.1 Fig.2

Figs. 1 and 2. Common Forms of Arbor Center Holes.

arbor by hand and tightening up on the tail center enough to make the reamer cut. Right here is the place to go slow. Take very light cuts at a slow speed and use plenty of oil. Ream sufficiently to clean up the center hole from the center to the edge of the curved mouth. After carefully reaming all the arbors, inspect them to see that the burrs caused by the milling have all been removed, and that all the other operations have been done properly. The arbors are now ready to be hardened. If the hardening is done with care, the majority of them will be fairly straight. Large arbors may be left hard, but arbors below ¾ inch should be drawn, so that they will not be so liable to break.

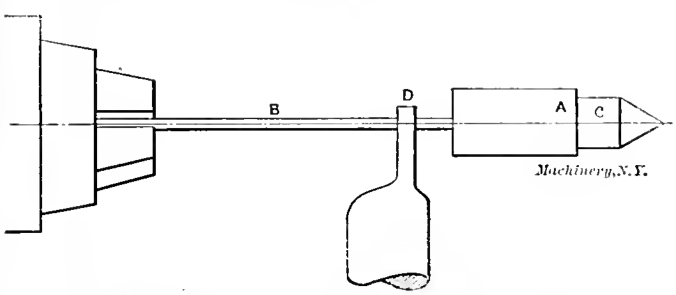


Fig. 3. Lap used for Polishing Arbor Center Holes

The first operation after hardening is to pickle off the scale, after which the center holes are lapped. An accurate center hole is the most important part of an arbor, and to get this, it must be carefully finished. Brass laps seem to work very well, and as the lap has to be of correct shape to get a true hole, it is advisable to make up a quantity of them, so that the temptation to continue using a lap which is worn out of shape will be removed. The lap should be gripped in a small chuck or holder, and run at a very high speed. A speed lathe with a lever feed is excellent. If the lathe is not provided with a lever feed, remove the tail-stock cap so that the spindle can be moved in and out very easily by taking hold of the tail-stock screw. For the rough lapping use coarse emery. Drop a little coal oil in the center hole, and then sprinkle in a small amount of the emery. Support the other end of the arbor on a center in the tail-spindle and gently feed the arbor onto the revolving lap, removing it as soon as it touches the lap. Repeat the operation, and keep turning the arbor to neutralize any error that may exist in the alignment of the machine. It is important to do the lapping by instantaneous contacts with the lap to prevent the emery getting caught and ringing the center hole. It is much easier to keep the hole smooth, than to smooth it up after it is scored. Lap just enough to correct any distortion that may have been caused by the hardening. After rough lapping, change the lap, and with a finer grade of emery, re-lap the center holes to get them smoother, and to correct any errors that may have occurred in the roughing out.

To get the required polish, we will proceed as follows: Make a small brass cup *A* (Fig. 3) with a flexible steel shaft *B* about 4 inches long and 3/32 inch in diameter. With sealing wax, embed a small piece of oilstone *C* in the cup. Then rig up a small rest with a short bearing at *D*, about ½ inch back of the cup. The oilstone can be trued up with a diamond or piece of emery wheel, to the correct 60-degree angle. The object of the flexible shaft is to neutralize any chatter that may be caused by entering the lap in the center hole. This chatter, if not provided for, will cause the point of the oilstone to chip off. The rest is to keep the lap revolving in one plane. If this is not done, the lap revolving at a high speed is liable to go down through the shop if it by chance gets a little off center. Clean out all the center holes with gasoline to remove all emery, and insert the lap, using plenty of lard oil. Bear lightly on the lap to prevent it from getting dry and sticking, which would cause the point to break off. The oil stone will require truing up for every fifteen or twenty holes lapped, but considering the quality of work done, and the rapidity, it is a refinement well worth while. The lapping done, carefully test all the holes with a standard 60-degree plug, and mark all that will need to be lapped again to correct errors.

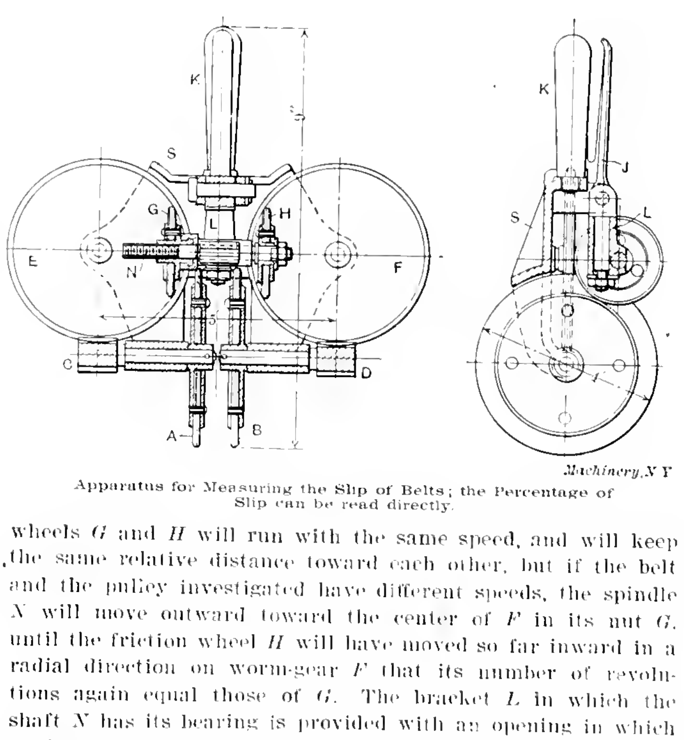
The last operation is to grind the cylindrical part. Because of the strains caused by the hardening, it is advisable to let the arbors season between the roughing and the finishing cuts. It will be found in some cases that they change shape after the roughing cut is taken. The arbor, if tapered, should have the number on the large end, and the amount of taper is governed by the length and the use to which it is to be put.

Lafayette, Ind. FOSTER HILLIX.

APPARATUS FOR MEASURING THE SLIP OF BELTS.

Belts slip under load a great deal more than is ordinarily supposed, and, for this reason, they are worn out much faster than is necessary, and at the same time the slip effects a great loss of driving power, so that a device which, under all circumstances, shows the amount of loss through slip, is of interest not only from a theoretical point of view, but also for its practical value. A simple and handy device for measuring belt slip is shown in the accompanying engraving. The device is held by the handle *K*, and applied in such a manner to the pulley on which the belt slip is to be measured that one of the two friction wheels *A* and *B* rests on the belt, while the other presses against the face of the pulley which projects outside of the width of the belt. The motion of wheels *A* and *B* is transmitted to the worm-wheels *E* and *F* by means of the worms *C* and *D*, of which one is right- and the other left-handed. From the worm-wheels *E* and *F* the motion is finally transmitted to the friction wheels *G* and *H*.

The hub of the wheel *G* is threaded on the inside so as to act as a nut on the threaded spindle *N*, which carries the other friction wheel *H*. When the belt is not slipping, the



Apparatus for Measuring the Slip of Belts; the Percentage of Slip can be read directly.

wheels *G* and *H* will run with the same speed, and will keep the same relative distance toward each other, but if the belt and the pulley investigated have different speeds, the spindle *N* will move outward toward the center of *F* in its nut *G*, until the friction wheel *H* will have moved so far inward in a radial direction on worm-gear *F* that its number of revolutions again equal those of *G*. The bracket *L* in which the shaft *N* has its bearing is provided with an opening in which a piece of glass is inserted. On this piece of glass a scale is provided, and the spindle *N* has a line cut at one place on its circumference, so that when the spindle moves in an inward direction the percentage of the loss through slipping

can be directly read off on the scale. The body L is connected with a lever J, which is mounted on a stud in the frame of the device, so that by pulling the lever towards the handle K, the friction wheels G and H may be disconnected from contact with the worm-wheels E and F at any time.

The appliance may be used for belts moving in either direction, and will show the correct result on the driven as well as the driving pulley, provided the device is applied correctly. It is, of course, necessary to always place the friction disk B against the part which is expected to run fastest, that is, in the case of driven pulleys against the belt, and in the case of driving pulleys, against the pulley. When correctly applied, the friction roller H and the spindle N on which it is mounted will, in the case of slip, move towards the center of F. If this is not the case, then the apparatus is not applied correctly, and should be turned around so that the proper friction disk works against the belt. The apparatus will also sometimes have to be put on the one side and sometimes on the other side of the pulley for which the belt slip is measured, in order that the scale on which the percentage of slip is read off may always be turned toward the operator of the device.

Pilsen, Austria-Hungary. MORITZ KROLL.

[The ingenious device shown and described above was designed by Prof. Kroll himself. His short and concise description hardly gives full justice to the ingenuity of this interesting device, but our readers will, no doubt, appreciate the simplicity of the mechanism by means of which the object sought is attained.—EDITOR.]

DIRECT FRACTIONAL-READING MICROMETER.

The direct fractional-reading micrometer, herein illustrated, is the result of talks with many mechanics in which all agreed that such a feature added to a micrometer would, by making it directly a fractional and decimal gage, more than double its practical value. While approximate readings in

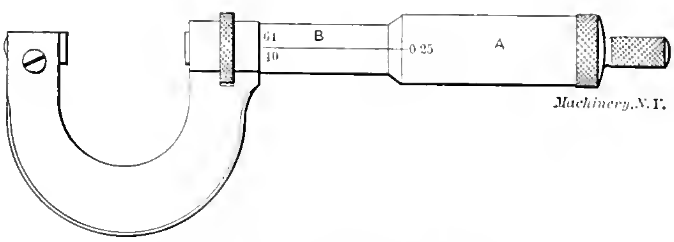


Fig 1. Direct Fractional-reading Micrometer.

64ths, etc., may be obtained by the graduations on the hub B (Fig. 1) as on an ordinary inch scale, the exact readings of 64ths, etc., may be obtained only by reference to graduations on the movable thimble A. There are but eight places on A which coincide with the long graduation line on B when any 64th, 32d, 16th, or 8th, is being measured, and each of these eight places is marked with a line, and the 64th, 32d, 16th, or

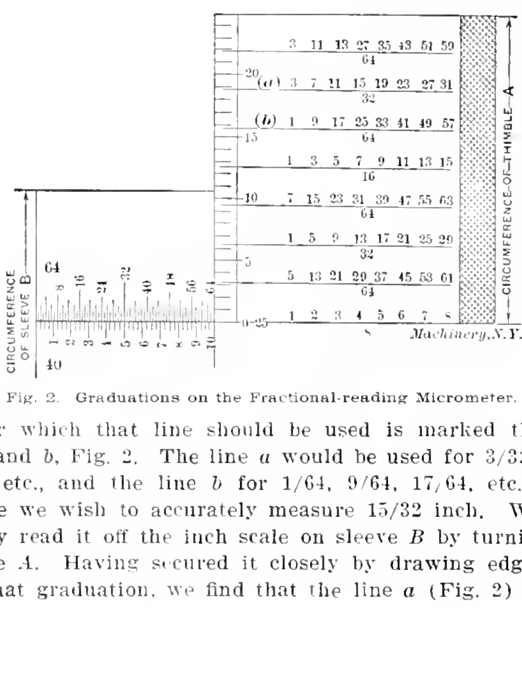


Fig. 2. Graduations on the Fractional-reading Micrometer.

8th for which that line should be used is marked thereon. See a and b, Fig. 2. The line a would be used for 3/32, 7/32, 11/32, etc., and the line b for 1/64, 9/64, 17/64, etc. Now suppose we wish to accurately measure 15/32 inch. We first roughly read it off the inch scale on sleeve B by turning out thimble A. Having secured it closely by drawing edge of A over that graduation, we find that the line a (Fig. 2) on the movable thimble very nearly or exactly coincides with the long graduation line on B. When these lines coincide, we have the exact measurement of 15/32 inch without reference to how many thousandths may be contained in the fraction. And so on through the scale any fraction may be found instantly. There is no mental arithmetic, use of tables, or memory work in using the tool. The new graduations are independent of the old, and may be used equally well with or without them.

Tools of various makes and sizes, which have been graduated, and are being graduated, differ from this in two re-

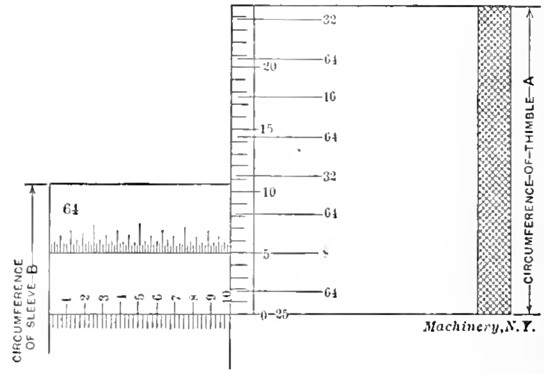


Fig. 3. Another Method of Graduating for Fractional Reading.

spects. Instead of using the zero line on A as a base line, a point is taken one-fifth of a turn around A, and the graduated scale on B is placed to correspond, as shown in Fig. 3; also, instead of making lines a, b, etc., on A full length, they are made about half an inch long, and the numerators are entirely omitted and the denominators placed at the end instead of under the line. To the ordinary user of the tool, this is all that is necessary for a perfectly clear reading of the fractions.

That this method of graduating is entirely new in principle and application, is proved by the very thorough search that was made in the patent office prior to the application, and further, by the fact that a broad patent has been allowed. To anyone having learned the use of micrometers, the new graduation appears, after one or two trials, perfectly simple, and they do away with all confusion as formerly experienced in reading fractions. CHARLES A. KELLEY.

Spring Lake, Mich.

THE CONFIDENCES OF A WORKMAN.

In the November, 1907, issue of MACHINERY there is an article on The Confidences of a Manufacturer which brings to my mind a little experience I had once, and incidentally I have learned that there is more than one kind of confidence. My title, which I received through promotion, was master mechanic. The place employed from 50 to 60 men, and some of the duties I performed were to look over the drawings that were made, and, as we did not employ a pattern-maker steady, take the drawings to an outside pattern-maker, and sometimes go personally and get the patterns and examine them. As our foundry deliveries were not regular, I sometimes carried the patterns to the foundry. (It might be well to mention here that the pattern-shop was about three miles in one direction, and the foundry about 4½ miles in another direction, by trolley.) I ordered all castings, and, as our patterns were returned each time they were used, I was obliged to get out the patterns, and when they were returned, check them all off, assort the castings, and place them in their proper bins. I also gave out the work to the men, looked after it, and often, with a new man, personally broke him in. I looked after all finished stock, and if a man was off a machine tool for a day, I was welcome to make use of it.

There was a constant cry from the management for better ways of doing the work, but if even a simple jig was suggested, it was stated that it would cost too much; if a fixture for some machine tool was suggested, the reply was, "Well, we haven't the time to make it," or "We cannot spare the machine as the machine has all it can do;" so, of course, the part would have to go back to the bench and be finished by hand. But even at that, when I did manage to make some

devices that were tried and liked, I would hear the old story repeated again. Then, in addition, when we made any new improvements in the machines we were building, of which I did a number, if it was a case for a patent, I made an assignment without any reward whatever. I also looked after all shafting and belting, motors, etc., made outside repairs to the buildings, looked after all the men's time cards, saw that they kept them straight, and I suppose did a number of other things that I do not recall just now—but I was supposed to enjoy the confidence of the management. When I went away, they called me "superintendent," but I didn't know it before. MARS.

EXPANSION BORING-BARS.

There still seems to be room for the improvement of boring-bars. There are shown in the accompanying engravings two different types of bars, which I do not claim to be past improving upon, but nevertheless they have proved to be very satisfactory in many respects. About ten months ago I made the bar shown in Fig. 1, and gave it to the foreman of the boring mill department of the Colburn Machine Tool Company,

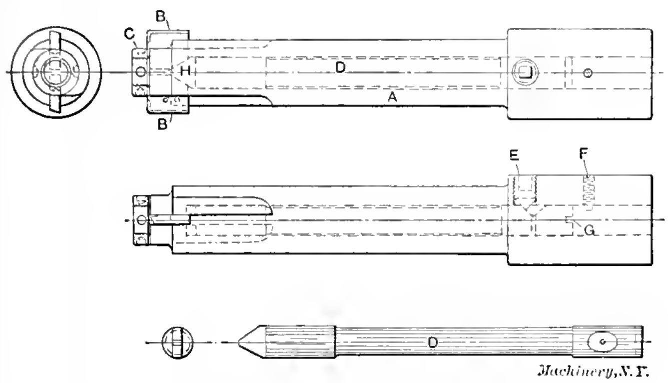


Fig. 1. Boring-bar with Adjustable Cutters.

by whom I was employed at the time as head tool-maker. He was very much pleased with it, and had me make up different sizes of cutters at once. The bar is still in good working order and does not show any great wear. A bar of somewhat similar construction, which was designed by one of the men under me, is shown in Fig. 2. This bar is a great deal cheaper and easier to make than the bar shown in Fig. 1, but does not prove so satisfactory in some respects. Referring to Fig. 1, bar *A* is made from a piece of machine steel. A hole for plunger *D* is drilled and reamed, the hole being bottomed out with a square-nosed drill. This may not seem practical, as in drilling long holes the drill is very liable to run off,

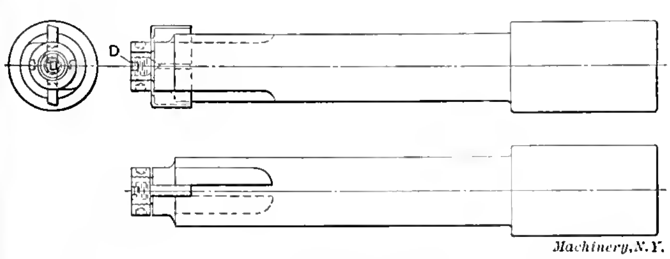


Fig. 2. Bar with Cutter Adjustment, but of Simpler Construction than the One shown in Fig. 1.

but in this case that does not make any material difference, as plunger *D* is all fitted in place before the cutters *B* are turned. Binder collar *C* is screwed firmly against the cutters *B*, and the bar is then put in the lathe and the cutters turned to size while in position in the bar. One cutter should be marked, so that each cutter can be placed back in the bar in the same position, making it impossible for them to be out of true, regardless of the location of the plunger hole. Binder collar *C* is made from machine steel, and case-hardened. The included angle of plunger *D* at *H* is 60 degrees. The maximum adjustment of the cutters is about 3/16 of an inch. This adjustment is accomplished by screwing the plug *E* against the conical surface of the plunger *D*, which forces the plunger against the cutters *B*, spreading them apart. Screw *F* is merely to keep the plunger from dropping out of place, in case screw *E* should be backed out too far. Screw-driver slot *G* is merely put in to aid in the assembling of plunger *D*. In setting cutters *B*, binder collar *C* should be tightened slightly by means of a spanner wrench, until after the cutters have been set to the proper size. One of the advantages that this bar has over the bar shown in Fig. 2, is that the adjustment screw *E* is always out of the way of the work and can easily be adjusted whether cutters be in the bore or out. The cutters of the bar shown in Fig. 2, are held in the same manner as in Fig. 1, but they are adjusted by means of the adjustment screw *D*, which is screwed in or out with a suitable wrench. One bad feature in connection with the bar shown in Fig. 2 is that the adjustment screw *D* sometimes jars loose and works out, but even then the binder collar *C* holds the cutters so firmly that I have never known them to move. These bars have both been in use on a 34-inch Colburn boring mill where there is lots of power to give them a hard test. The cutters used are made of high speed steel. B. M. WELLER.

Franklin, Pa.

MAKING PISTON RINGS.

The method here described of making piston rings is used with good results in a shop building first class gas engines. A common ring blank having three lugs on one end is jig drilled, and secured with three cap-screws to a turning plate which has a number of tapped holes for the different size ring blanks. This turning plate is clamped to the chuck face with three clamps, and after the blank is turned outside, the plate is given one-half turn on a chuck bushing the plate end of which is turned 1/32 inch eccentric to chuck end. A stop-pin hole is drilled in the plate, which is used when the plate is revolved one-half turn after turning blank. The blank is then in position for boring. The bushing on which the plate turns is a driving fit in the bore of the chuck of a turret lathe (in this case a "Gisholt"), and this bushing is bored to take a stiff cutter bar. Two cutters are used in boring, one for roughing, and the other for finishing the bore of the blank to size. The bushing and chuck are marked plainly so that the bushing will always be driven in the chuck with the eccentric in the same relation with the stop pin hole in the turning plate.

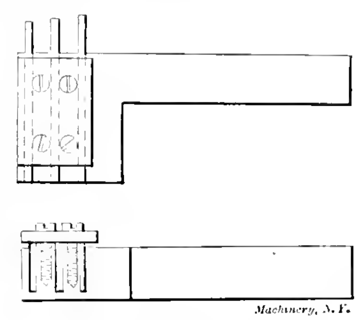


Fig. 1. Gang Tool for Cutting Off the Rings.

A gang cut-off tool is made, as shown in Fig. 1, and the rings are cut off 1/32 inch wide to allow for side finish. An expanding arbor (Fig. 2) and a straddle tool (Fig. 3) are used in facing the rings to size. A standard snap gage is used to keep the rings to a standard width. A straddle tool for each width of ring should be made so that readjusting on

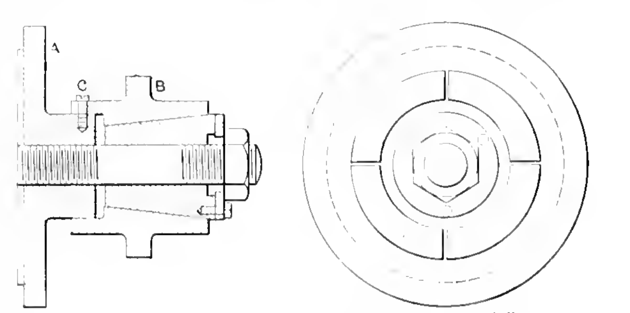


Fig. 2. Expanding Arbor for Holding the Rings while Facing them.

each size of ring will not be necessary. An almost incredible number of rings can be faced without regrinding when high speed steel bits are used. The expanding arbor plate *A* is secured to the face-plate of an engine lathe with three screws. The expanding sleeve *B* is held loosely to hub of plate by three screws *C*. These hold the expanding sleeve while drawing out the taper plug, and they also keep the bushing in the same position so that the ring to be faced will always

be central with the straddle tool. The sleeve is made in the usual way, one side being milled through with a milling saw, and a number of other slots being milled from both ends to within about ⅜ inch of the opposite ends. Almost any size sleeve can be made for this plate and arbor.

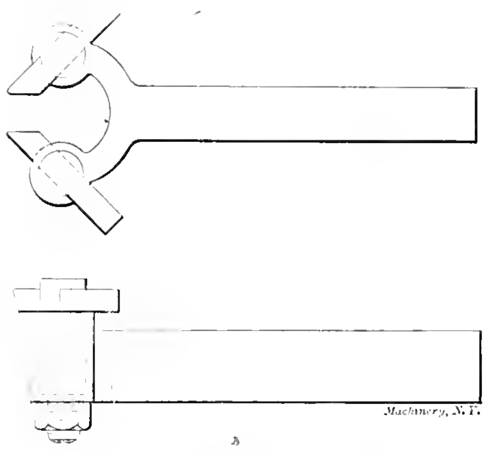


Fig. 3. Straddle Tool for Facing the Rings.

In Fig. 4 is shown the fixture used in milling the lap joint. The block *A* and clamp *B* are made to correspond with the outer and inner curvatures of the ring, the clamp having a flange to clamp down on the edge of the ring. The other end of the clamp is beveled to fit the block *C*. When the eccentric

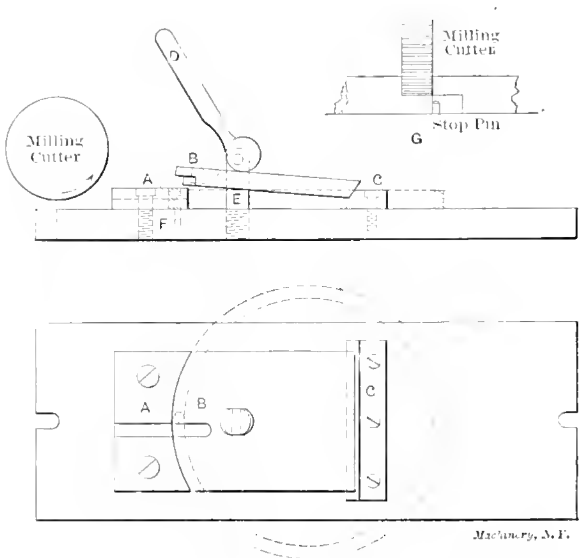


Fig. 4. Fixture for Holding the Rings when Milling the Lap Joints.

lever *D* is forced down, the clamp will hold the ring down and against the block *A*. The position of the ring is shown in Fig. 4 by the dotted lines. A coiled spring under the clamp *B*, and around the stud *E*, will raise the clamp so that the ring can be removed easily. After the rings are milled on

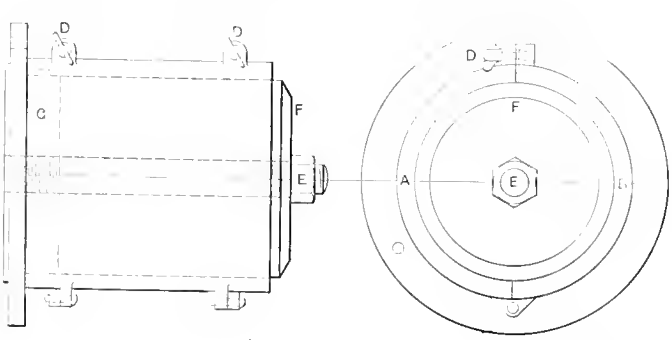


Fig. 5 Fixture for Holding the Rings when Finishing the Outside.

one side they are turned over, and the milled slot is set against a stop pin *F* which is inserted in the bottom plate. This stop pin sets the ring so that the cuts are taken as indicated at *G*, and a lap joint is formed when the rings spring together. A number of blocks and clamps can be made to use with rings of different sizes. The rings are now ready to be finished on the outside. The device shown in Fig. 5 is used in connection with this operation, and it is also secured to the face-plate. This device consists of a sleeve having two parts, *A* and *B*, these being connected with a hinged joint. The rings are placed inside this sleeve, and it is clamped to the plate *C* by the thumb screws *D*. The rings are then clamped to the plate by the nut *E* and plate *F*. The hinged sleeve is removed and the rings are turned to size.

Y. Ziegler.

TECHNICAL EDUCATION FOR MACHINISTS.

In this age of intellectual progress, one cannot help wondering at the comparative backwardness of the rank and file, engaged in mechanical arts, in acquiring technical knowledge pertaining to their vocations. Although technical knowledge is a rather broad term, it is generally applied to such knowledge as involves the fundamental and derived principles of any branch of industry, and upon which principles the evolution of any industry must be based. It can no longer be argued that the general lack of technical knowledge among machinists is due to absence of opportunity. Every large industrial center has institutions which offer every facility for technical education; and such facilities are in almost all cases available for persons for the mere asking, or at a minimum nominal cost.

It is manifestly impossible for every machinist to have had the benefits of a course of study in a technical school. Nearly every machinist starts to learn the trade at the average age of sixteen years. The knowledge he starts out with is rarely more than that acquired in the grammar school. Indeed, a canvass among the apprentices of any large plant would very likely show that not more than one-half have even graduated from the public grammar school or its equivalent. It is only in rare cases that a young machinist is found who is steadily pursuing a systematic course of technical study. Investigation will generally prove that those who do, have had the early advantage of better education, probably a few years in high school, which, no doubt, has given them the impulse to learn more.

In Greater New York, as well as in all larger cities, the Board of Education maintains a splendid system of evening schools of all grades. Here anyone can make up any deficiency in education due to lack of early opportunity. Instruction in these schools is absolutely free, including even the free use of text-books and supplies. The instructors are very often men who during the day teach in the best engineering and trade schools, and also men who hold important and responsible positions in the engineering professions. The correspondence schools also offer splendid opportunities for acquiring knowledge, although the scope of the knowledge they impart is necessarily somewhat limited on account of the impossibility of personal association between instructor and pupil. There are also the free public libraries whose shelves hold the best books on technical science. The Pratt Institute free library of Brooklyn has a splendid science reference room in which are kept current numbers of numerous industrial and technical periodicals, as well as complete reference libraries of every science and industry. This department could easily accommodate many times the number of persons who now regularly make use of it. It seems as though young men were needlessly starving in the midst of plenty. Although the democracy of education has been made practicable, how few there are who have thus far taken advantage of it. What valuable suggestions for mechanical improvement might come from machinists who can think with the precision acquired by a systematic course of technical training, and who have developed the capacity for keen observation during their daily work. Many large concerns have recognized the value of such training in their employes by maintaining regular schools, in which every apprentice receives, as far as practicable, a thorough technical training, aside from his regular shop instruction. In many cases these apprentices advance to responsible positions in these concerns. While it is true that the technical schools are graduating large numbers of young men as mechanical and electrical engineers, it is

equally true that these men are more or less handicapped by a lack of thorough shop training. The ambitious mechanic need not therefore fear much from the competition of college graduates if he is himself well equipped in technical knowledge. Of course, one cannot expect every machinist apprentice to become an expert mechanical or electrical engineer. There are, however, many men engaged in the trade who, if they followed their natural bent, and took advantage of some of the many educational opportunities, would develop into men who would eventually play an important part in the progress of the machine industries. F. WALSLEBEN.

Brooklyn Hills, L. I.

SIMPLE COST SYSTEM FOR SMALL SHOPS.

A great number of small shops, especially jobbing shops, use no cost system. It is then, very often, a part of the foreman's task to keep the record of the time and the materials needed to carry out the work. This may be easy to do when many of the same kind of pieces are required, but, when thirty men are working on several jobs, repair jobs for instance, the foreman's task may prove to be too heavy. It is obvious that under such conditions the exact cost and profit of a job are seldom known. The writer has had many occasions to note the big differences between the apparent and the real costs, and these differences indicated the necessity of a cost system even in the smallest shop. The one here illustrated was devised for, and has been for several years in use in, a jobbing shop employing about fifty men.

An order, Fig. 1, is sent from the office to the foreman for every job. Full details of the work to be done are given,

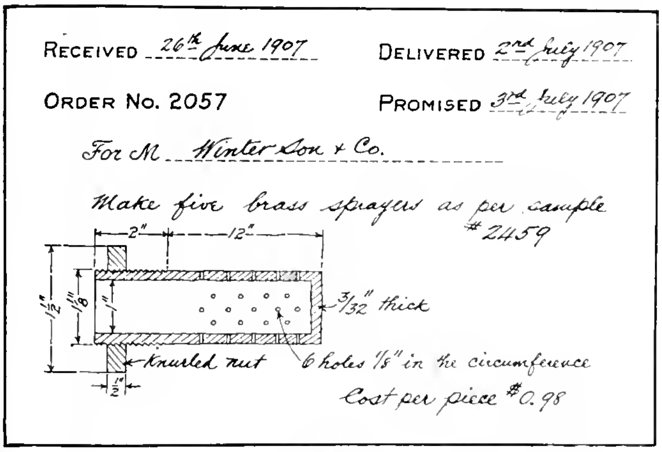

RECEIVED 26th June 1907 DELIVERED 2nd July 1907
ORDER No. 2057 PROMISED 3rd July 1907
For M. Winter Son + Co.
Make five brass sprayers as per sample #2459

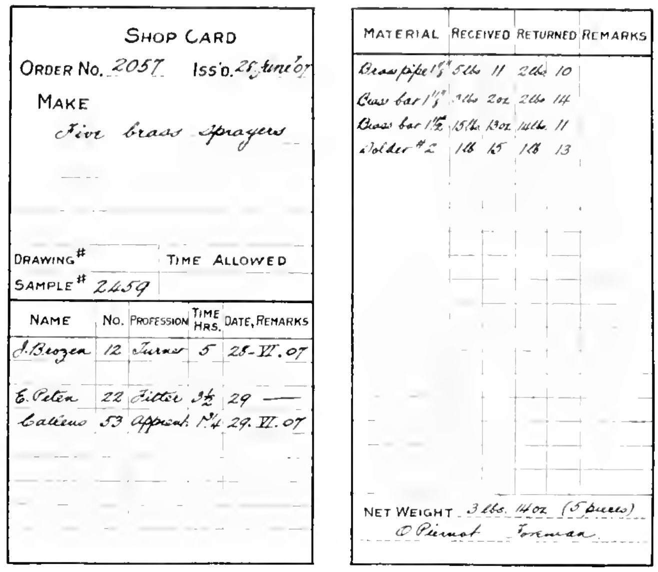
Fig. 1. Order for Foreman, giving Details of the Work to be Done.

indicating numbers of drawings, sketches or samples, if there are any, in short, everything that will furnish a ready reference in the future. The foreman notes in a special book the date order is received and the name and address of the customer. When the work is ready, he notes on the same line in his book the date of delivery. Every day the new orders are recorded, and the finished cancelled. Once in a month the whole is rewritten. Patterns, castings or special materials are ordered by the office according to the foreman's directions.

A shop order, Fig. 2, is given by the foreman to the workman for every piece or series of pieces to be made in the shop. All material wanted is applied for in the store-room. The storekeeper notes on the back side of the shop-card the kind and quantities of the materials used. When the work is finished the workman writes down, as shown in Fig. 2, his name, shop number, and the time devoted to the work.

The shop card, Fig. 2, was issued for the office order, Fig. 1, and a glance at both will show nearly everything in regard to the system. As will be seen, the work was first handled by the turner and then by the fitter. Finally a boy polished the finished sprayers, and delivered the work and the card to the foreman, who saw thus at a glance everything concerning the cost of the job. The net weight of material is marked upon the card which is then sent with the office order to the office, where special expenses and general charges are added. Finally, the cost and the date of delivery are marked upon the orders and they are filed.

Some orders require more than one shop card; for instance, to bore a 22-inch cylinder true, put new spring rings in the piston, true up the piston rod, and put new bronze bushing on the stuffing box. Four shop cards are then made, one for every part of the job, so that the cost of every detail is known. Nothing in the shop is done without an order, and not an hour is spent at a job without a shop card.


SHOP CARD

ORDER No. 2057 ISS'D. 28 June 07

MAKE

Five brass sprayers

DRAWING # TIME ALLOWED

SAMPLE # 2459

NAME	No.	PROFESSION	TIME HRS.	DATE, REMARKS
J. Brozen	12	Turner	5	28-VI.07
E. Peten	22	Fitter	3½	29 —
Callens	53	Apprent.	1¼	29.VI.07

MATERIAL	RECEIVED		RETURNED		REMARKS
Brass pipe 1⅛"	5 lbs	11	2 lbs	10	
Brass bar 1⅛"	3 lbs	2 oz	2 lbs	14	
Brass bar 1½"	15 lbs	13 oz	14 lbs	11	
Solder #2	1 lb	15	1 lb	13	

NET WEIGHT 3 lbs. 14 oz (5 pieces)

O Pierrot Foreman

Fig. 2. Workman's Shop Order on which Data are Recorded as shown.

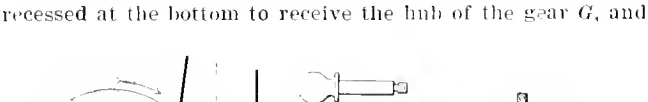
The management of the shop and the accountability of the business becomes much easier by the introduction of this system, which has proved to be quick, simple and economical.

Antwerp, Belgium. CHAS. ROELS.

BALL GRINDING FIXTURE.

Once, when employed by a firm engaged in the manufacture of printing presses, an occasion arose for making certain details, having a ball point as shown in Fig. 1 in the accompanying engraving. These balls had formerly been turned and then lapped with emery, but it was concluded that, by a proper fixture, these balls could be produced in a simpler way by grinding to the finished shape, after rough turning. The device shown was used on a Brown & Sharpe universal grinding machine.

Referring to Fig. 2, the frame A is made of cast iron, provided with a hole bored to receive the bolt B. The frame is recessed at the bottom to receive the hub of the gear G, and a



Figs. 1 and 2. Sample of the Work, and Fixture for Grinding the Ball Point on a Universal Grinder

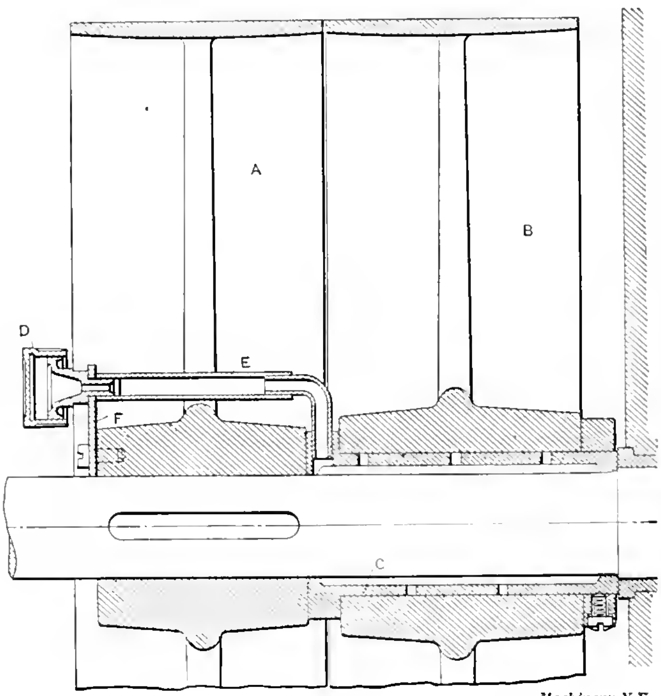
projection on the bottom of A is turned to a running fit in the cast iron plate P, upon which the fixture is mounted. A hole forming a bearing for the sleeve S is bored in A in the same plane as, and exactly at right angles to, the bolt hole B. A pulley R is mounted on the sleeve S, and keyed to it. This pulley is driven by a belt from an overhead pulley, causing the ball to revolve on its longitudinal axis. The wrought iron brackets or straps E are forged and support the fixture. They

are bolted to the sides of the bed, and are set so as to allow a slight clearance between the spur gear G and the table of the grinder. The rack M is fastened to the table, and is in the right position to engage with the spur gear G, and as the table is driven back and forth it carries the rack with it, which drives the spur gear, producing a rotating motion for the frame A, causing the ball to rotate on its perpendicular axis. Now, as the ball rotates on the perpendicular axis and has a revolving motion on its longitudinal axis, it is plainly seen how the ball is ground. This fixture gave good satisfaction in the shop where it was used. W. A. SAWYER.

Athol, Mass.

DEVICE FOR OILING LOOSE PULLEYS WHICH ARE INACCESSIBLE FOR ORDINARY OILING DEVICES.

When a loose pulley is placed very close to the frame of the machine, as is the case with the loose pulley shown in the accompanying engraving, the question of oiling the loose pulley may offer difficulties, and in dusty places sometimes cause disturbances in the running of the machine.



Section through Tight and Loose Pulleys showing Method of Oiling.

The oiling of loose pulleys mounted in this way, however, can easily be accomplished by the use of the device shown in the engraving. The loose pulley B is mounted on a bushing, which in turn is keyed to the shaft. In this bushing an oil reservoir is provided which is connected with the inside surface of the bore of the loose pulley by a number of small perforations. The oil cup is fastened to the tight pulley on the side where there is no difficulty of access. The oil cup is then connected with the oil chamber in the bushing by a small bent pipe as indicated in the engraving. By arranging this oiling device on the drive of a vertical gang saw, the disturbances in operation, on account of the bearing of the loose pulley running warm, were entirely eliminated.

Pilsen, Austria-Hungary. MORITZ KROLL.

PUZZLING ARITHMETICAL EXPRESSIONS.

It seems as if the mathematical rules for simplifying an expression like $10 + 4 \times 5$ are not well known among mechanics. The general idea is to solve in succession, instead of regarding the manner in which the expression is connected by the signs, $+$, $-$, $\times$, and $\div$. Mistakes are therefore commonly made. It surprised the writer to find that in a shop of about 300 men there were only two men who were sure that the correct answer to the expression $10 + 4 \times 5$ is 30, and this was in a shop with men of average intelligence. Most of the men got the result 70. The reason why the result of this expression is 30 instead of 70 is that the signs $\times$ and $\div$ take precedence over $+$ and $-$ in mathematical calculations. However, in no text-books that the writer has been able to obtain has this rule been given in plain words, although all the examples have been worked out according to this rule.

New Britain, Conn. D. W. JAMES

[In order to make the expression containing the numbers and signs mentioned in our correspondent's example equal 70, it would be necessary to put a parenthesis around the expression $10 + 4$; that is, $(10 + 4) \times 5 = 70$. Otherwise, the multiplication should be carried out before the addition, and the result will be 30. If, instead of treating this little problem as an arithmetical one, we transform it into algebraic form, the reason for this rule is very obvious. If we substitute a for 10, b for 4, and c for 5, we have $a + b \times c$, or, as it is commonly written, $a + bc$. A glance at this expression shows at once that b is to be multiplied by c before the result of the multiplication is added to a. If it is required to add a to b, and then multiply by c, the expression would have to take the form $(a + b)c$. If we insert the mathematical values for a, b and c in these two expressions, we get 30 and 70 respectively, as before, and we have a valid mathematical proof, as well, for our rule.—EDITOR.]

LOCKING DEVICE FOR JIGS.

Quite often drill jigs have a bushing plate in the form of a leaf which swings on a hinge out of the way so that the piece to be drilled can be put in place in the jig. This requires a locking device which can be depended upon to hold the bushing plate exactly in place while drilling. The locking device shown in Fig. 1, and also shown applied to a jig

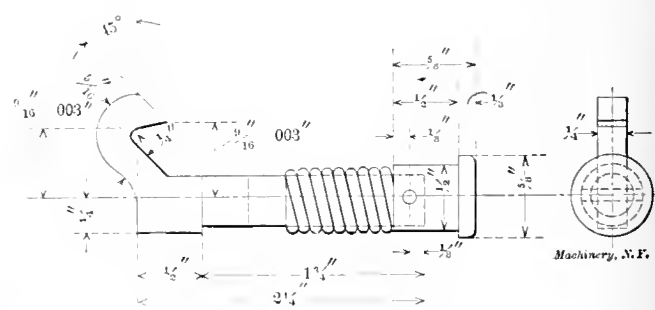


Fig. 1. Detail of Locking Device.

in Fig. 2, answers this purpose admirably, and after using a number of different designs I find the one shown here to be by far the best I have ever seen. To open the jig so as to put in the piece to be drilled, all that is necessary to do is to push the button on the end of the lock trigger and lift the leaf up. When the piece is in place in the jig, the leaf is again pressed down into place. The pressure springs the locking device, and the trigger grips the pin shown. The part

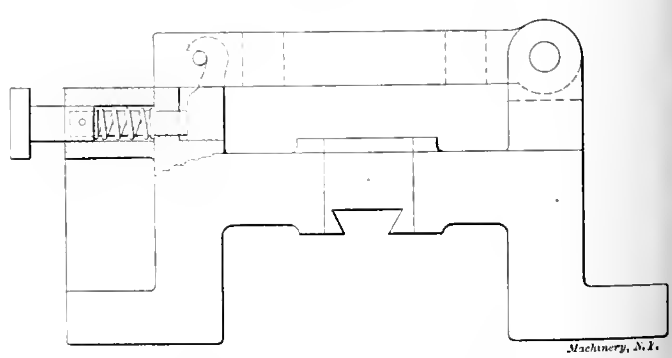


Fig. 2. The Locking Device applied to a Jig.

of the trigger which fits against the pin should taper slightly. This makes it hold much more tightly, and also takes up what little wear there may be on it. The device can be fitted to a great variety of jigs and fixtures. It is very simple and inexpensive to make, and above all, it is quick and simple to operate, positive in its action, and will last the lifetime of any jig without repairs. TOOL DESIGNER.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

SUBSTITUTE FOR STEADY-REST.

Under the head of "Shop Kinks" in MACHINERY I have a suggestion to make. A very good substitute for a follow-rest or steady-rest, and one which can be used in a great many cases where a steady-rest is troublesome, for instance on small shafts which are too long to turn without chattering unless a steady- or follow-rest is used, consists of a wooden block, say 4 inches square and of sufficient length to reach from the back side of the carriage to the shaft being turned. The block should bear on the shaft a little ahead of the cutting tool and its weight will prevent chattering to a very great extent. JOHN MCLEOD.

Birmingham, Ala.

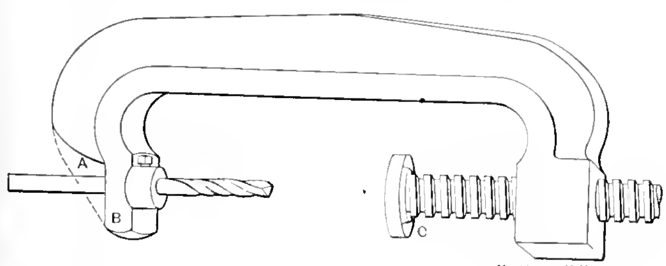
KINK FOR LINING.

I have seen several devices for section lining, but find the following very satisfactory: Take a bow pencil and set the needle point about one-sixteenth short of the pencil point, which should be sharpened to a chisel point; then set the bow pencil to the correct distance between the section lines wanted. Draw your first line with the pencil point next your triangle; your needle point will gage the width of lines and should not touch the paper but simply act as a guide for the eye. The bow pen can be used in the same manner. I do not claim this to be original, and some of the readers of MACHINERY may already be familiar with this method, but I have worked in some of the largest drawing-rooms in the country and have not known of this method being used.

TRIANGLE.

SIMPLE PORTABLE DRILL.

The quickest and simplest method of constructing a portable drill is by taking a large clamp, cutting out a part of the web, as shown at *A* in the accompanying engraving, and then drilling a half-inch hole through the upper jaw *B*, through which hole the drill may be passed. Then a collar with a set-screw is made, which is placed on the tool shank, the collar bearing against the inside of the upper jaw. For turning the



drill a chuck may be used with a bit stock, or a crank may be made provided with a set-screw for clamping the drill, which will serve the purpose equally well. The feeding is done by the clamp screw *C*. This style of drill may be used in numerous places where no other device could be applied; and if the clamp is wanted for clamping purposes, it may still be available for that purpose. G. M.

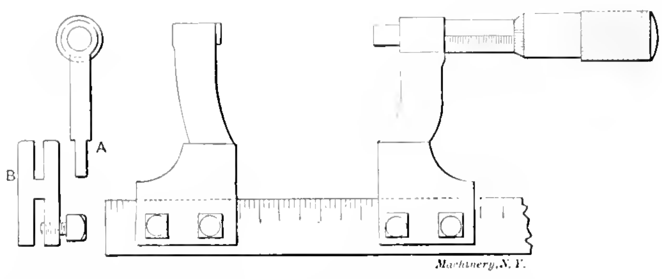
APPLYING LEATHER FILLETS TO PATTERNS.

It is very common to see a notice on the tags, attached to bundles of leather fillets, "Use plenty of good glue." Glue, however, is a bad thing to use for applying leather fillets to patterns, because the moisture from the wet sand penetrates the thin edges of the leather and makes them curl away from the patterns when glue is used. The best adhesive to use for leather fillets is the regular orange shellac used in varnishing patterns, excepting that the shellac used should be quite thick. A sufficient amount of fillet for the work in hand is given a coat of shellac on the inside, and the same is done with the corners of the patterns which are to receive the fillets. Repeat this operation about three times, allowing two or three minutes between the coats, so that the varnish may soak in. After applying the last coat, place the leather fillet in position and rub it into place with a round stick of suitable size to correspond to the radius of the fillet. Proceeding in this way, the result will be far more satisfactory than when using glue, and the fillet will be practically water-proof. J. W. WOLFENDEN.

Nashville, Tenn.

MICROMETER SCALE.

I have been using the micrometer, mounted as seen in the illustration, for some time, and I don't see how I could get along without it now. I use the micrometer on a 4, 6, 9, or 12-inch scale. It can be adjusted on standard plugs. I have made a set of gages up to 12 inches, out of 3/16-inch round tool steel wire. In mounting the micrometer, before cutting

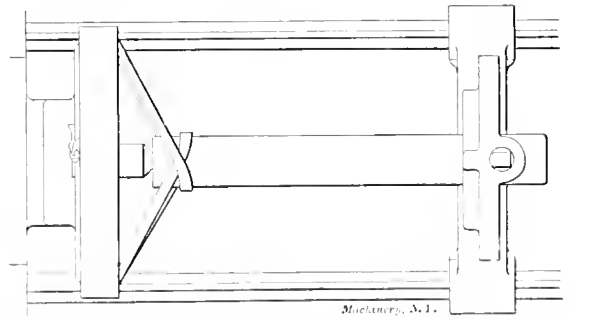


it apart, I milled the shoulders shown at *A*, and in milling the bottom pieces *B* used a piece of machine steel long enough for both, cutting the piece in halves after milling the slots. In this way I was sure of perfect alignment. In a shop where they do not keep a set of micrometers, this arrangement is very handy. WM. AINSCOUGH.

Plainfield, N. J.

USE OF THE STEADY-REST.

I have noticed that some men who claim to be tool-makers do not know how to make the best use of a steady-rest, and others seem to have very crude ideas about using it. A great many men use a chuck for holding one end of the work, even when it has centers in it. Of course, the work has to be trued up in the chuck, and this is a very difficult operation, although a very common one. A test indicator is almost indispensable for a job that requires accuracy. I never use a chuck unless the work is without centers. I always strap my work to the face-plate with a strip of belt lacing, and this method has proved very satisfactory. Two 3/4-inch holes are drilled in the face-place at right angles to the driving-slot, and opposite each other. Then the work is placed between the centers, and the jaws of the steady-rest adjusted to it. The face-plate is then unscrewed a few turns, and the leather strap is wrapped around the work from one side, and the two ends of the strap passed through one of the holes in the



face-plate. One end of the strap is then passed back through the opposite hole in the face-plate and around the work from the other side. The ends are then tied together, and the face-plate is screwed onto the spindle, which causes the strap to tighten and draw the work against the center as shown in the engraving. Work can be done in this way accurately and quickly. I never use wooden or fiber jaws unless a steady-rest is equipped with them. If the work has a finish, a strip of emery cloth with the cloth side next to the work will protect it, and keep it from being marred. J. J. VOFTEKER.

Decatur, Ill.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

DRILLING DEEP HOLES.

A. L. B.—What is the average time required for drilling small deep holes, say, from ¼- to ½-inch diameter and 20 to 30 inches deep, where special appliances are provided?

A.—The only drilling of this nature of which we have any record is gun barrel drilling, and the figures given below were taken from the records of a large concern, three or four years ago. Since then we understand the speed has been considerably accelerated, especially on 22-caliber barrels.

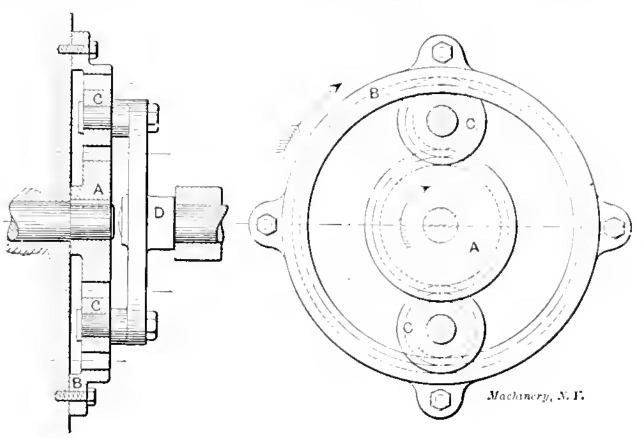
Caliber, inch.	Length, inches.	Time, minutes.	Driller's Daily Production.
0.22	24	48	120
0.32	24	34	130
0.38	24	24	140
0.44	24	24	140

The above figures are for low carbon steel. Nickel steel barrels require from 5 to 7 minutes longer.

EPICYCLIC GEARS.

L. A. F.—I desire to construct an epicyclic mechanism of the kind illustrated in the accompanying sketch. *B* is a stationary internal gear, *A* is the driving spur gear, and *C* two intermediates connecting *A* and *B*. These intermediates are mounted on pivots carried by disk *D*, which is keyed to the driven shaft. *A*, driving, makes 1,140 revolutions per minute; internal gear *B* has 62 teeth; how many teeth should gears *A* and *C* have to give *D* 690 revolutions per minute?

A.—A simple way to analyze a case of epicyclic gearing like this is to find, by the following method, how many revolutions *A* makes to one of *D*. In the sketch, *B* is shown held to the frame of the machine by cap screws. Remove these cap screws, and revolve the whole mechanism (with gears *A*, *B*



and *C* locked so that they do not turn on each other) in the direction of the arrow, for one revolution. This, of course, will revolve both *D* and *A* one revolution each. If the gears be now unlocked, and *D* be held stationary while internal gear *B* is revolved back again (in the direction opposite to the arrow) to the position it originally occupied, this movement will still further revolve *A* in the direction of the arrow, and will leave the mechanism in the same condition it would have been in had *B* remained fixed to the frame of the machine, and while *D* was revolved once in the direction of the arrow. If we can find, then, how many revolutions *A* makes in the operation we have just been through, we will know how many revolutions it makes for each revolution of *D* while the mechanism is in operation.

In the following analysis, these reference letters are used:

N_a = number of teeth in *A*
N_b = number of teeth in *B*
M_a = revolutions per minute of *A*
M_d = revolutions per minute of *D*

In revolving *B* in the direction of the arrow for one revolution with the gears locked, *A* evidently makes one revolution. In returning *B* to its original position with *D* locked, the number of revolutions *A* makes is evidently found by dividing the number of teeth in *B* by the number of teeth in *A*, since *C* acts merely as an idler under these conditions and does not affect the ratio. The sum of the two movements thus effected, gives the number of revolutions of *A* to one revolution of *B* when the mechanism is working. We have then

$$\text{revolutions of } A\text{, mechanism locked} = 1$$

$$\text{revolutions of } A\text{, returning } B \text{ to position} = \frac{N_b}{N_a}$$

$$\text{revolutions of } A \text{ to 1 revolution of } D = 1 + \frac{N_b}{N_a} \qquad (1)$$

The desired number of revolutions of *A* to one revolution of *D* is evidently found thus:

$$\text{revolutions of } A \text{ to 1 revolution of } D = \frac{M_a}{M_d} \qquad (2)$$

Making (1) and (2) equal to each other, we have the following equation:

$$\frac{M_a}{M_d} = 1 + \frac{N_b}{N_a}$$

This solved for N_a gives us $N_a\left(\frac{M_a}{M_d} - 1\right) = N_b$

$$N_a = \frac{N_b \times M_d}{M_a - M_d} \qquad (3)$$

which is the formula for finding the number of teeth in gear *A*, under the conditions proposed by our problem. Solving this formula for the figures given, we have

$$N_a = \frac{62 \times 690}{1140 - 690} = \frac{42,780}{450} = 95 +$$

which is evidently absurd, since it is impossible for *A* to have more teeth than *B*, the internal gear which surrounds it, both being of the same pitch. No mechanism of this sort will give *D* as much as half the number of revolutions per minute that *A* makes. The larger gear *A* is, and the smaller intermediate gear *C* is, the nearer 2 to 1 will the ratio be. It can be done by using compound gearing in place of *C*, but very likely you would not care to go to that extent of complication; otherwise the problem is impossible. In solving problems by this formula it should be noticed that the difference between the number of teeth in *A* and the number of teeth in *B* must be an even number: and that half this difference will be the number of teeth for each of the intermediate gears *C*.

JIB CRANES.

H. E. R. How should the stresses and sizes of the members for the crane shown in Fig. 1 be figured? The load is 5 tons. Members are to be built up of two channel irons each side, back to back.

A.—The calculation of the size of the channels is one of trial and error largely, and would occupy too much space to give here in detail, so we will simply give calculations showing the maximum stresses in the members we have selected as suitable for use in the case in question, after having tried various sizes. As shown in Fig. 2, it seems best to use 15-inch 33-pound channels for the yard arm, and 12-inch 20½-pound channels for the mast and brace. The channels forming the mast should be latticed. The calculations given below do not consider any of the minor factors which enter into the problem, such as the weight of the beams themselves, the weight of the trolley, and the pull of the ropes. These factors would appear to be amply taken care of in the margin of strength given by the channels selected. The designer, however, should always make sure of this.

The following table gives the properties of the shapes we will consider in our calculations:

Depth of channel in inches........	15	12	10
Weight per foot in pounds........	33.0	20.5	15.0
A = area of section in square inches	9.90	6.03	4.46
r = least radius of gyration........	0.912	0.805	0.718
Z = section modulus, axis perpendicular to web..............	41.7	21.4	13.4

In addition to the reference letters given in the table above and in Fig. 2, the following will be used:

M = bending moment.
S_b = maximum fiber stress due to bending.
S_t = maximum fiber stress due to tension.
S = maximum fiber stress.

First find the maximum fiber stress due to bending at D in the yard-arm, when the load is at the extreme outer position E in Fig. 2.

$$M = Wc = 5,000 \times 60 = 300,000 \text{ inch pounds.}$$

$$S_b = \frac{M}{Z} = \frac{300,000}{41.7} = 7,200 \text{ pounds per square inch} \quad (1)$$

Note that W is only half the total load, since each member of the structure is composed of two channels, one on each side. The bending moment at D when the load is at B is found thus:

$$M = \frac{Wl}{4} = \frac{5,000 \times 96}{4} = 120,000 \text{ inch-pounds} \quad (2)$$

This being much smaller than in the previous case, it will give less than half the fiber stress. Unless there is some good reason for the design of framework adopted, it should be well to make ED about one-fourth of the length of DH. If this is done, the bending moment will be the same whether the load is at E or B, and, will in either case, be less than the maximum moment we have just found, so that a smaller section could be used.

The vertical reaction at D is found thus:

$$R_1 = W \times \frac{a}{l} = 5,000 \times \frac{13}{8} = 8,125 \text{ pounds} \quad (3)$$

This produces a tensile stress in DH which may be found by the parallelogram of forces shown in Fig. 2, or by the following calculation:

$$R_3 = R_1 \times \frac{l}{g} = 8,125 \times \frac{8}{12} = 5,420 \text{ pounds} \quad (4)$$

The stress per square inch in DH due to this force is:

$$S_t = \frac{R_3}{A} = \frac{5,420}{9.9} = 550 \text{ pounds per square inch} \quad (5)$$

Adding this to the stress found in (1) we have the total stress in DH:

$$S = S_t + S_b = 550 + 7,200 = 7,750 \text{ pounds per sq. in.} \quad (6)$$

which is the maximum fiber stress in the yard-arm, occurring just to the right of point D. This is well within the limit of safety, which may be taken as about 13,000 pounds per square inch.

The allowable fiber stress in the brace may be calculated from the following formula based on Rankin's formula for columns:

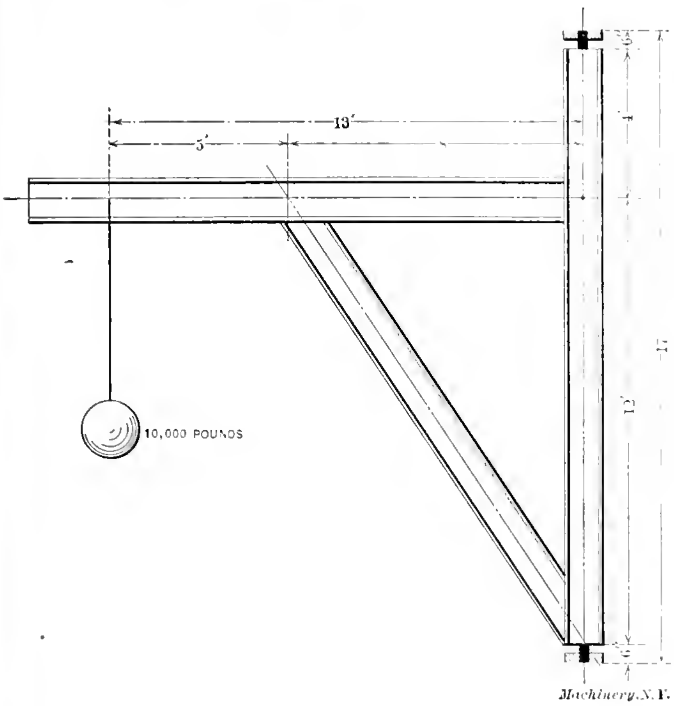


Fig. 1.

$$S = \frac{15,000}{1 + \frac{e^2}{13,500 \times r^2}} = \frac{15,000}{1 + \frac{173^2}{13,500 \times 0.805^2}}$$

$$= 3,395 \text{ pounds per square inch.} \quad (7)$$

The reaction producing compression in CD is found by the force diagram in Fig. 2, or by the following calculation:

$$R_2 = R_1 \times \frac{e}{g} = 8,125 \times \frac{173}{144} = 9,760 \text{ pounds} \quad (8)$$

The compressive stress per square inch in the brace is, then,

$$S = \frac{R_2}{A} = \frac{9,760}{6.03} = 1,620 \text{ pounds per square inch} \quad (9)$$

which is, as may be seen, not quite one-half the allowable amount. The ratio of the length to the radius of gyration ($e \div r$) in this strut is so great, being about 215, that it is wise to keep the unit compressive stress down to a very low point.

The mast is most liable to fail by bending at H when the load is at E. To find the bending moment at H, we must first find the horizontal reaction at G:

$$R_4 = W \times \frac{a}{k} = 5,000 \times \frac{13}{17} = 3,825 \text{ pounds} \quad (10)$$

The bending moment at H is then:

$$M = R_4 \times f = 3,825 \times 54 = 206,550 \text{ inch-pounds} \quad (11)$$

and the maximum fiber stress due to bending at this point is

$$S_b = \frac{M}{Z} = \frac{206,550}{21.4} = 9,650 \text{ pounds per square inch} \quad (12)$$

which is well within the limit of safety.

If the next size smaller standard channels had been used for these members, the results would have been as follows: A 12-inch $20\frac{1}{2}$-pound channel for the yard-arm would give a

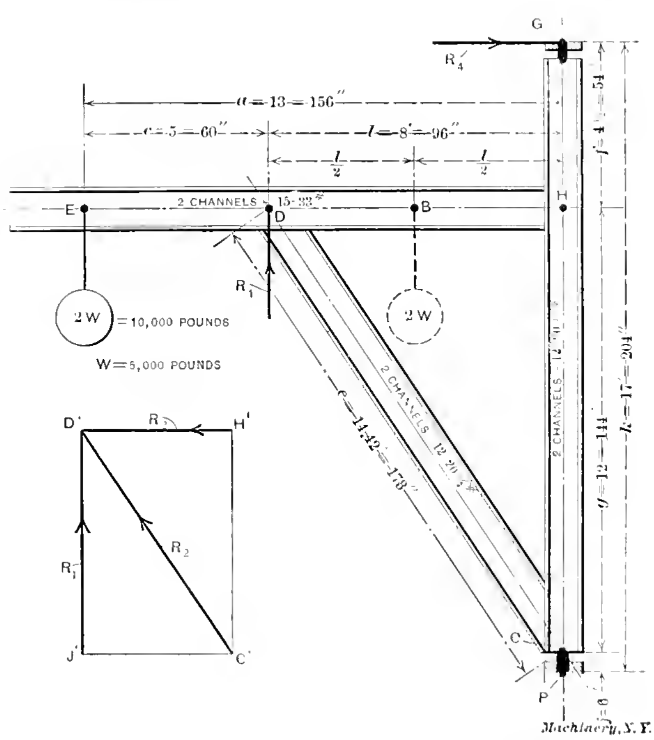


Fig. 2.

maximum stress at D of about 14,000 pounds, which is too much. The unit compressive stress in the brace, if made of 10-inch 15-pound channels, would be about 2,190 pounds. Rankin's formula for this would allow 2,830 pounds, but there is not enough margin of safety with the high ratio of e to r, which is here about 240. The maximum stress in the mast at H would be 15,400 pounds per square inch. It will thus be seen that the sizes we have selected are the commercial sizes best suited for the case in hand.

We expect to publish in a forthcoming issue of MACHINERY an exhaustive article dealing with jib cranes of this type, in which the matter will be taken up more thoroughly.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

QUICK CHANGE GEAR DRIVE FOR THE QUEEN CITY SHAPER.

The Queen City Machine Tool Co., Cincinnati, Ohio, has recently designed a positive speed changing mechanism for their 20-inch back-geared shaper, to take the place of the four-step cone previously used. This device has been designed with especial care, so that it will be simple, durable, effective and easily operated. The builders believe that they have so far accomplished their purpose, that the purchaser who desires to avail himself of the manifest advantages of the geared drive, may obtain them without running the risk of meeting the deficiencies which are found in many mechanisms of this kind.

The mechanism will be understood by reference to Figs. 2 and 3, which show in detail the mechanism seen applied to the shaper in Fig. 1. The single speed driving pulley at the left of Fig. 2 is keyed to the gear box shaft, which runs clear through the column to the gear box attached to the frame on the opposite side. At the right-hand end it carries a friction clutch, operated by the handle shown. The operation

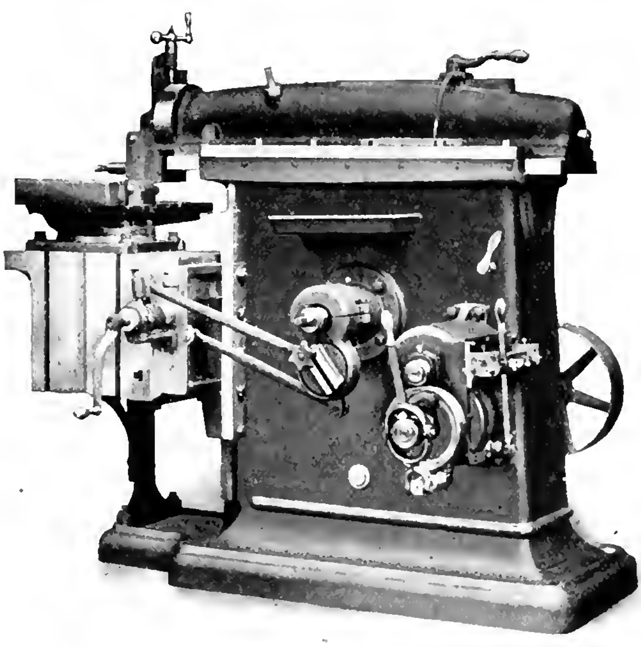


Fig. 1 Quick Change Gear Drive for Queen City Shaper.

of this clutch connects the shaft with a sleeve loosely mounted on it. It may thus be used for starting and stopping the machine, an overhead counter-shaft not being necessary.

The sleeve carries keyed to it a series of four gears of 21, 27, 32, and 38 teeth, respectively. On the driving shaft above the gear box shaft are keyed two sets of double gears, of 38 and 32, and 27 and 21 teeth, respectively. Though keyed to the shaft, these double gears are free to be shifted longitudinally, so that either one of the four gears in the sleeve may be engaged to its corresponding gear on the driving shaft, giving the latter the speed appropriate to the ratios of the driving gears in use at the time.

The mechanism for shifting the gears on the driving shaft is best seen in Fig. 3. The gear shifter lever is pivoted at the bottom on a universal joint, so that it may be moved in and out, or forward and back. Brackets attached to the rear of the gear box support the two sliding rods and the two fixed rods shown in the top view. When the gear shifter lever is tipped in toward the gear box, it lies between gear shifter No. 1 and the dog shown, both of which are fastened to sliding rod No. 1. The shifter lever may now be thrown toward the column or away from it, so that the 27- and 32-tooth gears may be engaged (see Fig. 2), or the 21- and 38-tooth pair. To engage the other set of gears, sliding rod No. 1 has to be brought to the central position shown, where it is held by a spring locking plunger; the shifter lever may then be swung past the fixed rods to operate sliding rod No. 2. The function of the fixed rods is thus to prevent the possibility of throwing two sets of sliding gears at once, by making it impossible to operate one set until the other has been moved to the neutral position. When the lever has

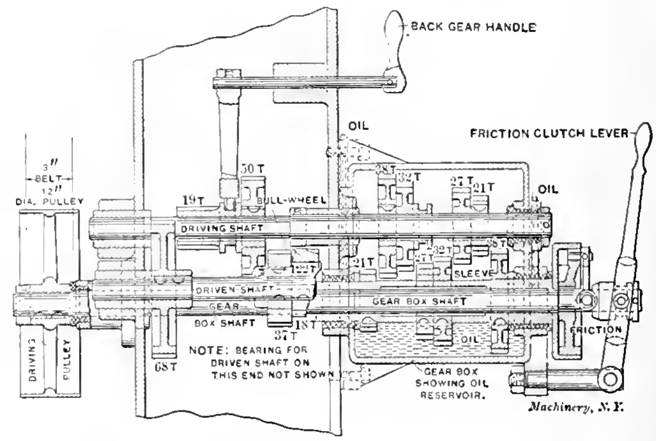


Fig. 2. Longitudinal Section through Driving Mechanism, showing Arrangement of Gearing.

been swung over to lie between the dogs on sliding rod No. 2, the gear shifter may be operated to bring either the 38- and 21-, or the 32- and 27-tooth combinations of Fig. 2 into action. The yoke shown, attached to a sliding rod No. 1, simply serves the purpose of preventing the rotation of that member, thus keeping gear shifter No. 1 in position, the yoke sliding freely on No. 2 for that purpose. Gear shifter No. 2 is kept in position from the fact that sliding rod No. 1 passes loosely through a hole in it, and thus supports it.

The four speeds obtained by the gear box are multiplied by two, giving eight in all, by the double sliding gear on the driving shaft inside the column, whose 19-tooth and 50-tooth members engage respectively with 68-tooth and 37-tooth gears, keyed to driven shaft shown, which also has keyed to it an 18-tooth pinion, engaging the bull wheel from which the ram

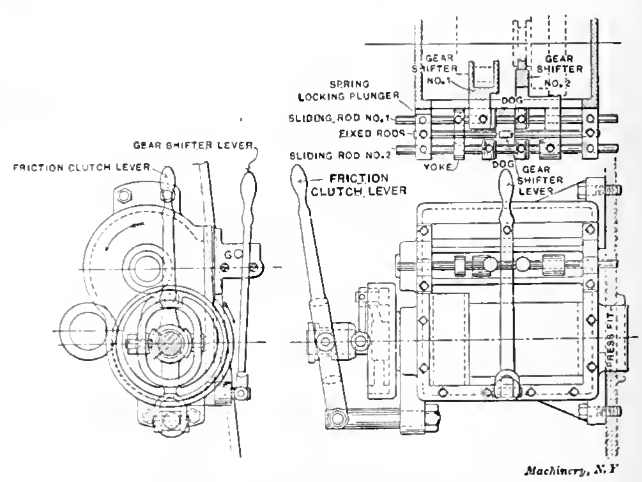


Fig. 3. The Arrangement of the Gear Box, and the Levere by which the Drive is Controlled.

is operated. This double gear is shifted, as plainly shown, by the back gear handle projecting through the side of the column.

The handles for stopping and starting the machines and making the eight speed changes are all located close together, as shown in Fig. 1, and the changes may be made almost instantaneously. The four gear box changes may be made in as many seconds. The clutch is disconnected for this purpose, so that the sleeve is free from the gear box shaft being driven by it only by the slight frictional contact of the bearings. The "selective" control, operated by the gear shifter lever, may then be used to obtain instantly any one of the

four speeds provided without going through the intermediate changes. The slow revolving of the telescopic sleeve permits the meshing of the gears at once, and since the load is off, no shock occurs, so that the change is as smoothly effected as with the cone pulley and the belt, although the power of the drive is very much greater than with the older arrangement.

The use in this mechanism of the principles which have become the standard for the automobile speed change devices will at once be recognized. The changes are made without the use of insecurely supported tumbler gears, or a multiplicity of clutches and levers. In the drawings, the clutches and all the gears are shown disengaged, and it will be noted that the length inside of the box is but slightly greater than the sum of the gear faces, so that the floor space required does not exceed that of a cone driven machine. The positive shifting of the gears and the arrangement of the rods, prevent the possibility of interference and insure safety and reliability. The gear box itself is a press fit in the column besides being firmly bolted to it. All parts are easily accessible for inspection without taking the box from the column. The gears all run in oil so that an efficient and durable action is assured.

When using a constant speed motor (for which this drive is especially suited) the changes can be made without stopping it. When the shaper pulley is belted to the line shaft, it should run at about 350 revolutions per minute on this size of machine. This gives cutting strokes of 7.2, 10.96, 15.4, 23.5, 34.8, 53.1, 74.7, and 114 per minute. An index plate aids in selecting the proper speeds.

EBERHARDT BROS. SMALL AUTOMATIC GEAR-CUTTING MACHINE.

Fig. 1 shows a front view, and Fig. 2 the rear elevation, of the smallest of the line of automatic gear-cutting machines made by Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J. This newly designed tool resembles somewhat its

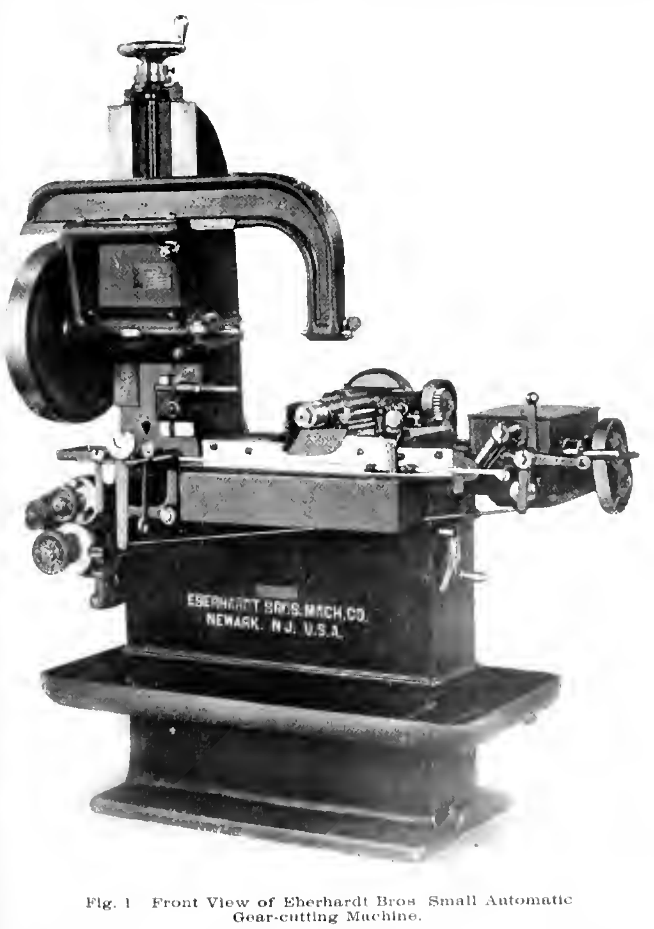


Fig. 1. Front View of Eberhardt Bros. Small Automatic Gear-cutting Machine.

predecessor, the combined spur and bevel gear cutting machine shown in "New Machinery and Tools" for July, 1907. The machine has the distinctive features of simplicity of construction and convenience of arrangement. These features are shown most prominently in the ribbed frame (see Fig. 2), doing away with the use of cores in the molding, and in the overhanging arm support provided for the work arbor. The result of these and similar provisions is an inexpensive and convenient machine for small work.

The machine is driven directly from the counter-shaft to the single speed tight and loose pulley shown in Fig. 2. This makes the use of a counter-shaft unnecessary. The indexing

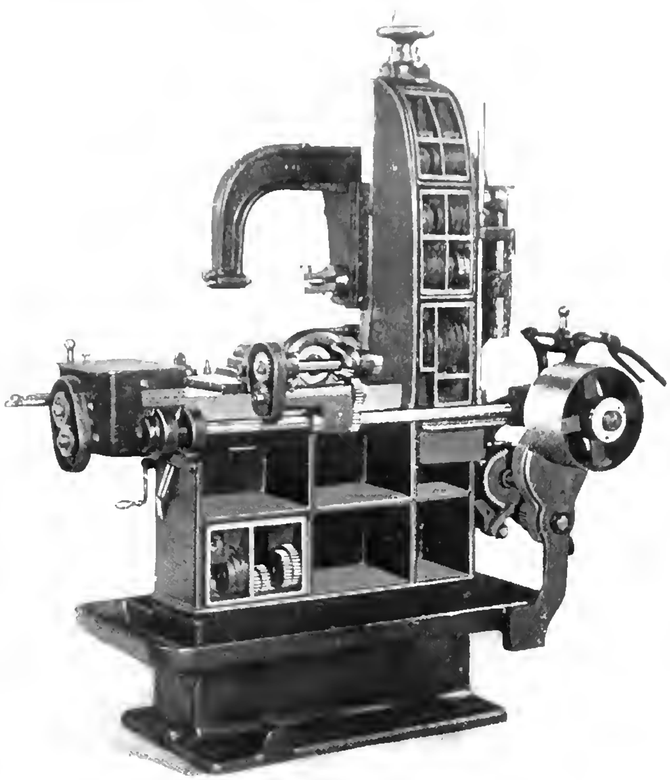


Fig. 2. Rear View of Machine, showing Spindle Drive, etc.

mechanism is connected to the shaft for this pulley by the gearing shown, while the cutter slide is driven through bevel gears and the long splined shaft running lengthwise of the bed. This splined shaft is geared to an intermediate shaft which is connected by change gearing (giving six rates of spindle speed) with the main bevel driving gear keyed to the spindle. This driving gear is of large diameter compared with the cutter, giving a strong, steady action to the latter.

The splined shaft from which the spindle movement is derived is continued forward to the feed box at the front of the bed, where is located the proper mechanism for automatically feeding the slide forward at a rate determined by the change gears provided (giving 8 changes) and quickly returning it at high speed to allow the work to be indexed and to commence a new cut. All these movements, as well as the control of the indexing, are positive.

The work arbors have tapered shanks, which fit the tapered hole in the steel work spindle. A bolt is provided at the rear of the work spindle for drawing in and forcing out the arbors without hammering. On most work, the overhanging arm shown is used to support the outer end of the work arbor. For work over 17 inches in diameter, for which the arm cannot be used, it is easily removed. A pair of centers and a dog driver are supplied, to be used for work similar to that of cutting a gear blank on a lathe mandrel, or the teeth of a pinion solid with a shaft.

This machine will cut gears as coarse as 8 diametral pitch in steel, or 6 diametral pitch in cast iron. It will thus be seen to be especially adapted to the cutting of change gears, and is used on this work in the shops of its builders, one machine being kept in continuous operation on change gears from 20 up to 6 diametral pitch. The machine is capable of being used for many odd jobs as well as for manufacturing, and has been especially designed to allow it to be quickly set up for work of various kinds. The operator can easily set the machine for any ordinary work in 15 minutes, and usually in much less time.

CINCINNATI AUTOMATIC GEAR-CUTTING MACHINE.

A new automatic gear-cutting machine of the orthodox type (such as shown in Figs. 21 to 28, in article entitled "Gear Cutting Machinery," engineering edition), has been placed on the market by the Cincinnati Shaper Co., Cincinnati, Ohio. Aside from the interesting points in the design and construction of this tool, which we will mention later, it is noteworthy from the fact that it is the first machine of its kind built in Cincinnati—a city which can claim to produce pretty nearly everything else required in the line of machine tools.

The main features in the design of this machine as may be seen in Figs. 1 to 4, are its simplicity and compactness, together with its rigid construction and the case with which it may be adjusted. The bed has been considerably shortened without decreasing the length of the cutter slide bearing, this being made possible by extending the cutter slide forward of the cutter spindle, so that it extends past the face of the column when at the forward extreme of its travel. It is gibbed with rectangular guiding surfaces instead of the usual dove-tail bearings, and has a long taper gib for taking up the wear. The same form of bearing and gib is used for holding the work saddle to the face of the column. In the case of both the work saddle and the cutter slide, the length of the guiding surface is much greater than its width, thus making any binding action impossible. This is particularly important in the case of the work saddle, since it prevents the work spindle and blank from dropping out of parallelism when the clamps are loosened for adjusting the work for the tooth depth. This fault, found in many gear-cutting machines, makes the micrometer reading of the screw practically worthless.

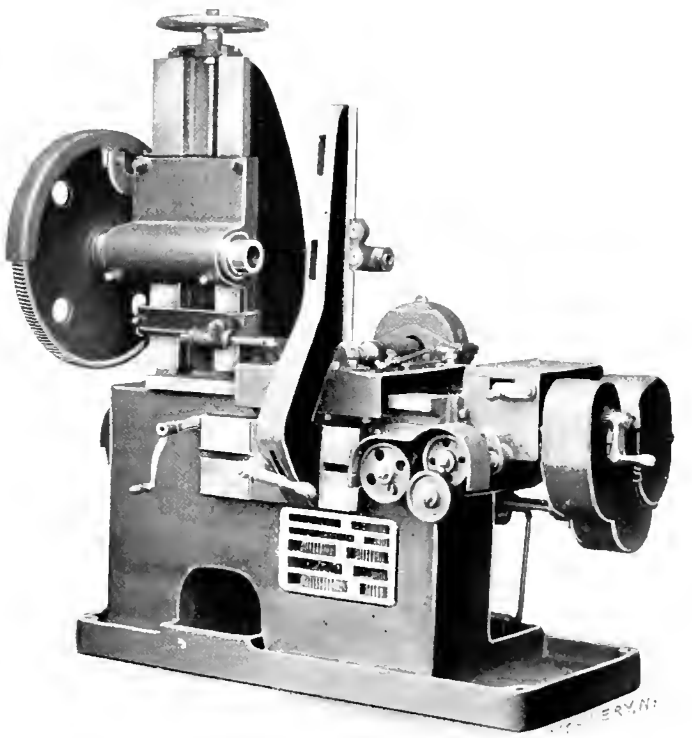


Fig. 1. Automatic Gear-cutting Machine made by Cincinnati Shaper Co

Both cutter and work spindles are of large diameter, are accurately ground, and are journaled in bronze bushings with provisions for taking up wear. The journal of the cutter spindle is adjustable endwise for centering the cutter to a gage furnished with the machine. The cutter spindle is driven by worm gearing provided with means for taking up the end thrust wear of the worm. The cutter end of the spindle has a No. 10 Brown & Sharpe hole for the cutter arbor, which is keyed to the spindle, and is drawn in or forced out by a threaded bolt. A removable bearing is provided for supporting the outer end of the cutter arbor.

All of the mechanism is driven from one single speed pulley *N* (see Figs. 3 and 4), the various changes for the feeds and spindle speeds, as well as the indexing, being obtained by change gears. Great care has been taken to provide short stiff shafts for the connections between the driving pulley and the spindle, so as to avoid torsional vibration in the members to which they transmit power. The driving pulley is connected by bevel gearing with a short shaft extending into gear box *O*. The swinging door, shown at the end of the gear box, in Fig. 2, covers the change gearing by which the desired spindle speeds are obtained. This change gearing gives six rates, ranging from 28 to 146 revolutions per minute. A splined shaft *P* leads from the change gearing through the worm carried by the cutter slide, thus driving the spindle. The drive, it will be seen, is simple and direct.

The gears for altering the feeds are mounted underneath the guard at the front of the machine in Fig. 1. They provide for ten changes, ranging from 1 to 7¼ inches per minute. Change gears for faster feeds can be furnished if desired. The feed of the cutter slide is effected by a screw, whose motion is controlled by positive clutches, operated by reverse lever *K*. The clutch for the quick return is cushioned to prevent undue shock. The feed motion and the indexing mechanism are so interlocked that it is impossible for the cutter to be fed forward until it has been indexed fully to its new position. All the movements have to take place in proper sequence, it being impossible for any one of them to begin until the succeeding ones have been completed.

An ingenious feature of the machine is best shown in Figs. 3 and 4. This is the arrangement for adjusting the dogs by which the movement of the cutter slide is limited and reversed. At the front of the bed are two shafts *A*, with ends squared for cranks. These are carried through to the rear of the machine where they are keyed to spiral gears *B* engaging mating gears *C* on screws *D*. These gears are keyed to the screws which thus turn with them, while still being allowed to move endwise through a limited distance. Stops *F*, *G*, and *H* are carried by screws *D*. Stop *F* is fixed as to longitudinal position on outer screw *D*, but allows the latter to revolve freely in it. Its inner end is supported by a slide screwed to the base of the machine, so that it thus helps to support both of screws *D*. Stop *G* is threaded on the inner screw, and slides loosely on the outer one, while stop *H* is threaded on the outer screw and slides on the inner one, as best shown in the upper detail view in Fig. 4. By this means the revolving of the left-hand shaft *A* adjusts stop *G*, while the revolving of the other adjusts stop *H*.

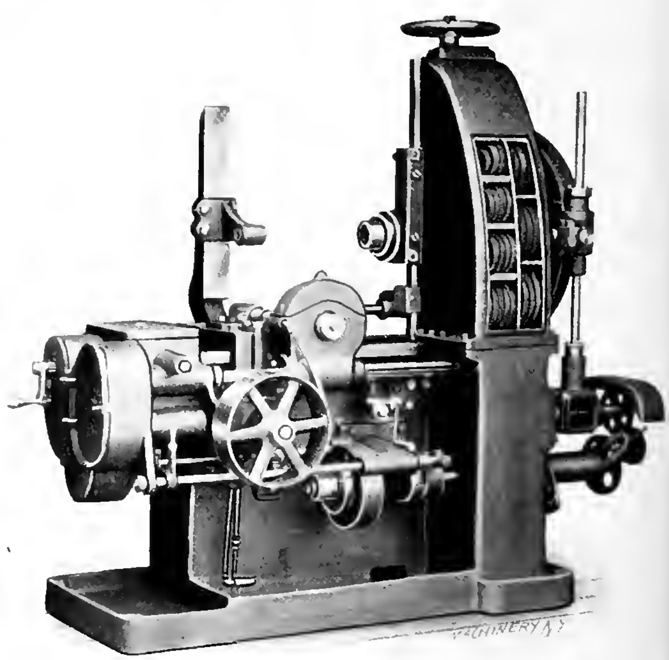


Fig. 2. Rear View of Cincinnati Gear-cutter, showing Driving Mechanism.

Tappet *E*, in the cutter slide, normally acts on stops *G* and *H* to reverse the motion of the cutter slide when it has reached either extreme of its travel. When striking *H* on its forward movement, it forces screws *D* to the left, thus moving spool *J*, which throws reversing lever *K*, returning the slide to its

forward position. Here the tappet strikes dog G which throws the spool J, and with it the reversing lever K in the other direction, starting the slide forward again on the feeding cut, though this is not allowed to take place until the indexing movement has been completed, as previously explained. By withdrawing pin E out of the reach of stop G, the return of the slide may be allowed to continue until E strikes fixed stop F, which is the extreme limit of the table movement in the backward direction. It is thus unnecessary to alter the adjustment when it is desired to run the slide clear back.

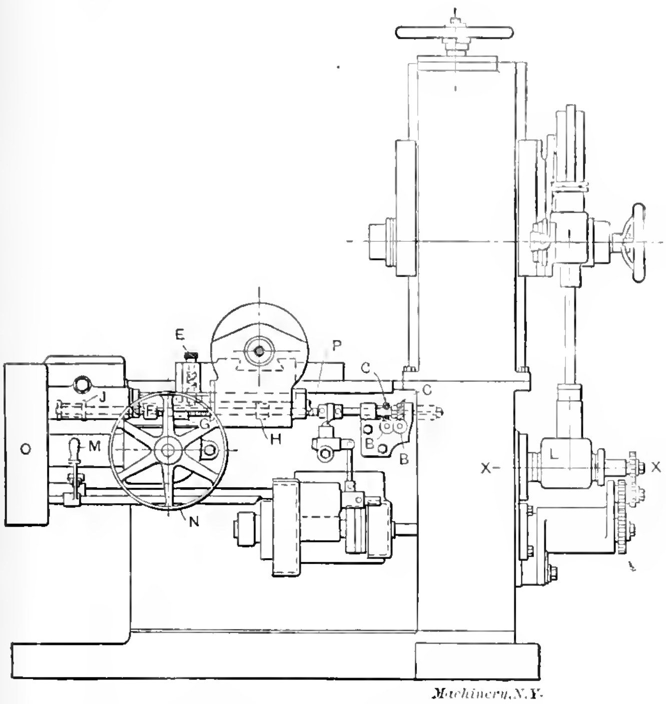


Fig. 3. Diagram of Rear Elevation of Machine.

This arrangement makes the setting of the stops possible from the front of the machine, and it is easily effected before the machine is started, by proceeding as follows: The cutter slide is run to the extreme forward position desired and then, by means of the crank, dog H is run against the tappet E until the reverse lever throws the clutch over to engage the reverse side. Then the cutter slide is run back by hand until the desired back position is reached, when dog G is run against the tappet until the clutch is thrown over to engage

Fig. 4. Plan of Gear-cutter, with Detail of Stop Adjusting Mechanism.

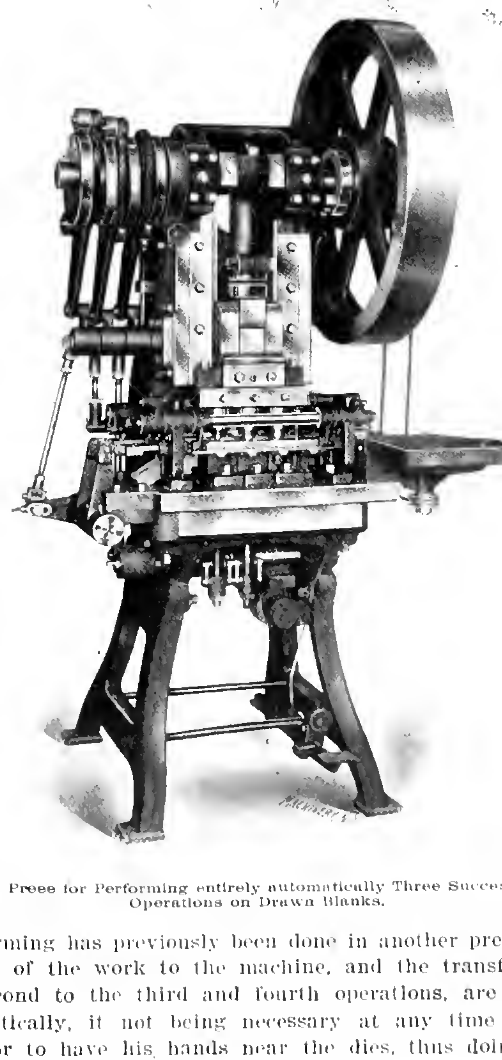
the feeding movement. Then, as is easily seen from the above description, the cutter slide will reverse at these positions. The crank for operating the cutter slide feed-screw is permanently mounted in place, but disconnects itself automatically when not being manually operated, so that it does not give trouble from its balance wheel effect as it rapidly revolves, or from catching in the clothing of the operator.

The indexing mechanism is effective, yet free from trappy, complicated parts. It operates without shock and is easily accessible. As has been mentioned, it is so interlocked with the feed-screw that the cutter cannot enter the work until the indexing has been completed. The number of gears in the indexing train has been reduced by the novel means provided for disengaging the index worm from the wheel. This is shown in Fig. 3. The vertical index worm-shaft is driven by bevel gearing in box L, which may be swung about axis X X. In throwing the worm out of connection with the index worm-wheel, the worm-shaft is simply rocked about its axis, suitable provision being made in the mounting of the worm for guiding it and bringing it back to its proper relation with the wheel. The index wheel is made in two parts, by the method commonly followed in such cases to insure the required degree of accuracy. The work spindle may be made to space once or to revolve continuously, by the operation of the indexing lever shown near the gear casing at the left of Fig. 2. Index gears are furnished to cut all numbers of teeth from 12 to 100 and, with the exception of prime numbers and their multiples, from 100 to 450. Special gears for cutting other numbers of teeth are furnished at an additional cost, if desired.

This machine is at present made in two sizes for cutting gears of 36 and 48 inches diameter, respectively, up to 10 inches width of face. It will cut 3 diametral pitch in cast iron, and 4 diametral pitch in steel. An outer support is provided for the work arbor, as well as a roller support for the rim of the gear blank. The net weight of the machine and counter-shaft is 4,000 pounds. The machine may be very easily arranged for motor drive, a constant-speed motor being secured to an extension of the base, and connected with the constant-speed driving shaft by spur or chain gearing.

BLISS AUTOMATIC GANG PRESS.

The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., has recently built the automatic gang press we herewith illustrate and describe. It was designed and built for performing at each stroke, simultaneously, the second, third and fourth operations on shells on which the first operation of cutting



Bliss Press for Performing entirely automatically Three Successive Operations on Drawn Blanks.

and forming has previously been done in another press. The feeding of the work to the machine, and the transfer from the second to the third and fourth operations, are effected automatically, it not being necessary at any time for the operator to have his hands near the dies, thus doing away with all possible danger from accident.

The drawn shells on which the die operations are to be performed, are laid on a revolving friction dial which forms the bottom of the hopper or tray at the right of the machine. This disk, which is driven by a round belt from a groove cut in the hub of the fly-wheel, carries the shells up to a stop, from which they are automatically released one at a time, and gripped by a reciprocating lateral feeding movement, operated by the bell crank lever seen at the extreme left of the bed of the machine. This movement carries the shell from the feeding position through the subsequent operations, finally discharging it into a chute, from which it falls into a receptacle conveniently placed to receive the finished article. After the first three revolutions of the press, a finished blank is produced at each revolution.

Of the three cam movements at the left end of the crank-shaft, the first one operates the reciprocating movement for the feed, through the bell crank levers just mentioned; the second one opens and closes the reciprocating guides for feeding the work forward; and the third one operates a positive knock-out motion, seen beneath the bed of the machine.

The main slide is adjustable, allowing the use of dies for a great variety of articles, and provided for different heights of dies, as well as allowing for the wear to which they are subjected. The lateral feed is also adjustable for different kinds of work. As may be seen, the press is of the inclinable type, adjusted by a worm and worm segment beneath the bed. For the work being performed in the case shown, however, the vertical position is the most suitable one.

The press runs at the rate of from 75 to 100 strokes per minute, the rate depending on the size and shape of the shell on which the operations are to be done. From 225 to 300 operations per minute are thus performed, entirely eliminating the intermediate handling between the operations, saving much time, labor and shop room.

SPECIAL REAMING AND TAPPING MACHINE.

With the present specialization in manufacturing, it becomes more and more desirable to have special machines built for carrying out, in the shortest time and with the simplest means, the various operations required on interchangeable work which is produced in large quantities. The accompanying halftones illustrate a special machine which is designed primarily for performing a few reaming and tapping operations on sections used for hot water heaters. Such a section is shown most plainly on the table of the machine in Fig. 2. These sections have, in the first place, three holes, one at the extreme top, and one each at the lower ends of the two legs, which must be bored and reamed to a nice fit. In these holes taper bushings, tapering both ways so that one end enters one section, and the other, the next, are inserted. These bushings then form the joint between two sections. The work is required to be very accurate, so that the sections can be drawn up together closely at the three points forming the joint. In Fig. 1 is shown the machine when carrying out this operation, together with the work placed on the machine table, the hole previously referred to at the top of the section being reamed. The sections are clamped on a circular revolving table as shown, and are located by a stud in the center of the table, which enters the center hole. The three holes to be bored and reamed are placed equidistant from the center, so that all that is necessary after the work has been properly located on the revolving table, and placed in proper position in relation to the machine spindle, is to revolve the table to

Fig. 1. Baker Bros. Reaming and Tapping Machine for Hot Water Heater Sections.

Fig. 2. Machine with Revolving Table Removed, and Work Mounted on Lower Rectangular Bed.

the successive positions. It will be noticed that an indexing arrangement is provided, with slots in the side of the revolving table, so that when rotating the table and indexing, the holes will be located exactly alike on the different sections. The table is mounted on ball bearings so that it can very easily be swung around from one position to the other. As soon as all three holes are bored, the boring-bar is removed, and the holes taper reamed. The reaming operations are first performed on one side of a great number of sections, and then taper bushings, which are to fit the reamed taper

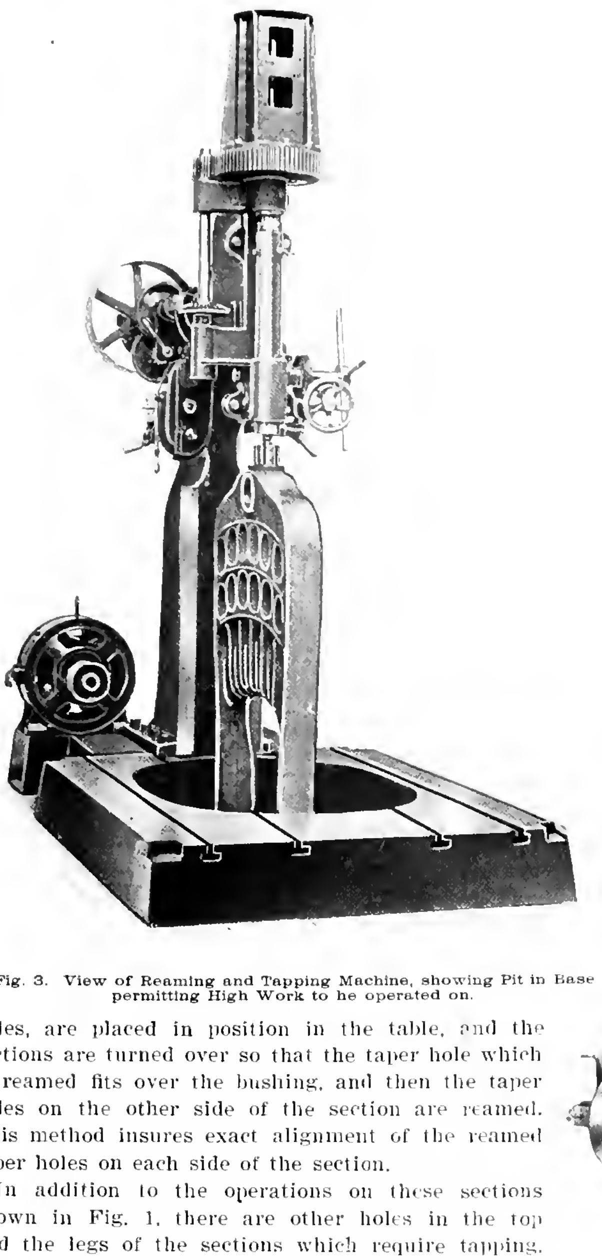


Fig. 3. View of Reaming and Tapping Machine, showing Pit in Base permitting High Work to be operated on.

holes, are placed in position in the table, and the sections are turned over so that the taper hole which is reamed fits over the bushing, and then the taper holes on the other side of the section are reamed. This method insures exact alignment of the reamed taper holes on each side of the section.

In addition to the operations on these sections shown in Fig. 1, there are other holes in the top and the legs of the sections which require tapping. The tapping of the hole in one of the legs is shown in Fig. 2, and the tapping of the hole in the top of the section is shown in Fig. 3. The last of these photographs shows only the work in position, without showing the jigs for holding it. It will be noticed that in Fig. 3 a novel feature of the construction of these special machines is shown. The base of the machine contains a large pit 40 x 56 inches, which permits high work to be operated upon. This opening is covered with the rectangular table shown in Fig. 2, on which, finally, the circular table shown in Fig. 1 is placed, when it is in use.

Referring to Fig. 2, it will be noticed that this machine is provided with individual motor drive, and that the speed changes are accomplished through the gear box shown on the side of the machine. The machine is built in two sizes, the one shown in Figs. 1, 2, and 3 respresenting the smaller size. In Fig. 4 is shown the larger size which here is shown belt driven; but either of these sizes may be belt or motor driven.

The belt driven machine shown is of exceptionally heavy design, and has a capacity for tapping holes up to 10 inches pipe tap size. As will be seen from the engraving, this machine is provided with triple back gearing and four different belt speeds, giving a large variation of spindle speeds.

A special feature of all the tapping machines built by Baker Brothers, Toledo, Ohio, who are the manufacturers of these machines, is the spindle drive, the design of which is shown in all the accompanying halftones. Instead of driving the spindle by means of a simple key and keyway, the motion is transmitted by means of a strongly designed driving head at the upper end of the spindle. This permits far greater power to be safely transmitted to the sliding spindle than is possible by commonly used driving arrangements.

SLOAN & CHACE PRECISION BENCH MILLING MACHINE.

The bench milling machine shown herewith is built by the Sloan & Chace Mfg. Co., Ltd., Newark, N. J. It is intended especially for tool-room use and experimental work, although it is adapted to some classes of precision manufacturing. It is built along the lines of the full-sized standard milling machine, with such alterations in design as to fit it for the more minute and accurate work it has to do.

One provision incorporated in the machine, which may be employed where extreme accuracy is required, is that for holding the head-stock of a bench lathe on the table of the miller. It is possible, owing to this provision, after setting up a piece of work on the face-plate or chuck of the lathe, and

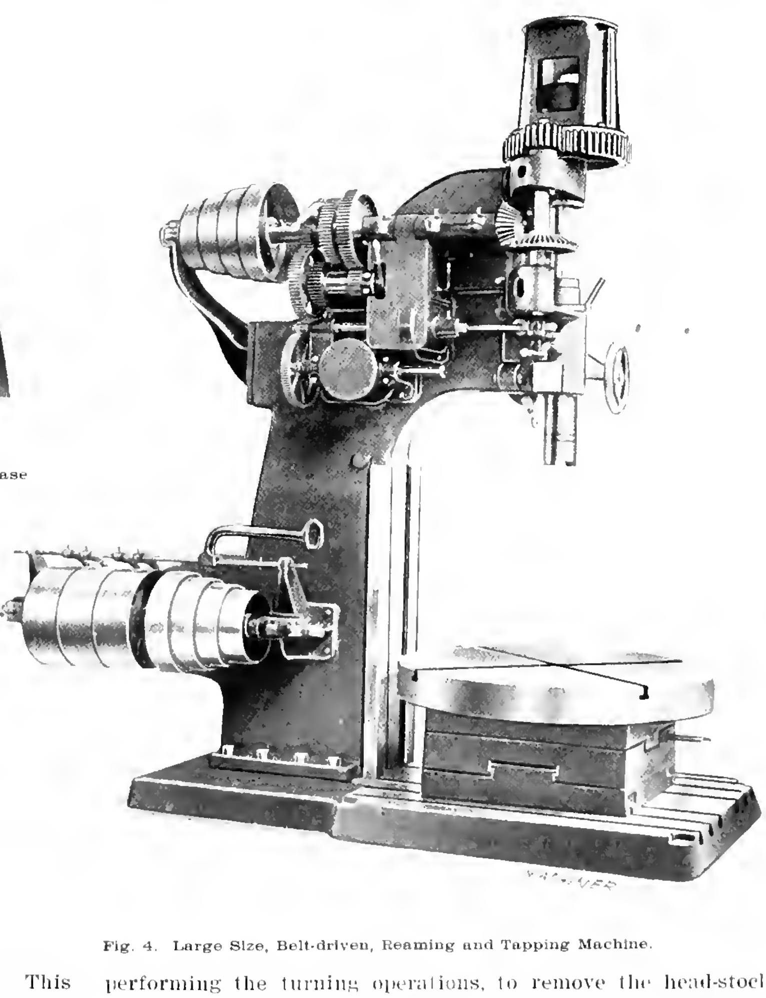
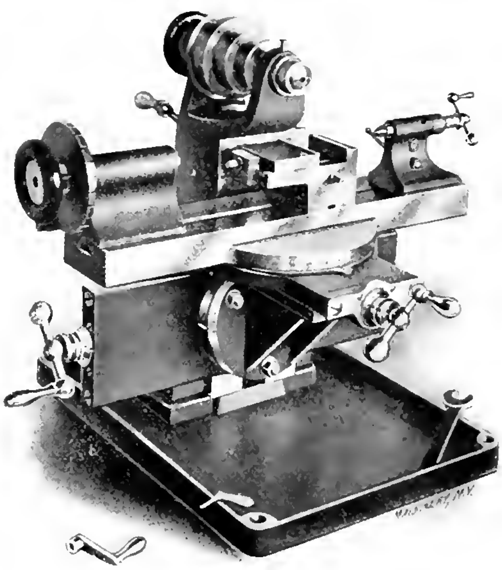


Fig. 4. Large Size, Belt-driven, Reaming and Tapping Machine.

performing the turning operations, to remove the head-stock of the lathe to the milling machine table, and clamp it there in place of the regular index head provided with the machine, using an adapter furnished for the purpose. Another respect in which it differs from the larger machine is in the arrangement of the slides. Instead of having the table longitudinally adjustable on the saddle, the knee is attached to a slide which is longitudinally adjustable on a saddle, which is in turn vertically adjustable on the face of the column. This change of construction is made to allow the most convenient use of an extra angular adjustment provided, by means of which

the work table may be set in any desired angular position about a horizontal axis parallel with the spindle. This angular adjustment, which is made by swiveling the knee on the longitudinal slide to which it is attached largely increases the usefulness of the machine. In combination with the table swivel and the index head, it permits angular settings in three planes.

The index head carries a hardened and ground spindle of the same diameter and chuck capacity as the cutter spindle,



Sloan & Chace Bench Milling Machine for Precision Work.

which is, in turn, similar in the same respects to the spindle of the maker's regular No. 5½ lathe. The tail-stock is accurately fitted to the table, and is bored in special fixtures which insure accurate alignment. The table has a working surface 22 inches long, allowing a maximum of 11½ inches between the index head and tail-stock centers. When the head and tail-stock of the No. 5½ lathe are mounted on the table, there is a distance of 6½ inches between centers. The feed-screws of both cross and longitudinal slides have adjustable dials, graduated to read to thousandths of an inch, and provided with adjustments for taking up wear. The elevating screw is operated by a bevel gear shaft having a hand crank at the back of the column, and is capable of easy and accurate adjustment by means of adjustable graduations.

The vise provided has jaws 3½ inches long by ¾ inch deep, and will open to take in 2⅛ inches. It may be used in either a horizontal or a vertical position. The vertical travel of the machine is 7 inches, the longitudinal movement is 10 inches, and the transverse movement is 4¾ inches. The counter-shaft provided has two speeds. The net weight, including the counter-shaft, is 308 pounds.

CLEVELAND DOUBLE TANG DRILL SOCKET.

We show herewith a new drill socket made by the Cleveland Twist Drill Co., Cleveland, O., embodying a special feature calculated to overcome the troubles incident to the driving of taper shank drills of the usual construction. As may be seen, a double tang is provided—one of the usual size, and

A Drill Socket with Double Driving Tangs.

an additional one of greater thickness. If the smaller one should break off, there is still the larger and stronger one to hold and drive the drill.

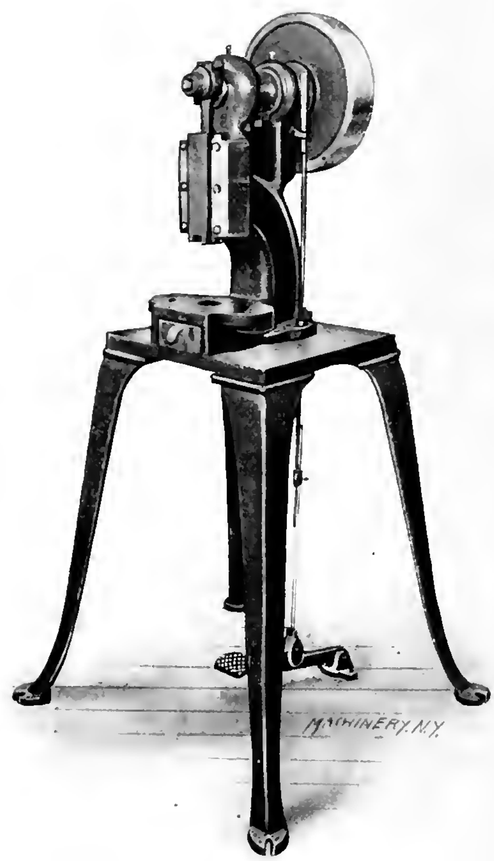
Not only does this device hold taper shank tools so that tangs cannot be twisted off, but old tools with tangs broken off can be ground or milled with new tangs to fit these sockets, so as to renew their life to the full extent of their usefulness. Most shops have an accumulation of drills that would still be serviceable except for their broken tangs. No turning down or key-way milling is required to fit these tools for use with this style of socket.

Any taper shank tool can be easily fitted to this line of sockets by grinding or milling a second tang below the original one. This second and stronger tang fits in the secondary opening of the "Perfect" socket, as the makers call this device. The shank is thus held by two bearing surfaces which cannot be twisted off under the severest strains. In contrast with some previous attempts at improved sockets, which have been complicated and high priced, this arrangement is both simple and inexpensive. It has no parts to get out of order or to wear out, and it fits any spindle having a regular taper hole.

STANDARD MACHINERY COMPANY'S LIGHT POWER PRESS.

The small power press shown herewith is being placed on the market by the Standard Machinery Co., 7 Beverly St., Providence, R. I. It is designed especially for light optical, hardware and jewelers' work, but is well adapted for all light operations requiring press work of any kind.

One of the features of the press is the clutch used. This is the Horton patented roller friction clutch, which engages instantly, there being less than 1/32 inch travel of the periphery of the fly-wheel from the time the treadle is pressed until the clutch takes hold. This clutch is of exceptional



A Power Press for Optical, Jewelers' and other Light Work.

strength, as well as being quick in its action, since there are several positive engagement points which connect simultaneously, giving a very rigid connection between the fly-wheel and the crank-shaft. A positive safety stop is provided which prevents the possibility of a second stopping in case the treadle is released and again depressed. When it is desired to run the machine continuously, the stop may be removed from the clutch, this being done by simply sliding it out of position.

All bearings are adjustable for wear, the slide having particularly long bearings with adjustable side gibs providing an accurate and easy means of alignment. The adjustment

of the plunger for vertical position is made by operating an eccentric bushing with a clamping collar, surrounding the crank-pin; this does not affect the length of the stroke. The base of the press is made with an opening of any size ranging from ½ to 1½ inches, and may be provided with a small drawer, shown in the engraving, to catch finished work. The table may be used, or the tool may be used as a bench press. Punches with round shanks or dove-tails may be used; both methods of fastening have been provided for in the design.

The regular stroke of the machine is 1 inch; when desired it may be made as large as 1½ inch. The adjustment for the stroke is ¾ inch, and the distance from the slide to the bolster with stroke up and adjustment down is 5½ inches. The total weight of the machine with table is 300 pounds. The normal speed of the press is 300 revolutions per minute.

SPRINGFIELD AUTOMATIC RING WHEEL EDGE GRINDER.

The accompanying half-tones show front and rear views of an automatic edge grinding machine, built by the Safety Emery Wheel Co., Columbus Ave., Springfield, Ohio. This machine is intended for grinding from the rough, flat edges and surfaces in iron, steel, brass, bronze, etc. The grinding process for this work not only removes the stock very rapidly, but leaves a fine finish as well—finer than can be obtained by any other means practicable for heavy work.

The machine is very heavily built. The base is in one solid casting of T-form, on the front portion of which is located the table support, while the rear is provided with ways to which is gibbed the heavy column on which the wheel spindle head is carried. The table is reciprocated auto-

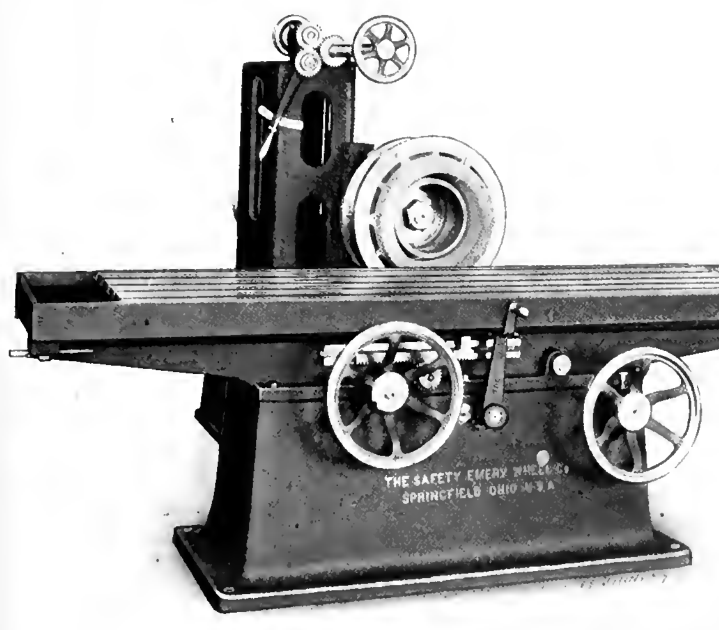


Fig. 1. Front View of Springfield Edge Grinder, note the Safety Chuck for the Ring Emery Wheel.

matically, suitable stops being provided for limiting its movement, as may be desired. The wheel column is fed automatically toward the work at any rate of feed required.

The spindle is driven from a drum on the counter-shaft by a flying belt arrangement, whose tension is maintained, whatever the vertical adjustment of the spindle may be. The tension is kept to the proper amount by shifting the lower idler pulley, which is attached to a bracket sliding in ways on the rear of the column, being adjusted by the screw shown. The wheel slide has a vertical adjustment of 12 inches on the column, which may be obtained by hand or by power. In the latter case, it is operated by the small pulley at the top of the column, and controlled by the tumbler gearing and hand lever shown. The grinding wheel is of the ring or cylinder shape, firmly held in the patent chuck made by this firm. It permits with perfect safety the high speed which is essential to fast cutting. The wheel spindle is supported in very heavy boxes, with suitable thrust bearings to take up end play.

An extra long bed supports the carriage, which travels on one flat and one V-way. The working surface of the table is provided with T-slots for clamping work or jigs and fixtures required for holding it. The carriage movement is triple back-geared, all gears and racks being cut from the solid. The motion of the carriage is easily controlled by the oper-

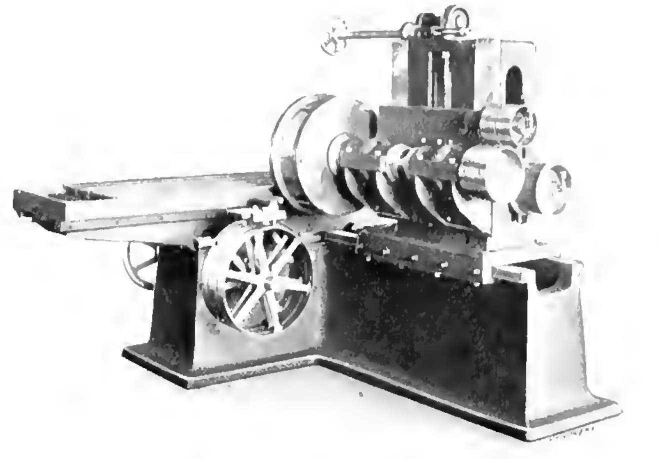


Fig. 2. Rear View of Edge Grinder showing Spindle Drive and Table Reversing Mechanism.

ator, being stopped at any desired point by centering the vertical reverse lever on the front of the bed, when it may be moved by hand, by means of the large hand-wheel at the right in Fig. 1. The reverse dogs which actuate this lever are provided with threaded contact points, which may be adjusted to give at each end of the table motion a greater or less movement to the sliding rack, seen beneath the edge of the table in Fig. 2. This rack operates a pinion, which, through a ratchet movement, operates the cross feed screw by means of which the wheel column is fed forward on the bed toward the work. Any feed, from 0.001 inch to ⅛ inch or more may be given to the column. All the operating mechanism is on the front of the machine, within easy reach of the operator in his working position.

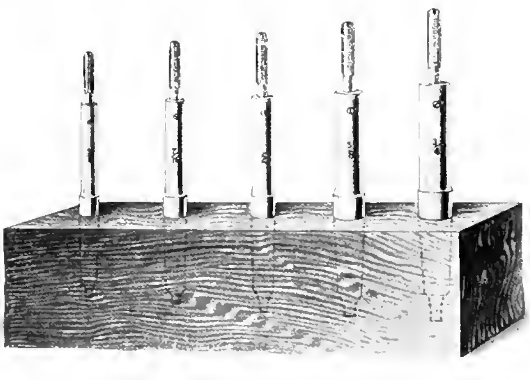
The machine is fitted for supplying water to the grinding wheel when desired, as is necessary for grinding steel. The rearward extension of the base serves as a water reservoir, from which the water is drawn and delivered to the work by a centrifugal pump.

This machine is made with a table working surface 70 inches wide, and of any length up to 130 inches. The machine shown has a working surface 50 inches long. On the larger sizes, a central base is used, with pedestal end supports for the bed. To adapt the work to knife grinding, the builders furnish a heavy knife bar, which can be bolted to the table for grinding any length of work up to the capacity of the machine; this can be readily removed when not needed. For the heaviest grinding of this kind, such as finishing off locomotive guide bars, etc., the builders recommend a heavier form of the machine, carrying a larger wheel, with a solid head.

CINCINNATI PERMANENT TAP SOCKETS.

When drilling and tapping in a drill press or drilling and tapping machine, considerable time is often consumed in changing from the drill to the tap, difficulty often being experienced because a suitable device for holding the taps is not at hand. It also takes considerable time to insert the various taps in, and remove them from, the holders. The Cincinnati Machine Tool Co., Western Avenue and Frank St., Cincinnati, Ohio, which makes a specialty of manufacturing the Cincinnati heavy pattern upright drilling and tapping machines, has therefore placed on the market tap holders of the description shown in the accompanying engraving, which, while very simple, have proved in their own shop a very effective means for overcoming the difficulties mentioned.

Each size tap is provided with a socket, having a shank to fit in the drill press spindle, as indicated. The tap remains permanently in its socket until it is worn out, and is then replaced by another tap. By this arrangement, the changing from the drill to the tap becomes very simple, the tap with its holder being simply slipped into the drill spindle socket, the same as if the tap itself had a taper shank. This entirely



Set of Five Cincinnati Permanent Tap Sockets.

eliminates the loss of time incident to the use of other tap holders. In the illustration, five tap holders are shown placed in a convenient wooden block ready for use. These holders are regularly provided with Morse taper shanks, but holders are also furnished with any other taper shank, or with straight shanks suitable for the "Presto" or "Magic" chucks.

HORIZONTAL MILLING ATTACHMENT FOR VERTICAL MILLER.

The design and construction of the vertical milling machine was immediately followed by the vertical spindle attachment for the horizontal type of machine: the accompanying illustration shows how this, in turn, is followed by the horizontal milling attachment for the vertical machine. The line engraving, Fig. 1, shows the design of a horizontal milling attachment for a vertical milling machine as made by the Becker-Brainard Milling Machine Co., Hyde Park, Mass. In Fig. 2 this attachment is shown applied to the vertical spindle of a Becker-Brainard vertical milling machine, at work on a steam turbine rotor.

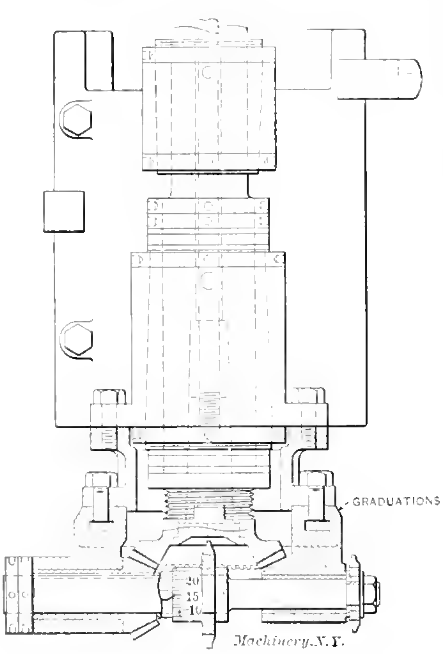


Fig. 1. Design of Becker-Brainard Horizontal Milling Attachment for Vertical Millers.

The attachment as shown in Fig. 1 consists essentially of two parts, the upper one of which is stationary, while the lower one is attached in such a manner that it can be swiveled completely around in a horizontal plane. The stationary part is attached to the column of the milling machine, and the swiveling part is provided with graduations at the place where it joins the stationary part, so that it can be accurately set and adjusted to any angle required, when it is clamped in position by the T-bolts shown. The horizontal spindle which is driven from the vertical spindle through bevel gears arranged as indicated in the line engraving, has a long bearing at each end. The milling cutter may be placed either on the outside end of the horizontal spindle, beyond the right-hand bearing, or between the two bearings. In the latter case, of course, the size of the cutter is limited by the driving bevel gear. The end play of the horizontal spindle is taken up by a nut provided with a check nut placed at the left-hand end of the spindle. At the other end, the cutter is clamped with a nut and washer, but the spindle may also be provided with a taper hole, taking the taper shank of an end milling cutter or shank mill.

The cutter when placed between the two bearings, as indicated, is specifically intended for cutting spirals, although it may also be used for general requirements. This cutter is held between two nuts as shown, one of which is graduated so that if adjustment has once been made for any given thickness of cutter, it being required to hold the cutter exactly in the center of the vertical spindle, any cutter of the same thickness may be set without requiring a new adjustment. It is evident that this attachment materially increases the usefulness of the vertical miller. It gives the vertical miller the same range as the horizontal type in the cutting of worms, spur gears, spirals, hobs, racks, etc., while, at the same time the machine retains the advantageous characteristics peculiar to the vertical type.

As mentioned above, a practical application of the horizontal attachment in connection with the No. 6 Becker-Brainard vertical milling machine, is shown in Fig. 2. It is here employed in milling the buckets of a Sturtevant steam turbine

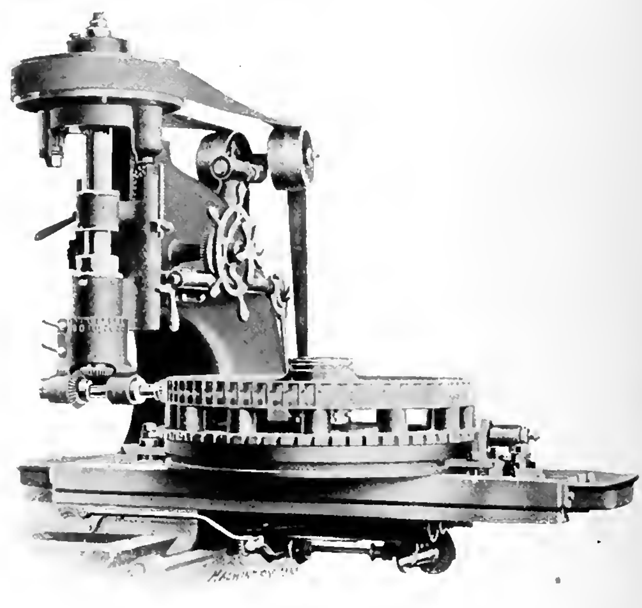


Fig 2. Horizontal Milling Attachment at Work on Steam Turbine Rotor.

rotor. The rotor is mounted on and clamped to a special index plate, which revolves freely on a stud projecting from a circular face-plate, which, in turn, is securely clamped to the table of the milling machine. An index pin entering the slots in the indexing plate, as plainly indicated in the half-tone, permits the rotor to be indexed around while each bucket is being milled. On account of the limited space between the column and the table in a horizontal milling machine, work of this character would be difficult, if not impossible, to perform on an ordinary horizontal machine, even with the use of a universal milling attachment. On the vertical miller, however, the space is not so limited, owing to the design of the column, and the use of this horizontal attachment in a vertical miller will permit a large variety of work to be performed on the vertical machine, for which either a larger horizontal machine or special machinery would be required.

TOSCOT FLEXIBLE METALLIC BELT COUPLING.

One difficulty common to flat belt couplings is that they form a rigid joint where the two ends are coupled together, so that if a belt provided with such a coupling runs over a small pulley, heavy strains are produced at the extreme edges of the coupling, which cause the belt to break along this line. In Fig. 1 is shown the Toscot flexible coupling, which overcomes this defect. This coupling is manufactured by the Tostevin & Cottie Mfg. Co., 635 Kent Ave., Brooklyn, N. Y.

It is provided with a joint in the center where the ends of the belt meet, and therefore permits the belt to come in close contact with the pulley all the way around.

Another improvement is that the coupling is so designed that it can be easily unhooked whenever it is desired to take

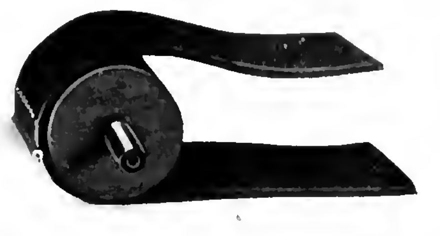


Fig. 1. Toscot Flexible Belt Coupling applied to Small Pulley

the joint apart or remove the belt. The hooking arrangement is shown plainly in Fig. 2, where the two ends of the belt, each having one section of the coupling attached, are shown as they are being uncoupled. The two sections of the coupling can be attached to the belt ends in any convenient place, and the belt taken to the respective pulleys where it is to be used, laid over the pulleys and simply hooked together. The attaching of the coupling to the belt is accomplished very easily. The end of each section of the coupling, which

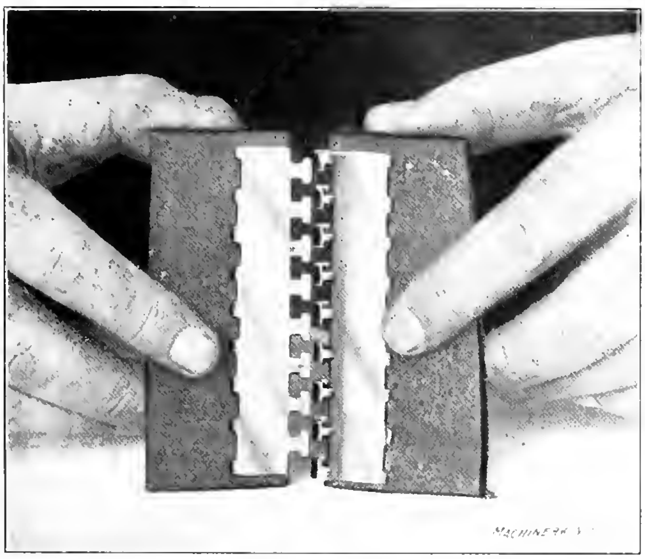


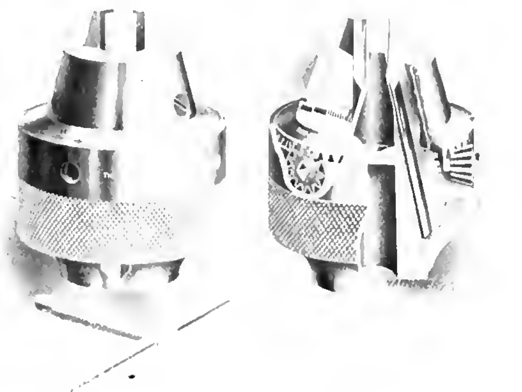
Fig. 2. View of Joint of Coupling showing Simplicity of Unhooking Belt.

is attached to the belt end, is provided with teeth. These teeth are driven through the belt with a hammer, using a backing consisting of a soft wooden block. The belt is then turned over, and the ends of the teeth clinched, the points being driven well into the leather. The convenience and simplicity of this operation is evident. These couplings are made for all standard widths of belts, varying from one inch to six inches.

SKINNER GEARED PATTERN DRILL CHUCK.

The Skinner Chuck Co., 94 N. Stanley St., New Britain, Conn., is making the improved style of drill chuck shown in the accompanying halftone. In the previous chuck of this type made by the same builder, the jaws were tightened by twisting the knurled sleeve by hand. When a strong grip was desired, it was obtained by the use of the spanner wrench. This latter means of tightening the chuck is sometimes objectionable on a light drill press, where the spindle has a tendency to turn with the wrench. In this new geared pattern chuck it is possible to operate it by hand as before, and, in addition, provision is made for using the common form of key wrench, by which the jaws may be tightened sufficiently to drive a high speed twist drill to its limit. In tightening the chuck in this manner, there is no strain tending to revolve the spindle of even the lightest machine.

As may be seen in the engravings, the improvement consists in sinking bevel pinions into the body of the knurled sleeve, and providing these pinions with a stationary gear for them to mesh with, fast to the body of the chuck. These pinions have square sockets, which may be reached by openings in the sleeve as shown, and may be operated with a common square key. As the chuck is tightened by the operation of these pinions and the key, the pinions travel on the gear, giving a very powerful grip. The key, however, is only used for giving the final tightening and for unloosening the chuck. All adjustments for different sizes of tools are effected more quickly by revolving the chuck by hand. Two pinions are provided, thus insuring longer life to the gearing and making it more convenient to apply the wrench. In case one pinion should break, the chuck would still be available for service, with the remaining pinion.



New Pattern of Skinner Chuck which allows Tightening without Revolving the Spindle.

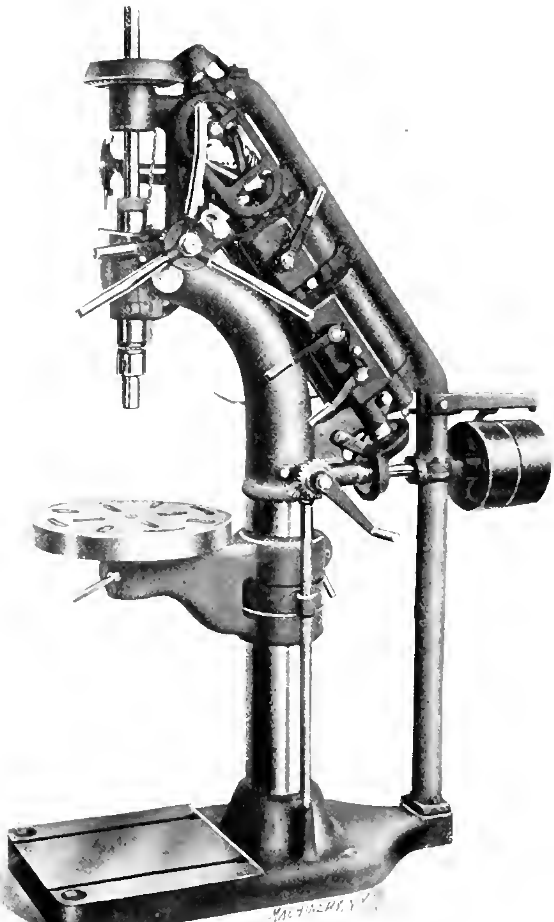
This tool is made with the same care used by the makers in the rest of their line. As in their other chucks of this design, a standard brand of steel is used for the jaws, this same make and brand having been used for years without change. Each jaw is hardened to an exactly uniform heat, this being made possible by the use of an electric furnace. Every chuck is tested for accuracy before leaving the works and the error carefully measured. No inaccuracy of over 0.002 inch is allowed to pass. Attention is called to the long bearing of the jaw in the solid threaded nut, and the angular bearing of the jaws on the bottom of the slot milled in the chuck body. Owing to the way in which these jaws are supported in these milled slots, they have no tendency to turn or rotate from the strain of driving the tool. The gears and pinions are hardened, and the jaws and cap are hardened and ground. The appearance of the chuck is neat, and there are no projections to injure either the work or the workman.

This chuck can be furnished with a hole through the center of the full capacity of the chuck, when it is desired to use it on a hollow spindle machine. It is readily taken apart for cleaning and oiling, a screw driver being the only tool necessary. Two sizes are now ready for delivery and other sizes will be furnished later.

BARNES 20-INCH UPRIGHT DRILL.

A medium-sized drill press of an entirely original design has been placed on the market by the Barnes Drill Co., Rockford, Ill. The novelty of the design and arrangement of the component parts is at once apparent upon examination of the accompanying halftone. The drill press, as shown, is provided with geared drive, located in the gear box at the lower end of the part of the frame where the driving and feed mechanism is placed. The main shaft in this gear box is driven from the horizontal pulley shaft by means of bevel gearing. There are four changes of speed in this gear box, without resorting to the back gears, and these speeds can be easily and quickly obtained without stopping the machine, by operating one of the two shifting levers shown on the front side of the gear box. The back gears, contained in a cover or box by themselves, are placed diagonally above the gear box, and operated by the lever shown. By means of the back gears operated in connection with the gear box eight changes of speed can thus be obtained, which is sufficient for all twist drills from 1/4 to 1 1/2 inch in diameter. The ratio of the back gears is 4 to 1.

Diagonally above the back gear box is placed the mechanism for the positive power feed. Any feed from 0.001 up to 0.025 inch can be instantly obtained while the drill is in motion by shifting the small index lever shown directly in front of the drill spindle between its two bearings. The feed changing mechanism is of an entirely new design, and its practicability and convenience add much to the utility of the drill. An automatic stop for the feed is also provided. The hand feed is operated through the spider or star wheel having three handles, located as shown in the half-tone. On the shaft on which this spider is placed a pinion is provided which runs with an internal gear, which in turn is connected with the pinion engaging with the feed rack. By this arrangement the leverage of the handles on the spider is equivalent to levers of hand-feed mechanism of the common design four times as long. The spider or star wheel also acts as a quick return lever.



Barnes 20-inch Upright Drill Press with Geared Drive of Original Design.

The remaining details of the machine are plainly shown in the halftone. The round table is regularly furnished, but square tables are also supplied on request. The table is raised and lowered by operating a crank connected by bevel gears with a screw located as shown. The bracket holding the table may be swung in an arc of nearly 180 degrees around the post.

If this machine is required to be fitted out as a tapping machine, reversing friction pulleys are put in place of the tight and loose pulleys shown in the half-tone, and this arrangement permits the machine to be used for tapping purposes as conveniently as machines with expensive geared tapping attachments. The engraving shows the machine driven from the counter-shaft, but these drills are also fitted with electric motors and starting rheostat, which makes the machine completely self-contained.

The frame of the machine, as can be easily perceived from the illustration, is of a rigid design; the column is heavy for this size of drill, and the back brace for supporting the gear boxes and feed mechanism makes it very rigid. This will be understood when it is known that the tool will drive a one-inch high speed twist drill, running at 190 revolutions continuously, at a feed of 2 inches per minute in steel, and 3 inches per minute in cast iron, without engaging the back gears. All levers and handles are easily within the reach of the operator when standing in front of the drill.

The height of the drill is 70 inches, the distance from the column to the center of the table is 10¼ inches, the maximum distance from the spindle to the table is 26¾ inches, and from the spindle to the base, 42 inches. The vertical travel of the spindle is 10 inches, and of the table 16 inches. The spindle is bored to take a No. 3 Morse taper. The floor space required, exclusive of the tight and loose pulleys, which overhang 7 inches, is 37½ x 16 inches, and the complete drill, back-geared, with positive power feed, weighs 740 pounds. The machine will, however, if required, be furnished without back gears, and also without a power feed and automatic stop, having simply the plain star-wheel feed lever for hand feed only. It should be noted that this machine is made by the Barnes Drill Co., and not by another firm of similar name.

EDGEMONT WET TOOL GRINDER.

The Edgemont Machine Co., Dayton, Ohio, is building the wet tool grinder herewith shown. This tool is intended to take the place of the cheap dry grinders so extensively used for tool sharpening. It costs very little, and offers a number of advantages. The danger of burning tools is avoided, and the wheel does not have to run as fast as in the dry grinder.

Wet Tool Grinder built by the Edgemont Machine Co.

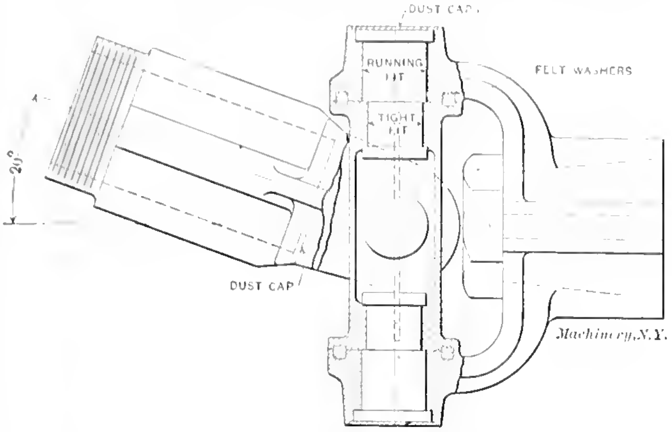
In comparison with the more elaborate wet grinders on the market, this machine is exceedingly simple and inexpensive. Water is supplied by a small tank on the top, and is allowed to run on the wheel until a sufficient quantity has accumulated on the lower wheel case. Owing to the special design of the casing the wheel is caused by the latter to pick the water up and spray it continuously over the work. There is no pump to get out of order, and no mechanism of any kind to deteriorate from grit and rust.

The machine is well built, with a large spindle of special steel, running in ample journals and self-oiling bearings. The height of the machine from the floor to the spindle is 40 inches. The floor space occupied is 14 x 23 inches. The weight complete is 200 pounds. A corundum wheel 12 inches in diameter and 2 inches face is used, and it should be speeded from 1,200 to 1,500 revolutions per minute. As may be surmised from the engraving, the grinder may be used as a bench machine when desired, the column being separate from the head, so that it may be used or not as convenience dictates.

MUTUAL MACHINE CO.'S UNIVERSAL JOINT.

The growth of the automobile industry has brought forth a great many designs of universal joints; in the accompanying line engraving we illustrate one of these, the Warren patent universal joint, manufactured by the Mutual Machine Co., 25 Wells St., Hartford, Conn. This device is known as the 1909 Universal Joint. One of its important features is the fact that the parts are joined together with rivets, instead of with bolts, as there is no reason to ever take the joint apart after it has once been put in place. To make the mechanism dust-proof, felt dust washers are compressed and placed in cavities in the fork before assembling; after the oil and grease come in contact with the felt, it expands and fills the corresponding cavities in the center blocks, the arrangement thereby becoming dust-proof. The hollow space in the center

blocks is filled, when assembled, with non-fluid grease, which is sufficient to last for several months, and when it is necessary to fill the receptacle again, a small screw, not shown in the illustration, is loosened, and the hollow space supplied with fresh grease. A strong point in favor of this joint is

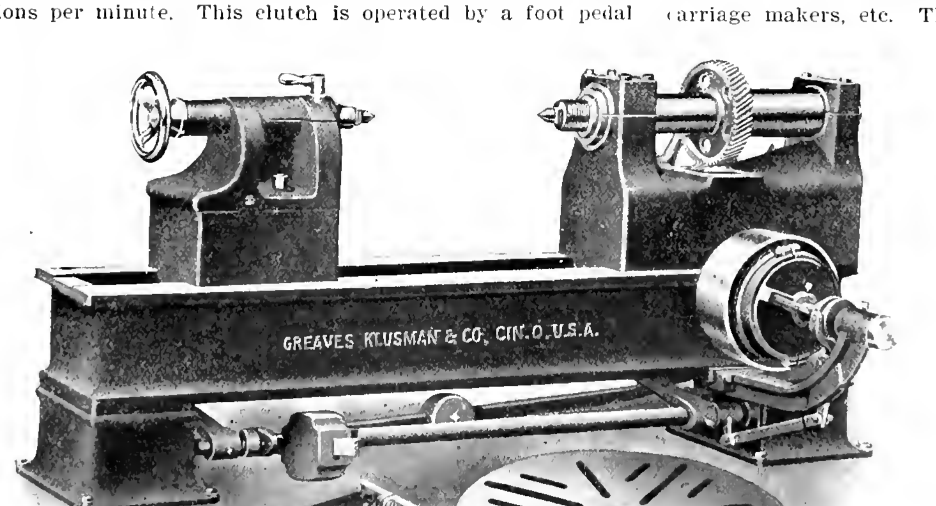


Warren Patent Universal Joint

that it is free from bolts, screws, nuts, cotter pins, etc., which are liable to work loose, and that it is unnecessary to apply any protective dust covers. An examination of the design, as shown in the engraving, will give a clear idea of the simplicity and rigidity of the construction.

ARMATURE BANDING AND FIELD COIL WINDING LATHE.

The engraving shows a special lathe built by Greaves, Klusman & Co., Cook & Alfred Sts., Cincinnati, Ohio. This machine is expressly designed to meet the requirements of electric motor and dynamo manufacturers and electrical repair shops, for the banding or armatures and the winding of field coils. For this purpose, the spindle is very strongly driven through the spiral gearing shown, which runs in a bath of oil. The gear casing has been removed in the engraving to show the construction. The change gears provided are attached to the front of the lathe (the engraving shows the rear view) and give four different spindle speeds of 15, 30, 60, and 120 revolutions per minute, respectively. The lower driving shaft passes through the bed and is equipped at the rear end with a self-releasing friction clutch pulley, 14 inches in diameter and 5 inches face, which should run at 360 revolutions per minute. This clutch is operated by a foot pedal



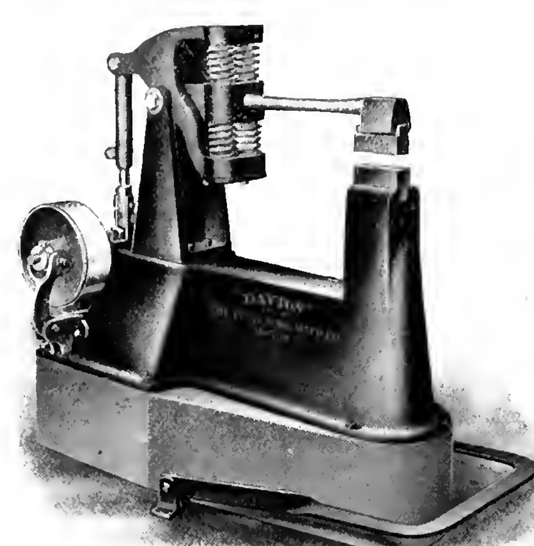
A Special Lathe for Winding Operations in Electrical Work

running the entire length of the bed, so that the operator can conveniently stop and start the machine from any point. This permits belting the machine direct from the line shaft without the use of a counter-shaft. When a motor drive is desired, a spur gear is substituted for the driving pulley, meshing with a pinion on the motor shaft, the motor being mounted on a bracket attached to the lathe bed.

The machine has a height of 36 inches from the floor to the center line of the spindle, being somewhat lower than the usual dimension, thus making it convenient for the operator when handling heavy armatures of large diameter. The equipment consists of the parts shown in the engraving, including the large face-plate. A counter-shaft is not furnished or required. A 12-foot bed is usually furnished. This will take 8 feet between centers. Longer or shorter beds are furnished if desired. With a 12-foot bed the machine weighs about 3,300 pounds. A special long travel slide rest for turning commutators can also be furnished with this machine if desired.

DAYTON POWER HAMMER.

The accompanying half-tone illustrates a power hammer, manufactured by the Foglesong Machine Co., Dayton, Ohio, and known as the Dayton spring-cushioned helve hammer. The machine is intended to meet the demand for a first-



Power Hammer with Friction Clutch Drive

class, moderate-priced machine, adapted for the requirements of general manufacture, blacksmith shops, wagon and carriage makers, etc. This machine has been in use in the factory of the makers, subjected to all kinds of work, and under all kinds of conditions, for a long time, and although embodying some interesting features in its design, it is by no means experimental. One of the features of this machine is a friction clutch instead of the common belt tightener for starting and stopping the machine, and controlling the stroke. Another feature of importance, not possessed by the upright style of hammer, is that of permitting such work as welding of circular pieces, tires, etc., to be done very conveniently, as there are no parts in the construction of the hammer which will obstruct the placing of work of any shape on the anvil. This feature will be greatly appreciated by blacksmiths. The driving shaft and the helve are made of hammered spindle steel. The helve is made a tapered fit, and keyed into the head, which is placed between strong and durable steel springs. Provisions are made so that all necessary adjustments can be made instantly, and the foot treadle is arranged so that

the operator can stand in the front or on either side of the hammer when operating it, the variation of the foot pressure on the treadle regulating both the rapidity and the force of the blow.

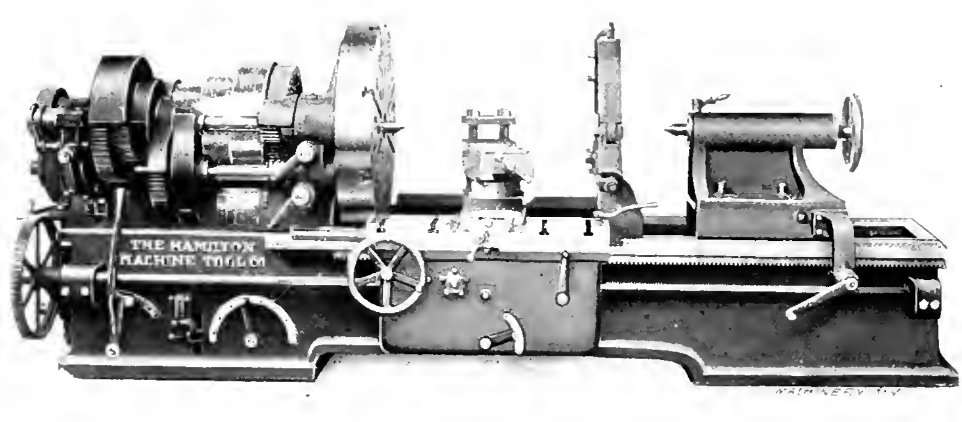
This hammer is made in two sizes, No. 2 and No. 3. The No. 2 hammer weighs 900 pounds, and occupies a floor space of 48 x 20 inches. The distance from the base to the top of the anvil is 24 inches, the length of the helve is $26\frac{1}{4}$ inches, and its diameter at the large end 2 inches. The length of the stroke is 8 inches. The speed of the driving pulley is 300 revolutions, its diameter being 12 inches; the width of the belt is $2\frac{1}{2}$ inches, and the power required for driving is from $\frac{1}{2}$ to $\frac{3}{4}$ H.P. On this hammer the manufacturers themselves have welded $1\frac{3}{4}$-inch steel axles and $\frac{3}{4}$ x 3-inch tires. The No. 3 hammer is larger and weighs 1,500 pounds, occupying a floor space of 50 x 20 inches. The distance from the base to the top of the anvil is 28 inches, the length of the helve is 34 inches, the diameter being 3 inches. The length of the stroke is 8 inches. The speed of the driving pulley is 250 revolutions per minute, its diameter being 18 inches; the width of the belt is 4 inches, and the power required from $\frac{3}{4}$ to 1 H.P.

HAMILTON 42-INCH HEAVY LATHE.

The Hamilton Machine Tool Co., of Hamilton, Ohio, has brought out a new 42-inch lathe of rigid construction, known as the Hamilton 42-inch heavy pattern lathe. This machine is shown in the accompanying half-tone, and, as will be readily seen, is of an exceptionally powerful design. It is intended particularly for heavy work, and embodies all the modern features common to the Hamilton lathes, such as quick-change gear mechanism, hollow steel spindle, automatic feed stop, and double apron. The machine may also be equipped with taper attachment, but this is not regularly furnished.

As shown in the illustration, the spindle is driven from the counter-shaft by a 6-inch belt. The cone pulley is provided with three steps, 16, 20, and 24 inches in diameter, respectively, and the speed variations thus obtainable, in combination with the quadruple gearing in the head-stock, allow ample speed changes as well as ample power for the heaviest work to which this lathe would be put. A feature of considerable importance is that the bed is considerably wider than customary, so that when turning work of the largest diameter within the capacity of the machine, the cutting tool is still supported by the outer V in the front of bed.

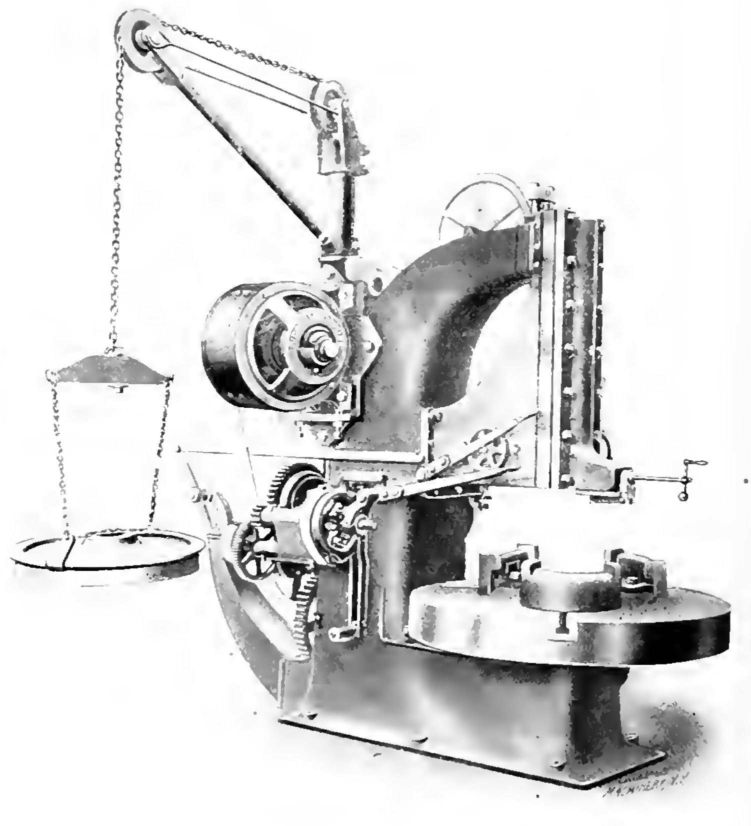
The principal dimensions are as follows: Swing over shears, $42\frac{1}{2}$ inches; swing over carriage, 30 inches; swing over compound rest, 28 inches; length between centers on 12-foot bed, 4 feet 6 inches; range of screw pitches which can be cut, 5/16 to 16 threads per inch. The range of feed is from 2 to 85 turns of the spindle per one inch forward motion of the carriage; the pitch of the lead-screw is one double thread per inch. The face-plate, which is internally geared, is 42 inches in diameter. The speed of the counter-shaft is 160 and 185 R. P. M., the size of the counter-shaft pulleys being 24 x 7 inches. The net weight of this machine, with a 12-foot bed is 24,000 pounds, and the increase in weight for each additional foot in the length of the bed is 450 pounds.



Hamilton 42-inch Lathe of Exceptionally Heavy Design.

IMPROVED MOTOR-DRIVEN CAR-WHEEL BORING MILL.

The accompanying half-tone illustrates a motor-driven car wheel boring mill manufactured by William Sellers & Co., Inc., Philadelphia, Pa., which embodies a number of improvements in car wheel boring mill machinery. The noteworthy features of this machine are the improved automatic chuck, the friction feed mechanism, and the crane attachment. The machine is known as a 54-inch wheel boring mill, and is of particularly heavy construction, and provided with powerful gearing, rendering it capable of taking the heaviest cuts required for the class of work for which it is intended.



Sellers' Motor-driven Car-wheel Boring Mill with Automatic Chuck and Crane Attachment.

The improved automatic chuck is self-closing, self-opening, and self-centering. It has three adjustable abutments, as shown in the half-tone, each of which is provided with an equalizing steel jaw, having two bearing points, so that the work is held and centered by six points on the circumference, thereby insuring accuracy in centering. This automatic chuck enables the work to be secured in its correct position in the machine, and subsequently released without any loss of time and labor. The power of the clutch grip increases with the resistance of the cut, and this feature is very important, as it obviates the necessity of stopping the table in order to tighten the chuck. The general action of this chuck is as follows: The first movement of the driving shaft causes the jaws to close in around the work, after which the motion is transmitted to the table to produce rotation. When the work is completed, the chuck is released by disengaging the driving clutch, and retarding the driving shaft

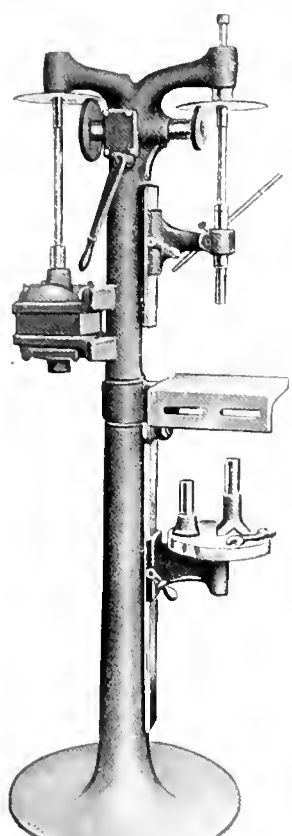
by means of a friction brake, provided for the purpose. The inertia of the table and work will then impart the necessary force required for opening the jaws.

The machine is motor driven, the motor being mounted, as shown in the half-tone, on the side of the machine frame. The motor is a Westinghouse type "S," of 7½ horse-power, capable of a variation in speed of approximately two to one, thereby eliminating all cone pulleys for speed variation. The efficiency of the machine is also increased by this motor drive, because the variable speed motor gives the required speed range in smaller steps, permitting the mill at all times to be run at its maximum capacity.

On the top of the rear part of the housing a crane is fitted, as shown, for lifting the car wheels into place on the table of the machine. This makes the machine very handy to operate, and self-contained in all its features.

MOTOR-DRIVEN VARIABLE SPEED SENSITIVE DRILL PRESS.

Last month we illustrated and described the principal features of a friction-driven sensitive drill press, built by the Washburn Shops of the Worcester Polytechnic Institute. The machine then described was of the belt-driven type. The accompanying half-tone shows the same machine with somewhat different arrangements in its driving parts, designed for motor drive. The arrangement of the motor and the driving mechanism, present novelties which make this modification of the machine very interesting from a mechanical point of view.



Washburn Motor-driven Sensitive Drill Press.

The machine, arranged as shown, has proved a great success, and it is stated that a noticeable feature to every-one who has operated this machine is the smoothness with which the drill is fed into the work, this being due to the entire elimination of belts. The induction motor (which, by the way, is furnished with the machine for either 110 or 220 volts, 2 or 3 phase, 25, 40 or 60 cycles) is bolted to the rear of the column, high enough to clear the square table of the machine when this is swung aside to enable the use of the round table. It also permits chips to be brushed from the table, without the liability of damage to the motor. At the same time, a motor placed in this position presents a neat appearance, and serves in a way to balance the machine against the weight of the square and round table on the other side of the column.

The motor is of constant speed, the speed variations being provided by mechanical means through the friction disks. The details of the friction drive were described in the April issue of MACHINERY, and it will only be necessary to mention the driving arrangement in a general way. The motor runs at 1,200 revolutions per minute, and by means of a double friction disk arrangement, shown at the top of the machine, a speed variation of the spindle ranging from 100 to 1,600 revolutions per minute is obtained. The drill spindle can be stopped without stopping the motor by throwing the speed lever to its extreme position. When in this position, the driver disk is released from contact with the friction roll, the disk being recessed in order to accomplish this. When the friction roll is in contact with the driving disk, its shaft or spindle is raised slightly and the weight of the rotor is taken by the disk, but when in the released position, the weight of the rotor is carried by a special collar. On starting the motor, the friction roll should not be in contact with the driver disk, the motor starting without load; then the friction roll is thrown into contact with the disk. Very little power is required for driving the machine, as the normal pressure on the roll is very slight until the drill is in use, when the pressure increases or decreases with the working pressure on the tool. The machine has some very commendable features, and will, undoubtedly, prove a very efficient sensitive drill.

CENTER GRINDER AND FRAME FOR PORTABLE DRILL.

In Fig. 1 of the accompanying half-tones is illustrated a new type of electrically-driven center grinder made by The United States Electrical Tool Co., of Cincinnati, O. This

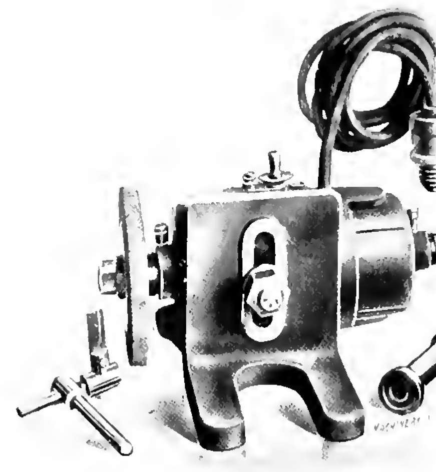


Fig. 1. Electric Center Grinder.

grinder is mounted on an angle plate, as shown. The lower part of the angle plate has a slot provided which straddles the tool-post of the lathe, and the device is clamped to the tool-post slide by means of the tool in the tool-post. In this way the grinding wheel with its motor may be held very rigidly, and there is no vibration in the motor of the kind

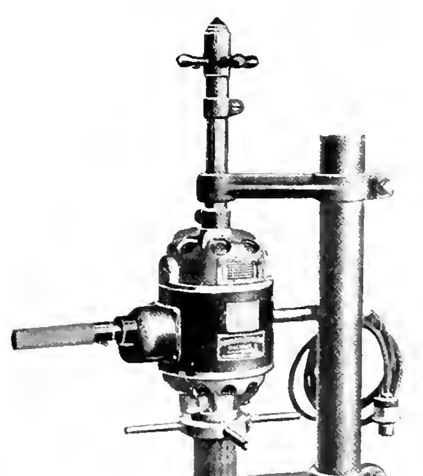


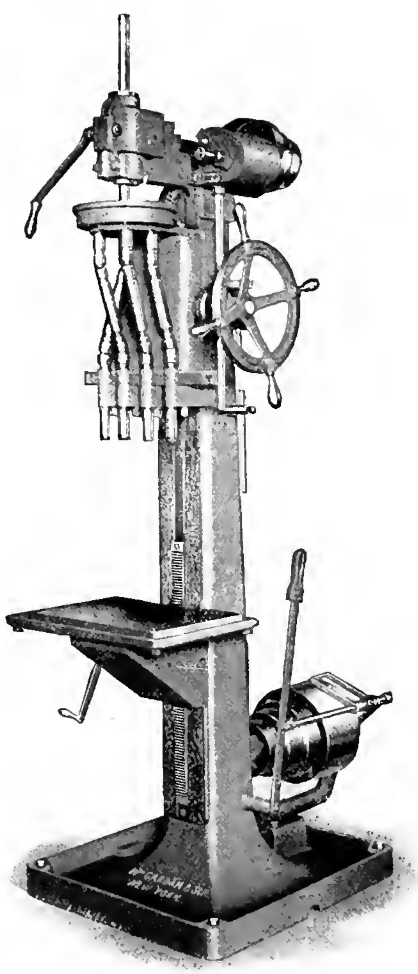
Fig. 2. Improvement of the "Old Man" applied to the Electrically-driven Drill.

so objectionable when the motor is attached to a shank. The motor and grinder can be raised or lowered to suit the height of the centers of the lathe by means of oblong slots provided in the vertical part of the angle plate, as plainly shown in the half-tone. The device can also be swiveled to any angle. The bearings are adjustable for taking up the wear, and provided with caps, making them dust-proof. The motor is of the air-cooled type.

Another handy device brought out by the same company is an improvement on the "old man" or a frame for portable drill, as shown in Fig. 2. This device consists of a rigid post, provided with two brackets, one having a plain bearing and the other arranged for feeding the drill. This post is placed in a base provided with oblong slots for clamping purposes. This improvement on the "old man" as usually constructed, will be appreciated and found very handy around the shop where portable electric drills are employed.

GARDAM ADJUSTABLE MULTIPLE SPINDLE DRILL.

The adjustable multiple spindle drill shown in the accompanying illustration is one of a series recently designed and placed on the market by Wm. Gardam & Son, 45-51 Rose St., New York, and intended to take the place, for manufacturing purposes, of the ordinary multiple spindle drilling machine with fixed spindles. The machine shown in the half-tone is adapted for drilling at one time a number of small holes up to ½ inch diameter, and a special feature of the tool is the ease with which it can be handled and the rapidity with which the changes can be made from one series of holes to another. While this particular drill is designed for four spindles, others are made with a varying number of spindles



Gardam Adjustable Multiple Spindle Drill.

having an adjustment forward and back of 3 inches, and sideways of 15 inches, the minimum distance between any two spindles being ordinarily 1¼ inch. The spindles can also be adjusted vertically to allow the use of drills of different lengths, and all are bored to take a No. 1 Morse taper shank. The head which carries the spindles is counterbalanced by a weight inclosed within the column.

The table is supported on a very rigid box knee, and is adjustable by rack and pinion. It is rectangular in shape, 16 x 12 inches, giving an ample working surface, and is surrounded by an oil groove. The size and shape of the table, however, can be adapted to special needs. In order to provide simple means for taking up the wear, the table and head bearings are scraped and provided with gibs. The base is cast with a rim to form an oil pan, preventing the overflow of oil, chips, etc. These drills are very suitable for working in gangs, and several of them may be mounted on a common base, and arranged to work together in groups. When set up in this way, one attendant can easily take care of and operate several machines. The counter-shaft is attached to the base, and is fitted with tight and loose pulleys, and has self-oiling bearings. The driving gears are made of carbon steel, and the machines can be supplied with or without direct-connected all-gear feed, and with or without tapping attachment. If required, they can also be easily adapted for individual motor drive.

THE HELE-SHAW CLUTCH.

One of the severest, and undoubtedly the most difficult and most delicate of all clutch problems, has been presented to the designer by the development of the automobile, and a

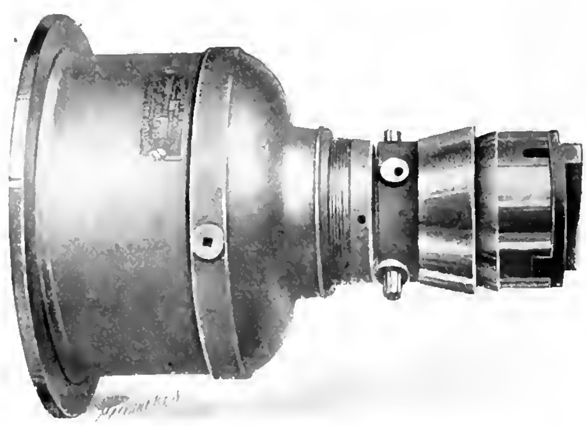


Fig. 1. General Appearance of the Hele-Shaw Clutch.

great many different ideas in clutch design have been due entirely to the development of the motor car. An interesting type of clutch for this as well as for other industrial purposes is shown in the accompanying half-tone, Fig. 1, and the line engraving, Fig. 2. The principal feature is that the power is transmitted through the friction between grooved disks of the cross section shown by the heavy black line at A in Fig. 2. A number of these disks are placed in the clutch, the V-groove of each fitting into the V-groove of the next. The power is transmitted by means of the outer edge of one, and the inner edge of the other, of each pair of disks engaging, respectively, with ribs in the outer casing B and inner drum C, engagement being through special notches cut in the edges of the disks. The outer casing is then attached to the motor or other prime mover, and the inner drum to the driven shaft, or *vice versa.* The spring D holds the disks in engagement with each other, until the disengaging lever is moved to the left, pulling with it the part E and the sleeve over the shaft F, thereby compressing the spring D, and releasing the pressure on disks A. The action, it is thus seen, is very simple.

It has been found that the V-shaped disks transmit considerably more power and permit a more even "pick-up" than clutches with flat disks. Other advantages claimed are also that the form of the disks permits the bodies of the plates to always be well separated, and leave free access for the oil circulation until the clutch is under engagement. This greatly increases the radiation of heat, as compared with flat disks. The special form also secures greater transverse strength, and the disks do not distort easily. The disks are oiled under ordinary circumstances, but if the oil should be lost by accident, the strength of the disks prevents injury even under the most unfavorable working conditions.

One of the most important features of the Hele-Shaw clutches, however, is their uniform rate of engagement or "pick-up," the engaging qualities being greatly enhanced by the special shape of the groove in the plates. The great number of surfaces and their large area make the clutch flexible and easily manipulated in case of slipping. The load is distributed over all the contact surfaces and therefore but a fraction of the load is placed on each disk, thereby preventing undue wear. When the clutch is first applied, the plates being pressed together by springs, the V-grooves intermesh gradually, bringing the driven series slowly to the speed of those driving, and forcing the oil out between them. The cushion of oil between the plates makes sudden engagement impossible, a factor which is of the greatest importance for motor car purposes. When the oil is finally squeezed out, the plates engage firmly with one another, and all slip ceases. As all lubricated clutches drag minutely the supposedly stationary disks when the car is not running, a small brake is used to stop the spinning of the driven shaft.

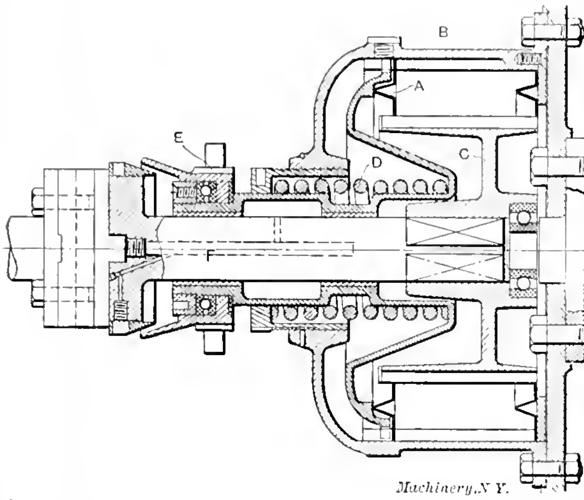


Fig. 2. Section of the Hele-Shaw Clutch, showing Design of Details.

The V-shaped plates are termed "Hele-Shaw friction disks" from their inventor, Professor Hele-Shaw, a description of whose original clutch appeared in the October, 1903, issue of MACHINERY. The clutch is manufactured in the United States by the Merchant & Evans Co., 517 Arch St., Philadelphia, Pa.

HENDEY SINGLE PULLEY AND MOTOR-DRIVEN GEARED HEAD LATHES.

In Figs. 1 to 3 are shown the designs adopted by the Hendey Machine Co., Torrington, Conn., for its single pulley driven lathes, and for those which are to be motor driven. The forms of construction adopted present a number of interesting features. For instance, a considerable range of mechanical speed changes, nine for the larger sizes and eight for the smaller ones, is obtained from a single speed pulley by a comparatively simple mechanism. The few gears and clutches required are very liberal in size, possessing ample strength and wearing qualities to meet all the requirements of high-speed turning.

The design of the drive for the 20 and 24-inch lathes is best seen in Fig. 2, which shows the head-stock of Fig. 1 with the cover removed. The driving pulley, as shown, is mounted on a shaft at the front of, and in the same longitudinal plane with, the spindle of the machine. It carries a set of three sliding gears, which may be shifted, by means of the horizontal handle near the top of the casing in Fig. 1, to engage with any one of three gears on a sleeve which runs loosely on the spindle. The shifting gears on the driving shaft are thrown out of engagement before their position is changed by rocking the lever shown at the front end of the head-stock in Fig. 1. This rotates the eccentric sleeve in which the driving shaft is mounted, so as to move the latter away from the spindle far enough to permit the gears to be moved without interference. At the back of the gear casing is a third shaft corresponding in function to the usual back gear shaft. The two gears of this shaft mesh with mating gears on the spindle sleeve, while the pinion at its right-hand end engages the large spindle driving gear.

The handle at the front of the casing, seen in both Figs. 1 and 2, carries double cam grooves which operate two rock shafts, one of which is connected with a positive clutch on the back gear shaft, to connect the latter with either of the two driving gears on its left-hand end, while the other operates a positive clutch on the spindle, connecting the spindle with either the sleeve at the left or the large spindle gear at the right. By this means it will be seen that nine different speeds are provided, the three obtained from the sliding gears being multiplied by three by the operation of the positive clutches, it being possible to transmit the motion either directly to the spindle from the sleeve, or through either of the two back gear ratios. The arrangement of these controlling handles is very convenient. The handle on the front side of the head-stock operating the positive clutches is used for stopping and starting the machine independently of the counter-shaft. It may be so quickly done by this means that an appreciable saving of time results in cases in which frequent changes of work are required.

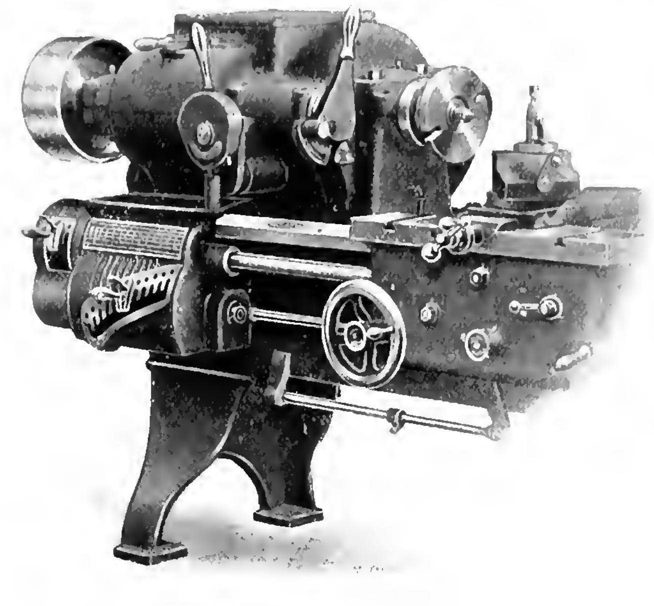


Fig. 1. Hendey-Norton 20-inch Lathe with Geared Head.

The head-stock casing forms a pan or reservoir for oil so that the gears which are enclosed are constantly lubricated. By this means they are caused to run more smoothly and they wear for a materially longer time, as well. Special attention has been given to the matter of continuous and efficient lubrication for the bearings, and for the gearing rotating freely on the shafts in the head. The spindles have taper journals running in annular bearings; and these, with the driving shaft and back gear bearings, are fitted with ring oilers, feeding from oil pockets in the casing; an exception is made in the case of the driving shaft of the 20- and 24-inch heads, which runs in babbitt-lined bearings formed in either end of the sliding gear cradle or rocker which throws the gears

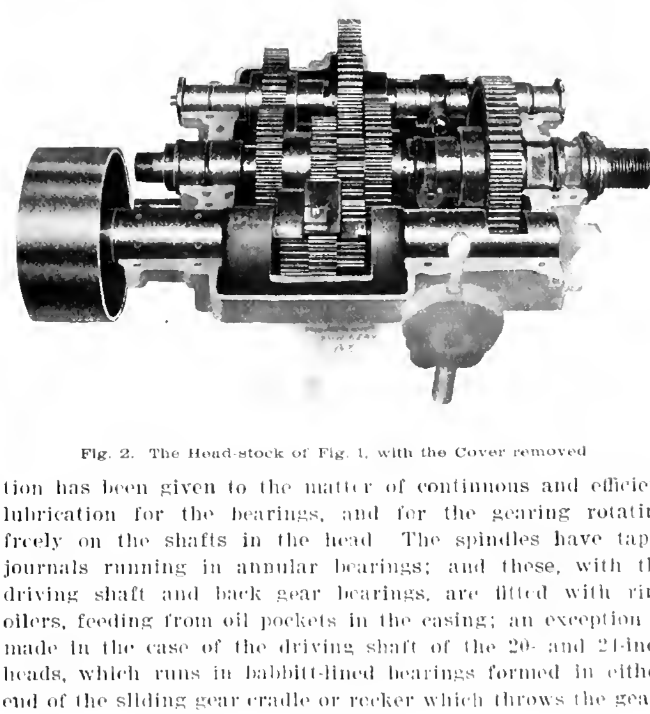


Fig. 2. The Head-stock of Fig. 1, with the Cover removed

out of mesh, as previously explained. All bearings of the free gears and of the clutches are automatically oiled from the oil bath. The removal of the upper half of the casing, as may be seen in Fig. 2, exposes all the bearings and journals and allows the component parts of the mechanism to be freely removed.

The driving pulley is 12 inches in diameter on the 20-inch lathe in question, and is driven by a 5-inch double belt. At the highest spindle speed the belt travels 3.14 feet per revolution of the spindle, while at the lowest spindle speed this is increased to 81.5 feet per revolution. By comparing this with like conditions on a 20-inch belt cone-driven lathe, it will be found that in addition to using only a 3-inch belt in place of the 5-inch one, the amounts of belt travel are but 1.24 feet and 37 feet, respectively. The difference in belt power is about 4 to 1 in favor of the geared head lathe. In all Hendey-Norton lathes, two speeds are available in the countershaft, since there is no necessity for providing a reverse drive for threading. By this means the nine mechanical spindle speeds are doubled, giving 18 in all, in geometrical progression. In the case in question this range is from 10 to 324 revolutions per minute, but may be varied, of course, to suit the class of work to be done. For motor-driven machines it is only necessary to mount the motor on top of the casing, and connect it with the driving shaft by gearing or by a chain drive.

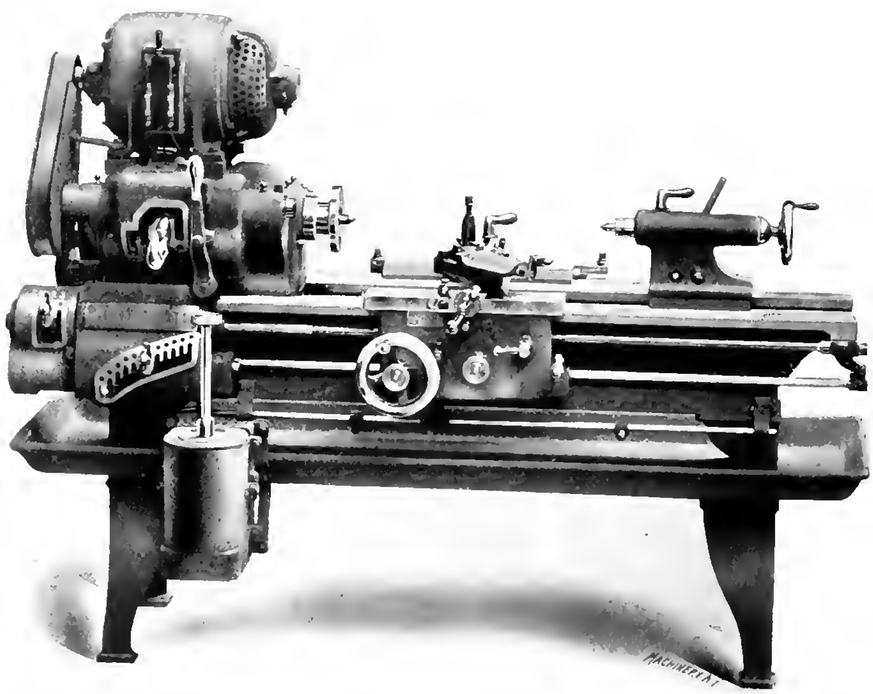


Fig. 3. Hendey-Norton 14-inch Motor-driven Lathe, showing Geared Head used on Smaller Sizes.

In Fig. 3 is shown a motor-driven machine, in which, however, a somewhat different mechanism is used for obtaining the mechanical speed changes. This lathe (which is smaller than the one previously shown, having 14 inches of swing) is suitably driven by a modification of the makers' well-known change gear mechanism used in their standard line of lathes. The intermediate shifting gears, mounted on the driving shaft, are controlled by a lever working in a slot in the gear casing, which is also provided with locking holes for the plunger pin of the lever. In this head there are 4 direct speeds and 4 through the back gears with the driving shaft running at a constant rate, giving 8 in all. The large lever at the front of the head controls a single positive clutch on the main spindle, and is used to start and stop the machine in the same way as a similar lever on the 20-inch machine shown in Figs. 1 and 2. In Fig. 3 a variable speed motor is used in place of the belt transmission to a single pulley; 20 gradations of speed are provided by the controller used, so that the operator has at his control 160 possible speeds in all. By this means he may adjust the rate to give all that the cutting tool will carry within very close limits. The power transmission from the motor to the driving shaft of the lathe head is effected by a silent chain which, with the sprockets on which it runs, is enclosed in a guard as shown.

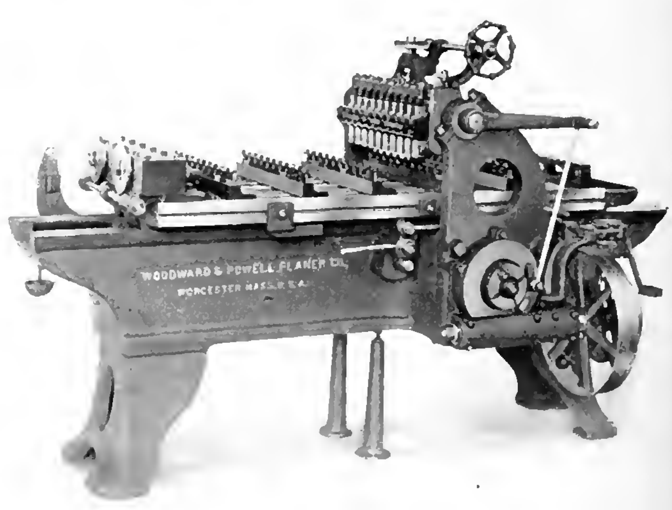
It will be seen that with either of the styles shown in Figs. 1 and 3 the mounting of the motor on top of the head is neatly done, the resulting combination not being at all top heavy. There is as well no over-hang in any direction, and the whole mechanism may be readily dismounted at any time when occasion may require. These gear-driven lathes are manufactured in all swings from 12 to 24 inches inclusive.

WOODWARD & POWELL PLANER FOR FLUTING FEED ROLLS.

We show herewith an illustration of a special planer recently built by the Woodward & Powell Planer Co., Worcester, Mass., for the special purpose of fluting feed rolls such as are largely used in textile machinery of various kinds. The construction of the planer involves a number of special features which are ingenious enough to warrant bringing the machine to the attention of our readers.

The feed rolls which are to be planed, are about 1¼ inch in diameter. The table of the planer is provided with 10 centers to accommodate 10 rolls side by side. These rolls, which are provided with square tenons on one end and corresponding square mortises on the other, are mounted on centers, those at the front end being squared to fit the mortise in the work, while the tail centers correspondingly fit the tenons. The rolls are supported throughout their length on V's, in which they are lightly held by clamps adjusted by the screws shown.

The head centers are arranged in two groups, the center spindle on each of which has a dial on the outer end. The 5 spindles in each group are geared together. These dials are left blank in the engraving, so that they may be cut with the requisite number of notches for the work in hand, the number depending on the number of grooves desired in the feed rolls. The hole in these dials is placed a little out of center, so that the space between consecutive notches will not be the same. This irregular spacing is necessary to break up the contact of the feed rolls against the leather-covered rolls they work with when assembled in the finished machine. If



A Planer fitted with Special Work- and Tool-holding Devices for Fluting Rolls.

the notches were spaced the same, a series of impressions would be formed in the leather rolls, making gears out of them. On the horizontal shaft which runs crossways of the front end of the table are two pawls engaging notches in the dials. When the table is returning, the back end of this shaft strikes the inclined latch, shown attached to the bracket

at the back side of the bed. This latch forces the shaft over and turns the two dials, consequently turning each of the ten spindles and indexing the rolls ready to cut the next groove. When the table starts back on the cutting stroke, a spring forces the shaft back to its original position, and the end of it strikes the latch which swings to the right until the shaft is cleared.

A tool is of course provided for each of the ten rolls. These tools are all mounted in the multiple holder shown, which is fastened to a slide mounted on a frame which can be rocked on trunnions in the housings fastened to the side of the bed. The friction box usually applied to operating the feed is, in this case, used for relieving the cutters on the return stroke. The friction disk is connected by the reach rod shown with a lever attached to the rocking tool-holder, so that the cutting blades are raised on the return stroke and brought back into position again at the beginning of the cutting stroke. The tool slide in which the blades are mounted fits vertically in dove-tail ways, being adjusted by a feed-screw operated by the bevel gears and hand-wheels shown.

It will be seen that the table of the planer is worm driven, being provided with a belt shifting mechanism of the type commonly used on spindles. The whole arrangement is an interesting modification of a standard machine for work of a highly specialized character.

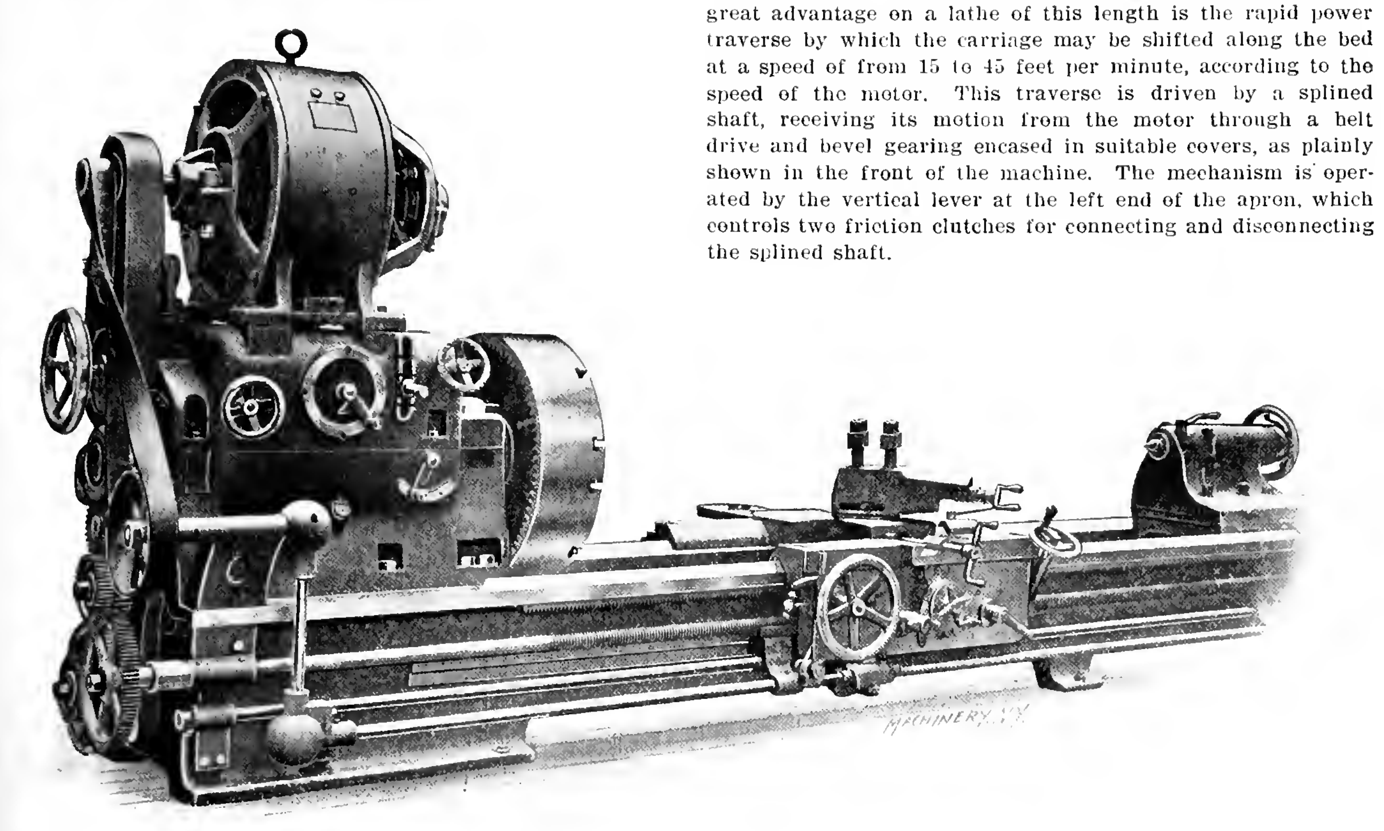
BRIDGEFORD 36-INCH GEARED HEAD LATHE.

The accompanying half-tone illustrates a new design of geared-head, motor-driven lathe, containing several features of mechanical interest; it is one of three machines recently built by the Bridgeford Machine Tool Works, Rochester, N. Y., for the Jones & Laughlin Steel Co.'s new shops at Woodlawn, Pa. One of the principal features of this lathe is that it has been designed exceptionally heavy, so as to meet the severest requirements placed on a machine of this kind through the use of high speed steel.

The drive is from a 15 H.P. Westinghouse motor, placed on the top of the frame of the geared head-stock. This motor provides a speed variation of from 300 to 900 R. P. M., and is direct-connected with the driving shaft of the head-stock through a rawhide intermediate gear. The arrangement in the geared head-stock provides for fifteen changes of speed, arranged in geometrical progression, obtainable through an easily operated speed variating mechanism in the head. The variable speed motor, however, adds to the efficiency of the tool, as it enables the operator to obtain a wide range of speeds without leaving his position at the carriage. The controller lever for the motor is mounted on the apron, and operates through a splined shaft. The controller and the resistance are placed on the back of the machine.

When the lathe is belt-driven, the speed variation obtainable through the motor is not available, but the 15 speeds provided for by the gearing in the head-stock give ample variations for different classes of work. In the case of belt-driven machines, the gear on the driving shaft is replaced by a pulley, running at a constant speed of 300 R. P. M. The spindle speeds then obtainable range from 3 to 150 R. P. M., which is sufficient for all purposes. All the driving gears within the head-stock are made of steel, and run in oil, and the bearings are so arranged as to receive a constant oil supply, thus insuring a minimum of loss of power through friction, and the durability of the tool, through the elimination of wear.

The lathe bed is 32 feet long, and a feature which is of great advantage on a lathe of this length is the rapid power traverse by which the carriage may be shifted along the bed at a speed of from 15 to 45 feet per minute, according to the speed of the motor. This traverse is driven by a splined shaft, receiving its motion from the motor through a belt drive and bevel gearing encased in suitable covers, as plainly shown in the front of the machine. The mechanism is operated by the vertical lever at the left end of the apron, which controls two friction clutches for connecting and disconnecting the splined shaft.



Heavy Bridgeford 36-inch Geared Head Lathe.

The lead-screw, the motor-controlling shaft and the rapid traverse shaft are all supported by automatic carriers which slide on a planed way on the front of the bed or frame. These carriers are plainly shown in the illustration; one of them always remains at the center of the travel, while the other is pushed along by the carriage. This method of supporting the lead-screw and the controlling and traverse shafts is a decided improvement over supporting them from the top of the frame, because by the former method the tail-stock is allowed free and unobstructed travel.

The lathe is designed to give a pulling power of 20,000 pounds on a 36-inch diameter, which is about four times that of the average cone-driven lathe of equal size. Motors varying from 15 to 25 H. P. are used, according to requirements. A constant speed motor can be employed instead of the variable speed motor referred to, but it is evident that variable speed is preferable. The total weight of the 36-inch lathe is about 29,000 pounds. It can be obtained with any length of bed desired, and the same type of machine is also built with 26, 32, 42 and 46-inch swing. It will be noted that in the half-tone part of the long bed has been omitted, in order to show the essential details more plainly. In the original photograph the omitted portion of the bed carries a rigid center rest, which is also furnished with the lathe.

IMPROVEMENTS IN THE UNIVERSAL MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE.

Important improvements have recently been made in the driving mechanism of the multiple spindle automatic screw machine made by the Universal Machine Screw Co., of Hartford, Conn. We have previously described this tool (see New Machinery and Tools in the February, 1906, issue of MACHINERY). A comparison of the description and illustrations given in that issue with the ones here given will at once show the difference in the two designs. The new arrangement provides for a single-belt drive in place of the three-belt drive required in the older machine. Besides reducing the cost of the belting used, an important feature is the fact that it permits greater flexibility in the arrangement of the machines, gives greater driving power to the spindle, and, by means of provisions to be described later, permits of varying through a wide range the ratio between the turning and threading speeds.

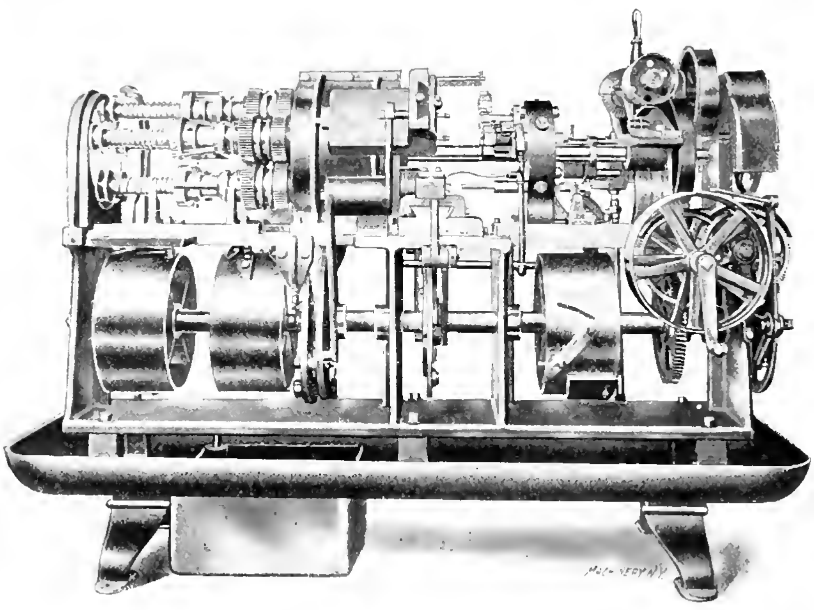


Fig. 1. Improved Design of the Universal Multiple Spindle Automatic Screw Machine.

As will be remembered, in this machine five spindles are employed, carried in a cylinder which is indexed to bring each spindle in turn opposite each of the five tool-holders, for which provision is made in the tool slide. The bars of stock which are held and rotated by these spindles project to the rear of the machine, where they are carried by reels supported by stands bolted to the floor. The tool-holder is fed forward by a cam on the cam shaft in the base of the machine, advancing all the tools simultaneously, and completing a piece of work at each revolution. The various cross-slide operations, the indexing of the cylinder, and the feeding and gripping of the stock, are also controlled by cams on the same cam shaft.

The threading is effected by reversing the spindle. The spindles normally revolve in a left-hand direction for all the turning, drilling, forming and cutting-off operations. For threading on the die, they are reversed to give a slow right-hand rotation suitable for the threading operation. When the die is advanced to the proper point on the work, the spindle carrying the latter is again reversed to throw in the regular left-hand movement, and the die is rapidly threaded off again. To obtain this alternate forward and backward rotation of the spindles in the cylinder, they are driven by two sets of gearing from their left-hand ends, of which the one nearest the turret is driven by a gear on a sleeve passing through the axis of the cylinder and leading toward the right of the machine, while the gear for driving the thread is keyed to a shaft passing through this sleeve, also extending toward the right. In the older design, this shaft and this sleeve were each driven by separate pulleys, belted to the counter-shaft. This has been changed in the new design to the method of driving shown in Figs. 1 and 2.

Sleeve A for driving the left-hand or turning movement, see Fig. 2, has keyed to it a gear F, driven by pinion E on shaft D, to which is keyed the driving pulley C of the machine. This driving pulley revolves at a high rate of speed, and the ratio of the driving gearing provided is such that it furnishes ample power for rotating the spindles. The right-hand end of short shaft D is connected by change gearing M with shaft B, which drives the spindles for the threading operation, as previously described. By this means a spindle speed suitable for threading can easily be obtained by changing gears M, the same as the gears for threading on a lathe are changed. The fact that an intermediate stud is introduced between D and B in this change gearing reverses the rotation of shaft B as compared with sleeve A.

The cam-shaft is also driven from the same pulley C. The left-hand end of shaft D (Figs. 2 and 3) carries a bevel pinion G, meshing with bevel gear H on shaft I. This shaft has loosely running upon it pulley J. J may be clutched to I by throwing lever K over, thus engaging the conical clutch surface shown. When lever K is thrown to the right so that the clutch is disconnected, a spring brake L is applied to pulley J which is thus instantly stopped. As may be seen in Fig. 1, J is to be belted to the driving pulley of the cam mechanism. It will thus be seen that the feeding and idle movements may be stopped or started independently of the spindle, greatly facilitating the setting up and operation of the machine.

Another improvement in the design is the new locking arrangement provided. Previously, the locking was done by a taper pin entering seats in the periphery of the cylinder. This has been replaced by a locking bolt of considerable size, thus giving great area of locking surface and reducing the possibility of error. This enters milled seats in the body of the cylinder, the milling being done on a fixture which has been very carefully made so as to divide these slots with great accuracy. As constructed, the upper face of the locking bolt is radial. A wedge adjustment is provided for keeping this radial face properly adjusted against the cap which confines the bolt in the slot in which it is held. The mechanism for operating the locking bolt and indexing the cylinder has been described in MACHINERY in the article previously referred to. The increased ruggedness and wearing surface given the lock-

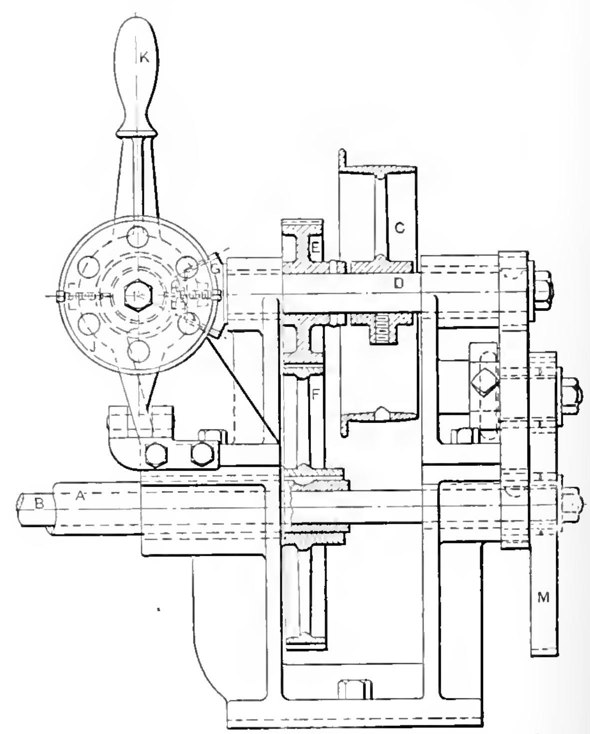


Fig. 2. The Spindle and Cam Shaft Driving Mechanism, Operated by a Single Belt.

ing bolt in this design should result in a lengthening of the effective life of the indexing mechanism.

The pump used in supplying the cutting tools with oil is also gear driven, from large gear *F* on the center sleeve. This does away with the belt drive commonly used on machines of this kind in which the belt often becomes oily and slips,

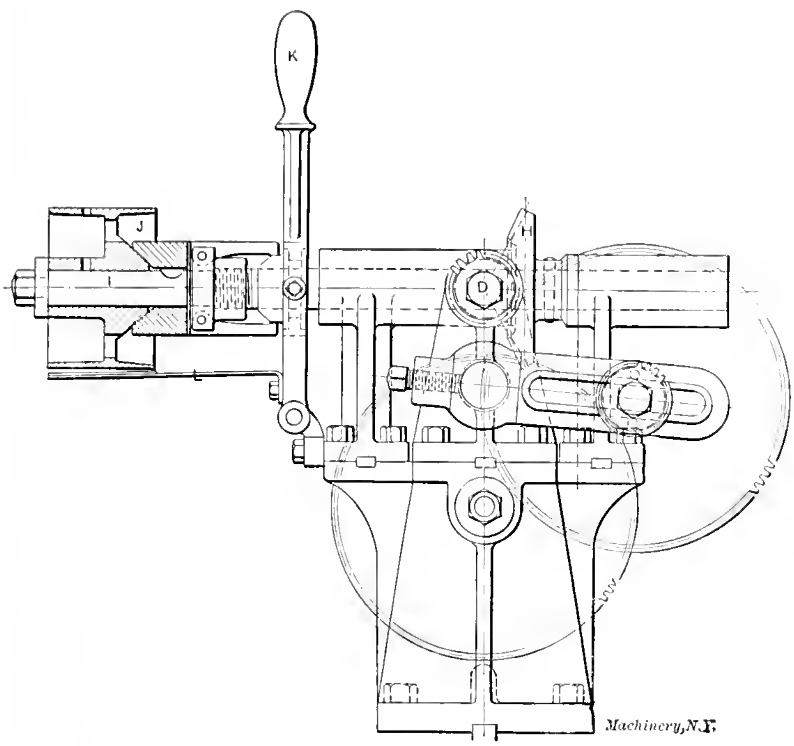


Fig. 3. End View of the Spindle and Cam Shaft Driving Mechanism.

thereby decreasing the flow of oil on the tools, resulting oftentimes in seriously heating and damaging them. Another new featnre of the machine is the design of the positive clutch used for connecting the spindles with either the left-hand turning or the right-hand threading movement. We hope to publish a description of the design of these new clutches in a later issue.

The capacity of the machine shown in Fig. 1, which is the No. 3 size, allows the use of stock up to $1\frac{1}{2}$ inch in diameter. It will turn up to 5 inches in length and will feed stock to 6 inches in length. Two smaller sizes are made.

TAYLOR & FENN AUTOMATIC SCREW SLOTTING MACHINE.

In the automatic screw slotting machine shown in Figs. 1 and 2 and described in the following paragraphs, the builder, the Taylor & Fenn Co., of Hartford, Conn., appears to have succeeded admirably in its attempt to design a simple and effective machine in which the possibilities of error on the part of the operator are reduced to a minimum, while the rate of production is set at the highest attainable pitch. The machine is entirely automatic in its action, and requires no attention beyond the filling of the hopper with blanks, the removal of the finished work, and the occasional sharpening of the saw with which the slotting is done.

The larger pulley at the left of the machine, driven by a constant speed belt, operates the work-holding and feeding movements. This pulley revolves on a stud, and drives a long pinion, which at the front meshes with a gear on a shaft extending beneath the bed of the machine and driving the hopper at the right, through the bevel gears shown. This hopper and the feeding mechanism connected with it, thus operate at constant speed, regardless of the size of the screw, and serve to keep full of blanks the chute leading to the work-holding disk. The principle of the feeding mechanism is the same as that employed on practically all machines of this kind. The slowly revolving hopper is filled with screws. A fork which dips into the hopper is raised from time to time to allow to slide downward into the chute, the screws whose heads have been caught between the adjustable bars which form the sides of the fork. If the chute is already filled, the blanks slide back down the fork when it is again dipped into the hopper. The raising and lowering of the fork is effected by a cam on the bevel gear shaft which drives the hopper. This cam operates a vertical rod passing through the center of the hopper which, in turn, acts on the fork through the radial bars shown. The chute is composed of a second pair of adjustable bars, which catch the heads of the screws and allow them to slide down to an escapement. This escapement, operated by cam mechanism to be described later, permits the blank to fall into position in the work-holding disk, when the proper time comes for grasping it and presenting it to the saw.

A particular feature of this feeding mechanism is the ease with which it may be adjusted for screws of different sizes. There are no parts which have to be removed and replaced for others in making changes, everything being permanently attached to the machine. Changing from one size to another is a matter simply of adjusting the distance between the guiding bars of the fork and the chute to the size of the body of the screw, and adjusting the top bar of the chute and the escapement to the size of the head of the screw.

The work-holding and cutter-feeding movements are operated from a cam shaft at the back of the machine, connected with the large driving pulley at the left by change gearing, so that the rate of operation may be altered to suit the size of work in hand. The mechanism for holding the work and presenting it to the saw will best be understood by comparing the top view of the machine, Fig. 2, with the line drawing, Fig. 3. After being released from the chute, the blank falls into the position shown at *A* in Fig. 3, where it is held between a seat in bushing *B* and spring *C*, which is attached to escapement lever *D*. This escapement lever, which thus both operates the escapement and holds the work in place in bushing *B*, is operated by cam *E* on the cam shaft at the rear

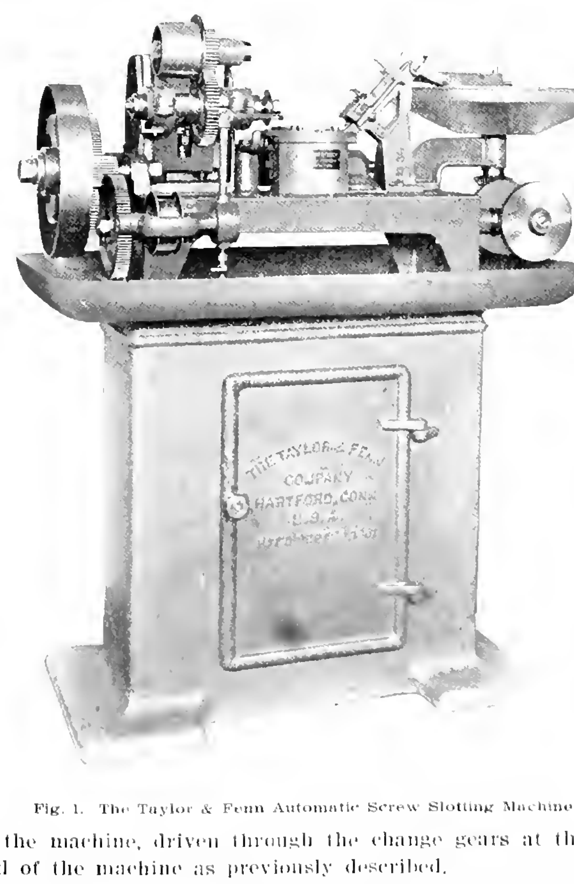


Fig. 1. The Taylor & Fenn Automatic Screw Slotting Machine.

of the machine, driven through the change gears at the left end of the machine as previously described.

At *F* is a vertical shaft extending down through the bed of the machine, driven by the bevel gears shown, from the shaft on which *E* is mounted. This shaft carries a revolving arm *G*,

which strikes locking lever *H*, pivoted at *J*, and raises it from the slot in disk *K*, in which it is seated. All these parts are shown in dotted lines, being located beneath the base of the machine. Continuing its movement, *G* strikes against the teeth of the star wheel *L* as shown, revolving it one-sixth of a turn. When this revolution has been completed, *H* again drops into the slot in *K*, locking the latter. The locking disk *K* and star wheel *L* are keyed to a vertical shaft passing up through the bed of the machine and operating turret or work-

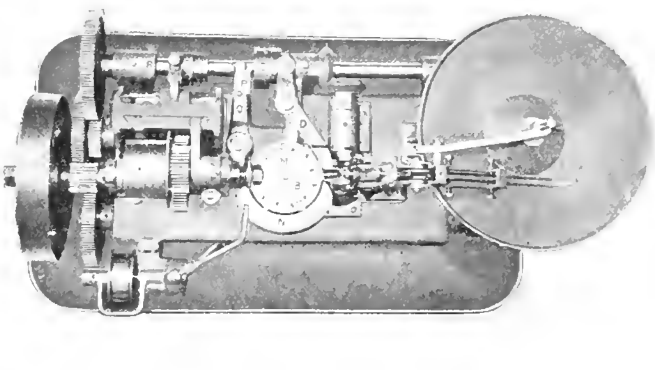


Fig. 2. Plan View of Screw Slotting Machine, showing Work-feeding and holding Mechanism.

holder *M*. As shown in Fig. 2, this work-holder carries six bushings *B*, and in its rotation receives the work from the chute and delivers it to a position directly beneath the slitting saw. The work is held loosely in place in the bushing by guard *N*, which is adjusted in or out to agree with the diameter of the body of the work.

As the work is indexed step by step around to the saw, and finally brought in position beneath it, a cam surface on the face of cam *E* operates lever *O*, whose inner end is thus pressed firmly against the work, clamping it to its seat in the bushing. Cam *E* does not bear directly on the end of the lever

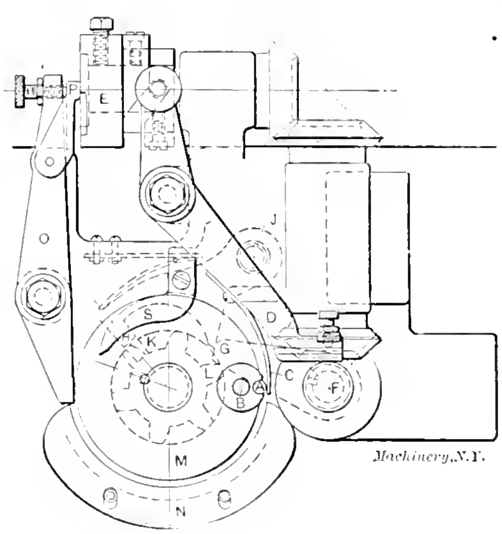


Fig. 3. Partial Plan View, showing Work-holder Indexing Mechanism.

O, but acts through the intermediate lever *P*, which is adjustable by means of the thumb screw shown. It is thus possible to regulate the pressure with which *O* bears on the work, varying the adjustment as the size of the stock varies.

The saw is mounted on a slide, gibbed to the face of a short column, and is driven by the constant speed pulley and gearing shown. It is held normally at the upward extreme of its travel by springs beneath it, seen in Fig. 1. The saw is fed down into the work by cam *Q* (see Fig. 2) acting on lever *R*. This cam operates in such a way as to bring the saw quickly down into contact with the work and feed it rapidly in, slowing the feeding motion gradually as the saw cuts to greater depth and takes a wider cut. As soon as the depth has been reached, the point of lever *R* drops off the cam and the slide flies back. Contact *P* on lever *O* then drops into the relieving space in the face of cam *E*, thus releasing the work from the bushing *B* and allowing it to drop into a chute by which it is carried to a box placed to receive it. Should the work not fall freely from its seat in the bushing, it is, by the continued rotation of the turret, finally ejected by the curved edge of ejector *S*. An oil pump is provided, as seen in Fig. 1, which keeps the saw and the work flooded so that the slotting operation can be performed at the highest possible rate.

It will be noted in Fig. 2 that bushings *B* are provided with a number of seats in their periphery. It is thus possible to provide for holding screws of a number of different sizes without requiring new bushings, as it is only necessary to loosen the screws holding the bushings and revolve them until the proper seat is brought to position to hold the work.

An important feature of the method of holding the work and presenting it to the saw is the fact that inaccuracies in indexing do not affect the centering of the slot in the head of the screw. An inaccuracy in the indexing only takes place in a direction lengthwise of the slot, and not at right angles with the face of the saw.

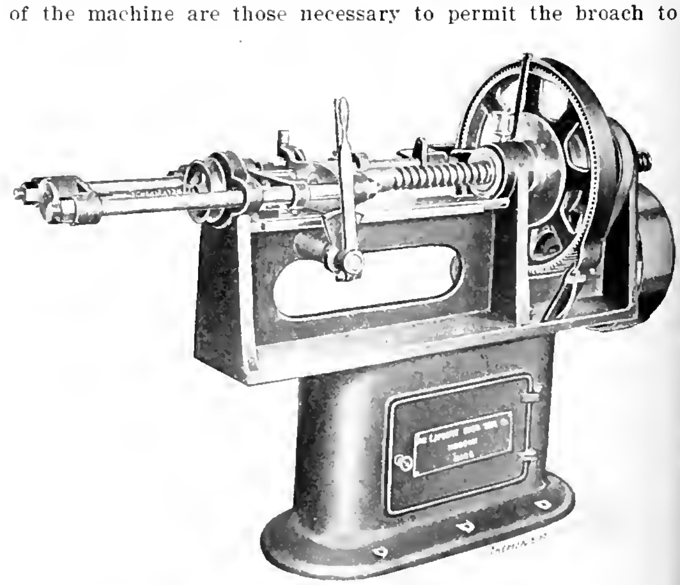
A screw adjustment is provided for shifting the spindle endwise in centering the slot, though this only needs to be done to make allowance for cutters of different thicknesses. The seats in bushings *B* are cut to such depth as to always present the screw in the same position whatever the diameter of the stock.

One of the provisions for making the machine fool-proof is the means furnished for allowing the driving pulley to slip on the hub of the pinion it drives, if any unwonted resistance is met in the mechanism. The pulley is not keyed to the pinion, but drives it by frictional contact, being clamped between collars with a degree of pressure adjusted to suit the requirements.

All gears are guarded, these guards being removed from the machines to show the mechanism better. This prevents the possibility of injury to the operator, as well as danger to the gears themselves from the accidental falling into them of screw blanks or chips. These provisions, together with the adjustability provided in the feeding and holding, should make the machine a thoroughly practical one for the work it is intended to perform.

LAPOINTE SPIRAL BROACHING MACHINE.

In the accompanying engraving is shown an ingenious modification of the well-known broaching machine built by the Lapointe Machine Tool Co., Hudson, Mass., which adapts it to the broaching of spirals, performing this operation in a very simple and effective fashion. The changes made in the design of the machine are those necessary to permit the broach to



Modification of the Lapointe Broaching Machine, adapting it to the Cutting of Spirals.

revolve freely while being forced through the work. The machine here shown should be compared with the standard design, which we have previously illustrated. (See the New Machinery and Tools Department of the July, 1907, issue of MACHINERY.

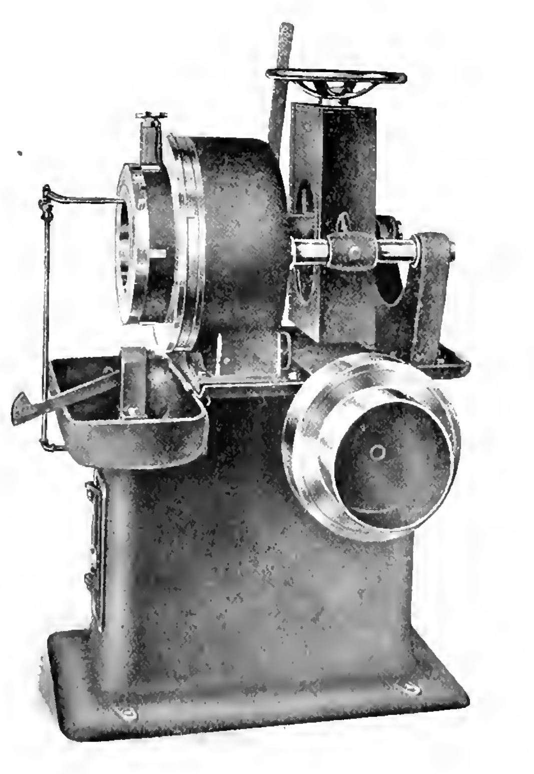
As in the standard machine, the broach is reciprocated by a ram with a screw thread cut in it, engaging a nut which

may be revolved in either direction, so as to drive the ram in or out. The reversal is effected in this machine by the shifting of belts, being controlled by reversing dogs which may be set to limit the stroke in the same way that a planer table is controlled. Instead of fastening the broach in the end of the ram and pulling it through the work, the broach is pushed, by a cross-head out in front of the machine, which is itself pulled by the two sliding rods shown, connecting it with the head of the ram. In this way the ram pulls the cross-head and the cross-head pushes the broach through the work, the latter being mounted on the front face of the bed of the machine in the same way as in the usual design. The broach is not held in a holder, but is supported on a hardened center, which thus allows it to revolve in accordance with the spiral of the grooves which the broach is to cut. The broach is revolved by its own lead, so that no complicated mechanism is necessary for obtaining the pitch of the spiral.

In the work shown, the lead of the spiral is about 6 inches per revolution. A twist considerably more rapid could be obtained if it were necessary, the limit for work of this diameter being about 3 inches lead. The number of grooves or threads makes no difference with the work of the broach. It will be seen that the arrangement is very satisfactory from the standpoint of rapid working, as neither the tools or the work have to be clamped in any way, it being merely necessary to place them in position and start up the machine. When the broach is passed through the work the operator picks it out from the bed, removes the work and inserts a new piece, proceeding as before.

THE LOEW IMPROVED VICTOR PIPE-THREADING MACHINE.

A machine embodying several new features of design which will tend to enhance the value of the pipe-threading machine, has been placed on the market by The Loew Manufacturing Co., of Cleveland, Ohio. This machine is known as the 1908 model of the Loew Victor pipe machine. The most important improvement in the design of the machine is the added strength given to parts subject to stresses, it having been the



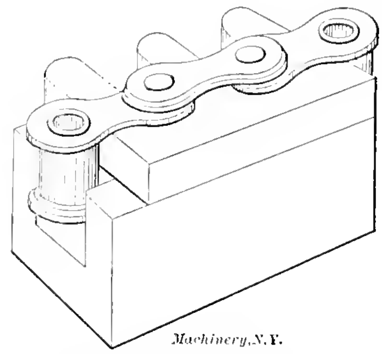
Improved Pipe-threading Machine of Heavy and Rigid Design

manufacturer's object to build a machine sufficiently strong and durable to withstand the same hard service to which all so-called lathe-bed machines are subjected. The increase in size from previous designs is indicated by the fact that the length of the base has been increased 8 inches; the diameter as well as the bearing surface of the head has been increased; a new oil pan has also been added to the machine; and, in all, this design is about 450 pounds heavier than its predecessor.

Outside of these specific improvements, the machine contains all the special features characteristic of the Loew Manufacturing Co.'s machines in general, which may be summarized as follows: The die-head is self-locking, and holds the die absolutely rigid, without the use of wing nuts or other locking devices; the machine is provided with automatic die releasing attachment, opening the dies and removing the burrs from the thread at the same time; there is no gearing on the outside of the machine, a feature of great importance for safety as well as convenience; and a self-locking, adjustable guide is provided which holds the pipe absolutely rigid. The power required to drive the machine fully loaded is about 1 H.P. The design of this machine enables it to do the same class of work as others of the regular lathe-bed type, although it is practically only one-third of the size of that class of pipe-threading machines.

DEVICE FOR HOLDING ROLLER CHAIN WHILE REPLACING LINKS.

During the last few years roller chain drives and link belts have come into use to a very great extent where short belt drives formerly had to be resorted to. The advantages of the chain drives in such cases are well known. The chains will not stretch like the belts, and all the common troubles of belt slip, slack belts, etc., are eliminated. One difficulty with chain drives, however, has been that sometimes a link proves defective or is accidentally injured, so that it is necessary to replace this link. Repair links are always supplied, but it is not always easy with the tools or apparatus at hand to place these links in position. For this purpose the Diamond Chain and Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., has placed the Diamond repair block on the market. With this tool which, as shown in the accompanying engraving, is small enough to be carried in the pocket, it is very easy to repair a riveted chain. The chain is placed in the block as indicated, and by giving both rivet heads in the link to be replaced a light tap with a hammer on a center punch, placed with its point at the center of the rivet, the old link may be detached and a new one put in its place, the chain drive being placed in action within a few minutes. This little tool will be appreciated by anybody who uses roller chain drives in any form.



Diamond Repair Block for Holding Roller Chain while replacing Links.

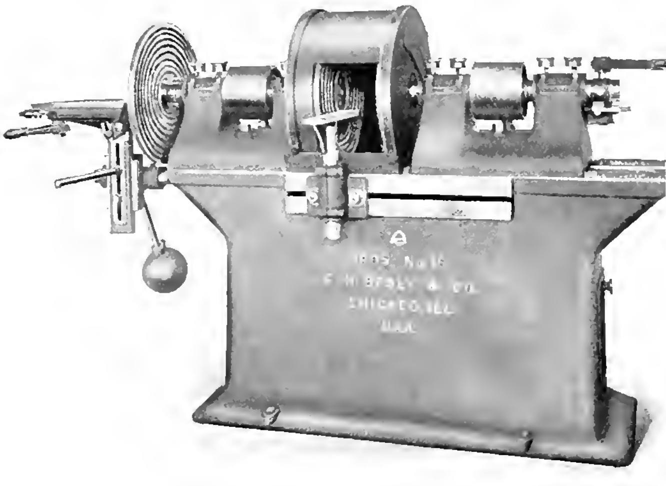
BESLY NO. 6 HEAVY SPIRAL DISK GRINDER.

This machine, built by Chas. H. Besly & Co., 15-17-19-21 So. Clinton St., Chicago, Ill., is a double disk grinder with a third disk for ordinary plain grinding at the left-hand end of the machine. This use of three disks makes the machine available for the full range of work which may be done on the disk grinder, the tool combining the advantages of both the single and double disk types.

The disk at the left-hand end of the machine may be provided with any one of the various styles of tables built by the makers. That shown is a geared lever feed table, which may be used for a large variety of grinding operations. The top is so designed that jigs and fixtures of all descriptions may readily be attached thereto. It may be clamped in a stationary position, or oscillated back and forth across the face of the disk at the will of the operator. For beveled work, it may be tipped to any angle up to 30 degrees from the horizontal position. It has a very powerful feeding mechanism controlled by an easily-operated short lever; a micrometer adjusting screw is provided for grinding to size. The bearing of the table on the shaft is very long and the thrust is

taken by collars which are rigidly clamped to the shaft, and so protected that dust and grit are excluded from the bearing surfaces, insuring long wear and continued rigidity throughout the life of the machine.

A special feature of the double disk portion of the machine is the adjustable dust hood arrangement. This is so constructed that the gap where the work is inserted between the disks, opens and closes automatically, according to the height or width of the work the machine is operating on. The parts of which it is made telescope together. The right-hand end of the hood, being attached to the movable head, is always brought into position by it, narrowing the gap or opening it as this head is moved in toward, or away from the opposite disk. It is also hinged at the back side of the machine, so that it can be instantly thrown back, giving free access to the disks. The dust pocket in the base of the machine is so arranged as to collect naturally practically all of the waste from the grinding operation. An exhaust pipe can be attached to the rear of the base or go up through the floor directly underneath, the latter being a desirable arrangement for some cases. When connected with a suitable exhaust fan, this machine in operation is entirely free from dust. A hood is also provided for the outside wheel on the left-hand end of the machine, though this is not shown in the engraving.



Combined Double Disk and Single Disk Grinder.

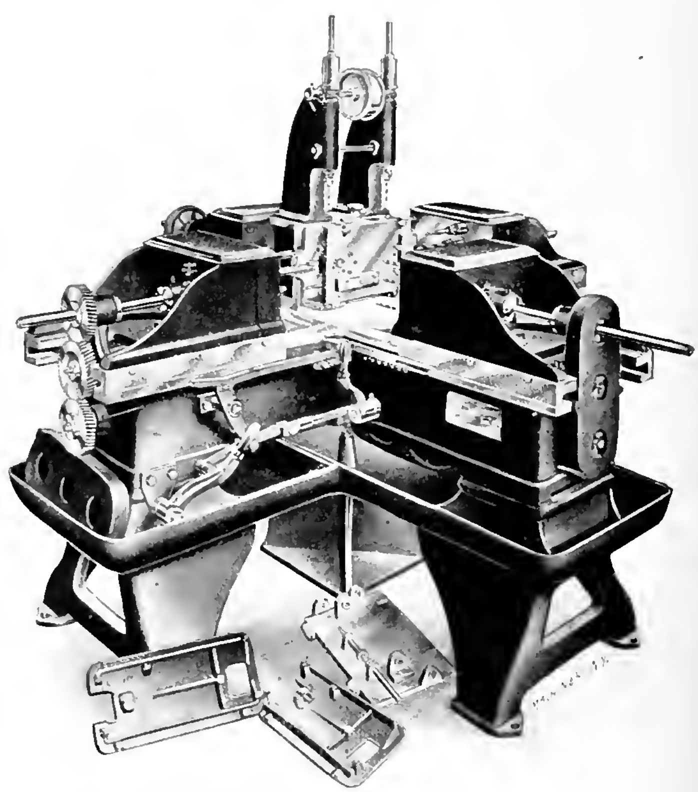
The machine as here shown, is equipped with 20-inch spiral disk wheels 13/16 inch thick. The spindles are driven by 6-inch belts at a speed of about 3,000 feet per minute, thus insuring ample driving power. The bearings are long and well protected from dust and grit. The sliding spindle is moved to and fro by rack and pinion arrangement giving the operator great leverage and making his work easy. An adjustable micrometer stop screw is provided for this movement. On the front of the base is cast a pad having a T-slot through its whole length on which the work rest brackets may be secured. Special fixtures may be fastened to the machine in the same way. The spindles are made of crucible machine steel ground all over, with special attention given to the matter of lubrication. The net weight of this machine with all accessories is 3,600 pounds. This includes work rests of various widths, a setting up press, counter-shaft and an assortment of spiral grinding surfaces. Solid wheel chucks can be furnished with this machine if desired.

NATIONAL AUTOMATIC FIVE-WAY DRILLING MACHINE.

The National Automatic Tool Co., Dayton, Ohio, is the builder of machinery which automatically performs machine shop operations on parts which are made in large quantities. We show herewith an example of its product in the shape of a five-way drilling machine, which, in the case shown, is engaged in drilling a sewing machine bed-plate having 19 holes, 5 of which are counterbored and one of which is 7/8 inch in diameter and 1 inch long. The work is done in forty-five seconds. The tool is universal and can be arranged for any other class of work.

As may be seen in the engraving, the machine is mounted on a cross-shaped bed-plate of great depth in proportion to its length and width, and heavily ribbed on the inside, making it free from appreciable deflection. This is an essential feature where combination drills and counterbores and large drills are used, and where accurate alignment between spindles and jigs is desired. This bed is mounted in an oil pan which keeps the dirt and chips from the floor, and forms a receptacle for the oil or drilling compound used. In the case shown, in which all four sides, as well as the top of the piece are to be operated on, each of the four branches of the bed is provided with a drilling head mounted on a slide, by which it is fed into the work. These drilling heads are each made up for the particular work to which the machine is set, carrying drills of the required sizes, rotated by suitable gears of the proper speeds. The work is held on a bracket in the center of the bed in a jig, to permit the rapid clamping of the work and to guide properly the various drills and counterbores used. Where holes are to be drilled in from the top, as in this case, brackets are also provided for the vertical spindles.

After the work has been clamped in place in the jig, the machine is started and the four heads are fed in toward the work by cams, one for each head. These cams, which are of the cylindrical type, give a rapid forward movement until the drills have reached the work, when they are fed in slowly to the proper depth and quickly returned again. The cam shaft stops at the end of the backward movement, mechanism being provided for this to obviate the possibility of the injury which would result to the workman if the machine should not be shut off, but should again return while he was removing the work. The cams for feeding the heads are mounted inside the four ends of the bed, and control rolls attached to adjustable bars, which may be clamped in any suitable longitudinal position with relation to the slides, thus furnishing means for adjusting the depth to which the drills are set. Power is transmitted from the rear of the machine to the several ways by means of miter gears of liberal proportions and carried to the driving shafts of the drill heads by means of twisted tooth gears and raw-hide idlers. The main driving shafts have their bearings in a sleeve which is rigidly fastened to the bed, and about which the cam drum revolves.



A Machine for Automatically Drilling Five Sides of Work made in Large Quantities.

The removable drill heads are securely fastened and dowelled to the sides. Each is composed of two sections, dowelled together, each section being a receptacle for oil, giving thorough lubrication to the spindles, driving shaft and gears. Each spindle has three bearings and its driving gear

is located between two of them. Where long life and great accuracy of alignment is desired, spindles are made of tool steel hardened, ground and lapped. Ordinarily, however, it is sufficient to have the spindles ground all over, running in bushings of high grade phosphor bronze. All of the spindles are provided with ball thrust bearings with lock nuts at the rear to take up end motion due to wear. Idler studs are hardened and ground and supported at both ends, the gears running in the middle of the studs between two bearings.

Each removable drill box with its spindles carries its own master gear, so that by taking out the spindle driving shaft, the whole drill box may be removed and another one fastened in place for machining a new piece of work. Each spindle carries a chuck made especially for the size of the drill to be used. Morse tapers are used on all the chucks.

These machines are made in two, three and four-way designs, as well as for drilling in five directions, as shown in the engraving. The machines are universal and can be arranged for any class of work within the range of the machine. They are in use at the present time for drilling sewing machine bed-plates, phonograph side frames, gun receivers, etc.

LAPOINTE DOUBLE DRILL PRESS.

In Figs. 1 and 2 is shown a drill of novel design, made by the Lapointe Machine Tool Co., of Hudson, Mass. The novel feature of the machine, as will at once be seen, is the arrangement by which two drill spindles are mounted on the same column—not side by side as in the orthodox double-spindle drill, but on opposite sides of the column, forming two separate machines. The driving and feeding mechanisms of these two drills are so arranged that one of them is a sensitive

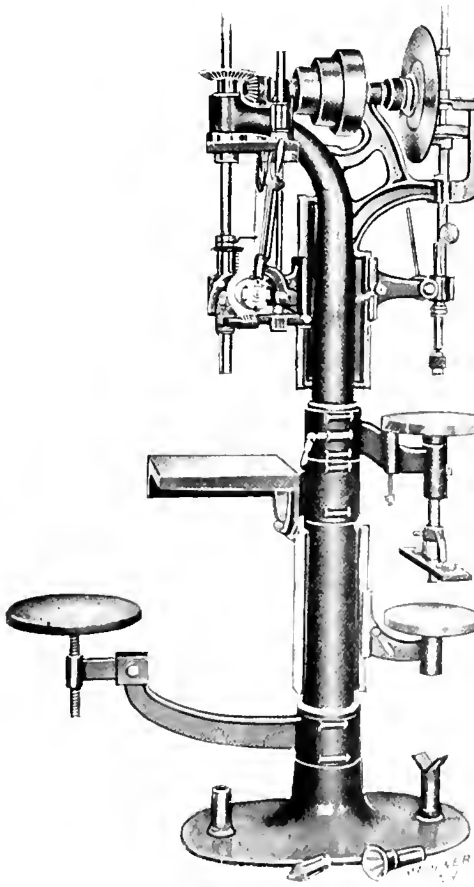


Fig. 1. The Lapointe Double Drill Press

drill, while the other has all the conveniences of the small standard drill press. The full range of the machine provides for drilling holes up to 1 inch in diameter. It will be seen that this machine is a "double drill press" rather than a "double spindle drill press."

The two engravings show opposite sides of the machine. The sensitive drill is on the right of Fig. 1. As may be seen, this drill is of the friction type, in which the changes of speed are obtained by shifting a friction wheel across the face of the driving disk. The spindle is stopped by pushing the driving wheel to the upper limit of its travel, where it enters a recess in the face of the disk; this recess is seen in Fig. 2. The other side of the machine carries a drill spindle driven by bevel gears from the cone pulley shaft. The driving bevel pinion may be thrown out of engagement by the lever shown, so that this spindle, as well as the other one, may be

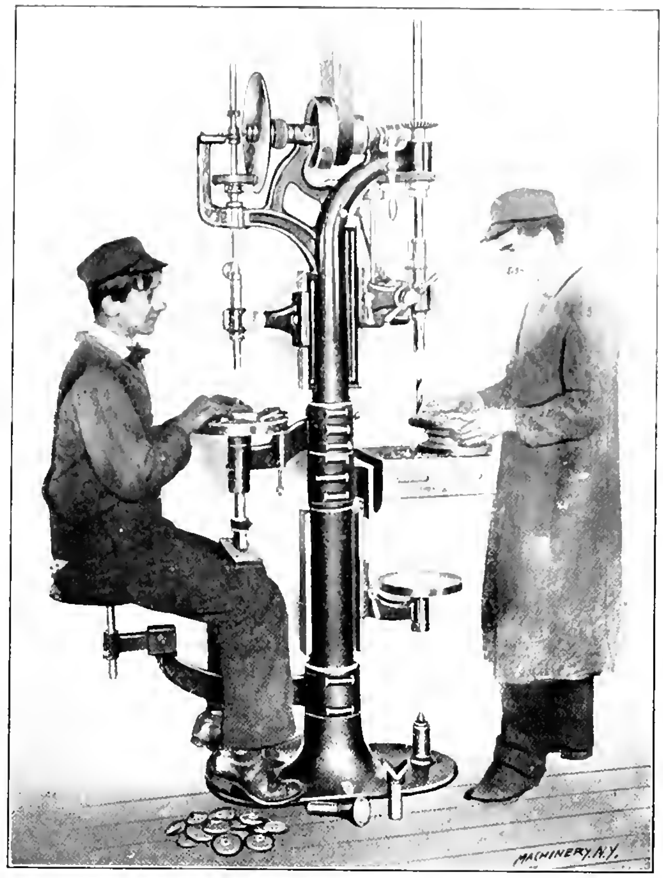


Fig 2. The Drill Press in Action, the Knee Feed being used by Operator on the Left.

stopped independently of the driving shaft. This spindle is carried by a sliding head, and is provided with power feed, a lever feed and a quick return. An automatic stop is also incorporated in the mechanism. This is seen best in Fig. 1.

A variety of work tables is provided. Any one of these may be used with either of the two spindles, so that a great range of work is provided for. At the left of Fig. 1 is shown a rectangular work table, which may be swiveled to any angle about a horizontal axis. It has a narrow clamping surface on its side, as well, for the work which is more conveniently held in such a position. At the left of Fig. 2 the round table is shown in use. This is being fed to the drill, in the case shown, by the knees of the workman, who sits on a stool which is part of the equipment of the machine. This arrangement allows both hands to be used for the insertion and removal of work, and in the case of small pieces and quickly drilled holes thus materially increases the product of the machine. Besides this, a second small round table is provided, on a bracket sliding on ways on either side of the column. The latter table may be removed and a V-block, a pointed center or a cup center used in its place. The latter parts may also be inserted, as shown, in sockets provided for them in the base, when it is desired to center long shafts or do other similar work.

Aside from the compactness obtained by incorporating two machines in one, this design gives the advantage of providing an unusually large combination of work tables and holding devices, permitting work of any kind to be done in the most satisfactory manner. The arrangement of the tables and the spindles is such that the work can be clamped on the sensitive drill side, for instance, and have a hole drilled in this position, and then be swung around to the opposite side to counterbore or drill a larger hole with a heavier drill. This may be done without unclamping the work.

AN AMERICAN MECHANIC IN EUROPE—2.

THE SECOND OF A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

Nuremberg, April 15th, 1908.

During the time which has elapsed since the writer's previous letter, he has met all the prominent machine tool dealers in Berlin, Magdeburg, Leipzig, and Chemnitz, who have freely given their views in regard to the present business conditions in Germany. It may be said, in general, that the machine tool trade has improved somewhat during the last month. All large dealers seen during the last week of February reported business dull throughout the machine tool field, but, with a few exceptions, all the dealers whom the writer has come in contact with during the last two weeks have reported conditions brighter and business better. One dealer in Dresden said that he had done a good business during March.

One difficulty of the American machine tool trade in Germany seems to be that the German user wants to get machines exactly according to his own preconceived ideas, and is not willing to vary these ideas to suit the manufacturer's standard models and designs. This creates a demand for many special designs which the manufacturers here have to meet, and it prevents the German machine tool builders from going far into the specialization of their product. At the same time it is a serious drawback in the selling of American machinery. This condition has been responsible for a new departure in the policy of many German concerns, which originally did not make machine tools, but which now have their own departments for making all the tools they themselves use. This, of course, takes away a large part of the work from the firms specializing in machine tools.

Decentralization of Machine Industries.

Regarding the location of the large machine shops, the same conditions are visible in Berlin as are in evidence in New York, London, and many other large American and European cities. As the population of a city increases, the centrally located portions become crowded and overpopulated, so that the ground rent becomes higher, and with it, as a matter of consequence, the price of land, the cost of living, and the cost of labor prices. Because of this, many industrial concerns, especially the larger ones and those developing most rapidly, have established plants in the suburbs, where land is cheaper, and where ample space is available for present needs and future expansion. The cheaper price of land makes the living expenses for the employes smaller, and they are therefore able and willing to work for smaller wages than they could accept when forced to either live in the city, or to pay railroad fares to and from the factory. At the same time the employes live a more comfortable and pleasant life in the suburbs, in spite of their nominally smaller earnings.

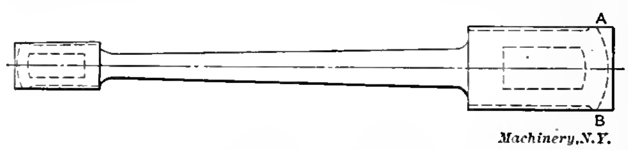
Works of the Firm of A. Borsig.

A direct example of this condition is that of the works of the firm of A. Borsig, Berlin-Tegel. These works were, up to a few years ago, located in Berlin, but as the premises became too crowded, the works were moved to Tegel, a suburb a few miles out from Berlin. This plant has grown so that it now employs about 6,000 men throughout the various departments. In addition to the Tegel plant, this firm has one plant in Oberschlesien, where about 1,200 men are employed. This latter plant consists of a steel mill, with blast furnaces, rolling mills, etc. All the raw materials, cast iron, steel, sheet iron, boiler plate, etc., which are required in the various kinds of manufacture in the Tegel plant are taken directly from the works in Oberschlesien.

The principal product of the Borsig plant is locomotives, but boilers, steam engines, pumps, and refrigerating machinery are also built. Up to a short time ago this firm also built the Oechelhäuser gas engine, but, as there was not enough commercial return to warrant the building of these engines, the firm has discontinued this line of manufacture. The gas engine industry, in general, seems to be waning at the present time in Germany. It is not as lively now as it has been for a few years past. It was interesting to notice the extent to which portable machines were used in the Borsig works. Such machine tools as drills, milling machines, and riveting machines, with the exception of the largest and heaviest ones, are all portable and mounted on wheels, so that they can be easily moved from one place to another, enabling the finishing of large pieces of work without the expense and difficulty of moving large boilers or heavy locomotive frames. The floors are all made of concrete, as this facilitates the movement of the portable machines, and in the concrete floor are embedded a large number of tracks running in different directions for accommodating small trucks. The portable machine tools in this plant are partly electrically, and partly pneumatically, driven, and are equipped with devices by means of which they can be fairly well secured to the floor, so as to enable the tools to work with the greatest possible efficiency.

Interesting Use of the Oxy-hydrogen Blow-pipe.

The use of the oxy-hydrogen blow-pipe method for cutting steel is not fundamentally new to technical men, as this method and various applications of it have been described from time to time in the technical press. The following use of this appliance in the Borsig works, however, is rather novel, and should be of particular interest to the readers of MACHINERY. The accompanying engraving shows the outlines of a connecting-rod. This rod is first forged and the two side surfaces



Connecting-rod from which Surplus Metal is removed by the Oxy-hydrogen Blow-pipe Method.

are planed, after which the connecting-rod has an outline as represented by the full lines. Now lines are scribed on the connecting-rod as shown by the dotted lines, and a heavy punch-mark line is made a trifle outside of the scribed lines. This line is followed by the blow-pipe gas jet, and a slot about 1/8 inch wide is thereby cut through the rod, leaving for finishing about 1/16 to 1/8 inch. All the surplus material is removed in this manner, and the surface left from the cut is fairly smooth and true. For locomotive connecting-rods of medium size, the time required for cutting the length shown at AB is about 2 to 3 minutes. The apparatus for applying the gas flame to the work consists of a plain nozzle connected to a flexible pipe, with the apparatus mounted on two small wheels, which makes it easy for the operator to apply the jet exactly where wanted, and to get the cut square with the planed surface. The edges of the connecting-rod are afterwards finished by milling.

Use of Magnetic Chucks.

Prominent German machine builders make extensive use of magnetic chucks. The writer saw in particular a large number in use in the shops of Ludwig Loewe & Co., Berlin. For small work particularly, when quick clamping is of importance and comparatively small power is required to hold a piece of work in position during the operation performed on it, the magnetic chucks have there found a wide field of usefulness. On machine tools there are many small parts like washers, sliding pieces, etc., having flat surfaces, which, for the sake of accuracy and smooth finish are required to be finished by grinding. To clamp such pieces in ordinary chucks is usually difficult and slow; in such cases the magnetic chucks are always used. As is well-known, when finish-grinding but very little power is required to hold the piece of work in place, and the magnetic chuck does not need to have a very high holding power, so that a piece of work may even be removed by hand without disconnecting the current. The current is taken from ordinary lamp sockets.

German Foundry Practice for High Grade Castings.

The casting of cylinders for automobiles is considered to be one of the most difficult problems that the foundry man has to deal with. The casting must be of the very best material, and, as far as possible, be free from blow-holes and other defects, because of the high temperature and pressures on automobile cylinders. A prominent German firm, which makes a specialty of casting automobile cylinders and is considered as turning out a very high grade article, places spe-

cial emphasis on the importance of the design and the making of the cores for obtaining good and sound cylinder castings. As these cores are very small, the problem of making them is a rather difficult one. The sand used for making the cores is of a rather coarse grain, and for binding purposes dextrin is employed. This produces a very strong and hard core. For making the vent holes in these small cores a tallow-coated thread is put in the center (or wherever wanted). When the core is heated for the purpose of drying, the tallow melts, and the thread can be pulled out, leaving behind it a very small vent hole. The gases produced when pouring the metal have an easy access to the vent hole, due to the coarseness of the sand, and pass through the vent hole out into the atmosphere. Resistances for electric apparatus which are only about 3/32 inch thick are cast by using cores made on similar lines.

General Observations on the Machine Tool Industry in Berlin.

The leading machine tool building concerns in Berlin are the firm of Ludwig Loewe & Co., and the Deutsche Niles Werkzeugmaschinen-Fabrik, Oberschoeneweide, near Berlin. In order to avoid undue and unnecessary competition, these two concerns are working under a trade agreement, so that the former one is specializing on small tools and machine tools of small and ordinary sizes, and the latter concern is devoting itself to large heavy machine tools. A short time ago the Deutsche Niles Werkzeugmaschinen-Fabrik built a giant planer, which in size and working capacity is claimed to have been superior to the one recently built by the Bement-Miles Works in Philadelphia. This large German planer was built for a German turbine building concern. [The Bement-Miles planer was described in the January, 1908, issue of MACHINERY.—EDITOR.]

In addition to the two large concerns mentioned, there are in Berlin a great number of smaller ones, employing all the way from 25 to 150 men. A few of these have already followed the American practice of specializing on certain types and kinds of machine tools, but the large majority of them are building any one particular machine which they think will sell best at the moment, be it shaper, lathe, gear-cutting machine, or any other kind of machine tool. Although these concerns are not, according to American ideas, strictly up to date, they are still filling a certain want. They make the cheap grade of machinery required by many small manufacturers, who cannot afford to pay the price of, or do not need, a strictly first class type of machine tool. These small firms seem to be reasonably prosperous.

The Machine Industry in Magdeburg and Dresden.

A concern which is well-known for good workmanship, and for the high efficiency of its products, not only in Germany, but all over Europe, is the firm of R. Wolf, of Magdeburg-Buckau. This firm originally built only portable steam engines, but having had great success in this business, the building of larger stationary steam engines of the same type as the portable engines was also taken up. It may be mentioned in this connection that in Europe stationary steam engines are often used which are built entirely along the lines of the type of engines known as portable in the United States, though they are installed for stationary use in manufacturing establishments. These larger stationary engines of the portable type are now built in units up to 600 H. P.

Through the introduction of an improved design of superheated steam, compound, condensing, portable engine, a point of efficiency has been reached, which, as a rule, is attainable only in units of very large size. A 50 H.P. engine, recently built, consumed during the test run only 1.12 pound of coal per H.P. hour, and in a 100 H.P. engine of this design the firm has brought down the consumption to one pound of coal per H.P. hour. [This is as low a coal consumption as is attained by triple or quadruple expansion condensing engines on large ocean-going steamers.—EDITOR.] The old shops of this firm in Buckau have proved too small for the amount of business done at the present time, and a large new plant is being built some distance out from the city. This new plant, which will be of the most modern construction, is to be used for the building of large stationary engines of the portable type, while the old plant will be used for building small sizes exclusively. The new shops are located alongside the railroad, and are arranged so that all the raw materials, castings, etc., will enter the shop at the end farthest away from the railroad, and the finished engines will be assembled, tested, and made ready for shipment, at the end nearest the railroad, where they can conveniently be loaded directly on the railroad cars.

The machine tool industry in Magdeburg and Dresden is largely represented by a few small concerns belonging to the same class as the small concerns in Berlin, previously mentioned. The Dresdner Bohrmaschinenfabrik, Dresden, however, is an exception to this rule. This concern employs about 300 men, and makes a specialty of drill presses and chucks, and the specialization of these tools has been carried to a high degree of perfection. The unit principle of design has, in particular, been highly developed in their machines. The units are manufactured independently of the completed machines, for which they are intended, and are often made in lots of 100 at a time, and kept in stock until needed for assembling purposes. The same detail units are often used for several different types of machines, a feature which is highly important in bringing down the labor cost in specialized manufacture.

Chemnitz—a Center of Machine Tool Industry.

During the last few decades Chemnitz has succeeded in establishing itself as one of the largest and most important centers of the machine industry in Germany, and this in spite of its location far from navigable rivers, and its lack of water power. At the present time, Chemnitz, according to the United States Consul in that city, exports more machinery to the United States than any other German city, Berlin not excepted.

Nearly all branches of machine industry are here represented. One of the largest locomotive works in the world, the Sächsischen Maschinenfabrik, is located here, and is, as regards size, the leading concern. In addition to a large locomotive department, this firm has departments for steam engines, boilers, steam turbines, and machine tools, principally those of heavy design. One branch of the machine industry that has largely helped to give Chemnitz a well-known name is machinery for various uses in the textile industry, most particularly knitting machinery. These machines require a high degree of precision work, and their manufacture necessitates the designing and using of many special machine tools. This fact has forced, or, at least, greatly encouraged, some concerns originally only making textile machinery to add a department for the manufacture of machine tools. An example of this is the firm of Schubert & Salzer. The machine tools obtainable in the market could not entirely satisfy their needs, and therefore they were forced to make all special tools themselves. Having once started in this line of business, when the demand for high grade machine tools increased, they extended this department, and commenced to make machine tools for the market.

The manufacturing of machine tools occupies now one of the foremost places in the Chemnitz machine industry. Here are located concerns engaged solely in machine tool manufacture, employing up to 2,000 men, making strictly first-class machinery, and there are also a large number of concerns with from 25 to 50 men, many of whom make only cheap grades of machines. All kinds and sizes of machine tools are being built here, from the large and heavy machines built by the Sächsischen Maschinenfabrik down to the very smallest machines for fine precision work.

The Reinecker Works in Chemnitz.

The firm of J. E. Reinecker is one of the leading concerns for the manufacture of high grade machine tools of all types. This firm has also a large department for small tools. It was founded by J. E. Reinecker in 1859, and was, at first, only a very small concern, devoting itself to the making of machine tools. The development of the firm has been rapid, and 2,000 men are now employed in the shops. Although this firm builds all kinds of machine tools, the specialties given most attention are the most commonly used sizes of plain and universal milling machines; milling machines of the planer type; heavy duty relieving lathes, grinding machines—especially tool grinders; and gear-cutting machinery.

The department for gear-cutting machinery is highly developed and would deserve more than incidental mention. A large variety of machines are manufactured for cutting bevel gears, spur gears, worms, worm-gears, and racks. The Bilgram bevel gear planer is manufactured by the Reinecker firm for the European market, and its excellent design and workmanship has gained for it a high reputation and a large number of users. Careful methods of selling, and of placing the machines in the customers' shops, must also be given some credit for the success. In most cases, a competent man is sent with the machine sold to teach the buyer to use the machine to best advantage, to the great satisfaction of the customers. A great deal of the success of this department is due to the energy of, and the work done by, Mr. August Hoffman, an American, who introduced the Bilgram bevel gear planer in Europe, and who is in charge of the gear-cutting machinery department of the Reinecker firm.

Schubert & Salzer and other Chemnitz Machine Tool Builders.

The firm of Schubert & Salzer, as previously mentioned, originally specialized in building textile machinery, but they now, in addition to these, make also cash registers and machine tools. It has also already been referred to that, by the force of circumstances, this firm was carried into the manufacture of machine tools. It should, however, also be mentioned that, according to their own statement, one reason for this was that they found the American machines which were formerly largely employed in their shops, with a few good exceptions, too weak for their material and kind of work. This was one of the causes that forced them to make ordinary machine tools. They are now, in addition to making all their own special machines, devoting themselves to milling machines, drill presses, and planers which are designed to have a number of cutting tools working simultaneously—in some cases, as many as six. The Wanderer Fahrradwerke began the manufacture of machine tools for reasons similar to those mentioned in the previous case. This firm originally engaged solely in the bicycle industry, but later added a department for typewriting machines and machine tools, and is now carrying on all these three lines of manufacture. In addition to making the machine tools for their own special purposes, they have specialized in milling machines and gear-cutting machinery.

As mentioned about small Berlin firms, there are also in Chemnitz a large number of small concerns which have not specialized on any particular kinds of machine tools, but are making any kind required. A small concern which constitutes a remarkable exception to this rule is the firm of Messdorf & Mehnert. This firm employs about 150 men. Up to a few years ago all kinds of machine tools were built, and not less than four different designs of gear-cutting machines were manufactured; now, however, nothing but certain types of milling machines are built.

Secrecy in the Trades.

The German machine manufacturing concerns have gained the reputation of keeping what they choose to call "trade secrets" with a jealous zeal, and they are claimed to object to any visitors in their shops, because of fear that these would carry away with them some valuable suggestions or new designs of special tools, or whatever it may be that they call trade secrets. Whether this reputation be justified or not is perhaps difficult to say. The writer's experience regarding this has been that large well-known concerns, well equipped with new modern machine tools and employing up to date methods, and making and turning out a first class product, are the ones who least object to visitors in their shops, but the old, conservative concerns with ancient tools and methods do not "for their life" allow anybody to visit the shops under any conditions. In many cases the writer has succeeded in learning something about the concerns which, from principle, never allow any visitors, and he has seen some of their machines either in the stock rooms of machinery dealers, or in other shops, and he has found indications of the truth of the above statement. On one occasion the writer was refused permission to visit the shops of a certain concern because, as they said, they had so many special things which they did not want anybody to see. The same day he had occasion to meet a gentleman who was well acquainted with the shops referred to. Upon hearing of their refusal to allow him to visit the shops, he said: "You did not miss much, but you saved your clothes from being spoiled by dirty oil, dripping down from the counter-shafts and hangers."

Criticisms of American Machine Tools.

In my previous letter I mentioned that American machines and tools were too weak for the German demand. A dealer who handles both American and German machinery to about the same extent, and who, therefore, can be considered as impartial on the subject, gave a few statements as to which parts usually suffer from lack of strength, and which are not made by manufacturers according to the requirements of German buyers.

The American plain face-plate is not accepted in Germany. German dealers, in order to sell American machines, many times at their own expense substitute German chucks for the plain face-plates on American lathes.

Tool-posts on lathes are often made too weak. Heavier turning tools are used in Germany, and sometimes the American tool-posts are not large enough to take these tools.

The speed boxes on the drill presses and on milling machines are not made strong enough, and, besides, the German buyer objects to cast iron running with cast iron in gearing. He prefers to have cast iron gears meshing with steel gears.

As a personal opinion, the dealer from whom the writer obtained this specific information, expressed the idea that if the American manufacturers would simply meet these requirements of the German buyers, the American foreign trade in machine tools would be greatly benefited thereby, and would gain considerably more ground in Germany.

* * *

EXPOSITION OF SAFETY DEVICES.

The American Institute of Safety Devices and Industrial Hygiene, a sub-organization of the American Institute of Social Service, has opened an exposition of safety devices on the fifth floor of the new building of the McGraw Publishing Co., 231 W. 39th St., New York City. The exposition was opened on April 13, and will remain open until June 1. It is free to the public, and open from 10 A. M. to 6 P. M., except Sundays. The exposition embraces all kinds of safety devices employed in manufacturing, mining, transportation, and in electrical and chemical industries. Some of the exhibits are of special interest to machine tool builders, in particular some selections of large photographs from the Brown & Sharpe Mfg. Co., and from the various plants of the Niles-Bement-Pond Co., showing installations for safeguarding the workmen in these establishments, as well as machines built by these companies, provided with proper guards over gearing, emery wheels, etc. There are very few actual exhibits as yet of safety devices pertaining directly to the machine tool trade. A number of photographs are shown, giving interior views of the prominent museums for safety devices in Paris, Berlin, Munich and Vienna, as well as photographs of safety devices employed in the industries in Europe.

Some of the exhibits appear to be more of an advertising nature than embodying actual safety devices, and as long as the space permits the exhibits of objects of this kind there can be no objection to their presence, but in case the interest shown by our manufacturers in this exhibit should be large enough so that the space allowed became limited, it might be suggested that exhibits which appear to be of a commercial nature, rather than embodying an interest in the safety of American life and labor, should be carefully scrutinized. The aim which the Institute of Social Service has in view is to increase the realization among our American people of the terrible tribute paid annually in our industries in the form of loss of life and limb of our workers, and to arouse a public spirit which will demand that proper safeguards be placed around the industrial worker, so that his risks may be lessened as much as possible. Most of the 500,000 industrial accidents, which annually occur in the United States alone, could be prevented without great expense, simply if the general public became fully aware of, and interested in, the possibilities of safety appliances in various forms.

MISCELLANEOUS FOREIGN NOTES.

Italian Imports of Machinery.—Figures published by *La Métallurgie* indicate that in 1905 the imports of machinery into Italy from Germany had a value of about $12,000,000. The value of the machinery imported from Great Britain had a value of about $7,000,000, and from France, $1,300,000. The value of the imports of machinery from the United States is not mentioned in the table published by the journal referred to.

Machine Tools in Turkey.—The increase of railways in Turkey and its possessions, and the general impetus given to trades in general, has caused a demand for machine tools. The conditions of the country, however, are peculiar, and, at present, the greatest demand is for small machines driven by foot power, but the increase in the use of machine tools has also increased the need and demand for motors of various kinds, and it is likely that machine tools of ordinary descriptions will soon find a market in the country.

German Imports and Exports.—The figures for the imports and exports of Germany during the first month of the year indicate that its foreign trade was depressed, and that business conditions were not satisfactory. The imports dropped from 4,194,000 tons for January, 1907, to 3,644,000 tons for the same month, 1908. The exports dropped from 3,264,000 tons to 3,168,000 tons. In January, 1906, the imports and exports were 4,578,000 tons and 3,611,000 tons, respectively, so that there has been a steady decline in foreign trade for the last two years.

Demand for American Agricultural Machinery in Sweden.—According to *Engineering*, the Swedish government lately sent a special agent to the United States and Canada for the purpose of examining and studying such agricultural implements and machinery, used in these countries, as might be suitable for the conditions in Sweden. A report has been forwarded to the government, in which it is proposed that the state should appropriate a certain sum for the purchase and thorough testing, under proper supervision, of such implements.

Machinery Business in Germany.—The past year appears to have been exceptionally profitable to the German machine builders. The Gritzner Machine Co. reports a profit of 888,500 marks ($215,000)—a considerable increase over the previous year—and is paying 15 per cent dividends. The Wülfel Iron Works, Hanover, are paying 10 per cent. The East German Machinery Company, Heiligenbeil, is paying 9 per cent, and most firms show considerably higher profits for the past year than for the year previous. However, recent reports indicate a falling off in the trade, even if this falling off is not serious enough to cause any anxiety on the part of German machine builders.

Chinese Exposition.—Consul-General W. Roderick Dorsey reports that it is proposed to hold an exhibition in Shanghai during 1909, under the name of The Shanghai International Exhibition. This exposition will be confined to staple manufactures and machinery. The project is as yet, not fully worked out, and it is impossible at the present time to secure any particulars as to the space available for different exhibits, or the terms on which space may be rented. Seventy acres of land, however, have been secured in a suitable location. American manufacturers and exporters interested may secure further information as soon as available by addressing Mr. L. E. Canning, Secretary China Association, 6 Peking Road, Shanghai, China.

German Trade Conditions and the Tactics of the German Steel Trust.— It is understood that the manner in which the German steel trust treats its customers has caused considerable opposition. The steel trust is said to control 95 per cent of the iron and steel output of Germany, and consequently dealers and buyers are completely at the mercy of the combination. The trust leaves to each dealer only a very limited territory, and insists upon being supplied with the names of the buyers, the prices, and all particulars concerning the sale. The dealers are therefore somewhat apprehensive of the fact that this might mean that the trust will finally do its business directly. This, of course, would not impose any hardship on the German industries as such, for direct dealing is as a rule always preferable to dealings through intermediate agents, but the manner in which the trust goes about to accomplish its purpose seems rather arbitrary. It is also complained that the trust charges higher prices in such parts of Germany where it is difficult for foreign steel to compete on account of the longer shipping distance by rail. It is stated, however, that the steel industry itself is not in as prosperous a state at the present time as before the renewal of the syndicate. Thousands of employes have recently been dismissed by works belonging to the trust. Krupp's works alone have reduced their force by about 3,000 men. The German motor car industry, which held its own rather longer than that of France and the United States at the time when the inevitable reaction came, also commences to show signs of depression.

* * *

A novel feature of the coming Master Mechanics' Convention at Atlantic City will be the exhibit of the Committee on the Apprenticeship System. It is expected that all the railroads operating apprentice schools will send models, drawings and photographs to show in a comprehensive manner the rapid advancement which is being made in this phase of railroad activity. The Central Railroad of New Jersey, the Grand Trunk, the New York Central Lines, and the Santa Fe have already arranged to exhibit.

* * *

SPRING MEETING OF THE A. S. M. E.

The semi-annual meeting of the American Society of Mechanical Engineers will be held in Detroit, Mich., June 23-26. Among the papers to be presented at this session are: "A Method of Cleaning Gas Conduits," by W. D. Mount; "A Method of Checking Conical Pistons for Stress," by Prof. George H. Shepard; "Clutches," with special reference to automobile clutches, by H. Souther; "Horse-Power, Friction Losses, and Efficiencies of Gas and Oil Engines," by Prof. L. S. Marks; "Some Pitot Tube Studies," by Prof. W. D. Gregory; "The Thermal Properties of Superheated Steam," by Prof. R. C. H. Heck; "A Journal Friction Measuring Machine," by Henry Hess; "A By-Product Coke Oven," by W. H. Blauvelt; "Tests of Some High Speed Steam Engines," by F. W. Dean. There will be a symposium upon machinery for conveying materials, with papers by several authorities. The Society for the Promotion of Engineering Education and the Society of Automobile Engineers will also hold their annual meeting in Detroit at this time, which will enable members of each society to participate in the sessions of the other.

* * *

THE MACHINERY CLUB.

The new quarters for this club in the Hudson Terminal Building are nearly completed, and it is expected will be ready for occupancy soon after May 15th. The intention is to open the rooms with a formal reception which will be held about May 20th. The total membership to date is nearly nine hundred. The officers of the club are as follows:

Officers—F. H. Stillman, president; R. C. McKinney, vice-president; Walter L. Pierce, treasurer; W. Seton Henry, Acting Secretary.

Governors—O. C. Gayley, Pressed Steel Car Co.; George A. Post, Standard Coupler Co.; Walter L. Pierce, Lidgerwood Mfg. Co.; F. H. Stillman, Watson-Stillman Co.; C. A. Moore, Manning, Maxwell & Moore; H. L. Shippy, John A. Roebling's Sons Co.; T. N. Motley, T. N. Motley & Co.; Henry Prentiss, Prentiss Tool & Supply Co.; H. B. Kirkland, National Metal Molding Co.; W. P. Pressinger, Chicago Pneumatic Tool Co.; A. B. See, A. B. See Electric Elevator Co.; W. H. Marshall, American Locomotive Co.; R. C. McKinney, Niles-Bement-Pond Co.; E. H. Wells, Babcock & Wilcox Co.; W. L. Saunders, Ingersoll-Rand Co.; Otis H. Cutler, American Brake Shoe & Foundry Co.; J. R. Vandyck, Vandyck, Churchill Co.; Kenyon B. Conger, Hudson Companies; Wm. B. Albright, Sherwin-Williams Co.; Chas. A. Schieren, Jr., Chas. A. Schieren & Co.

Executive Committee—F. H. Stillman, Chairman; R. C. McKinney, Walter L. Pierce, Geo. A. Post, Henry Prentiss.

House Committee—T. N. Motley, Chairman; Chas. A. Schieren, Jr., Percy A. Ware, Geo. Howells, Edward H. Benners.

Membership Committee—J. R. Vandyck, Chairman; Geo. L. Gillon, Chas. B. Crook.

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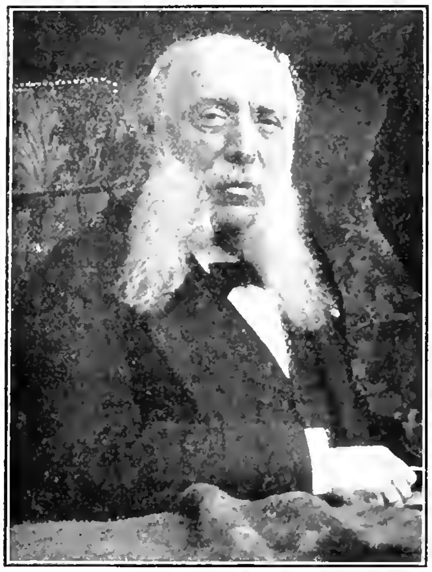
A WELL-KNOWN DUTCH TRADING HOUSE, AND ITS HEAD.

One of the largest trading houses in Europe, and one that is of considerable importance to American machine tool builders is that of R. S. Stockvis & Sons, Rotterdam, Amsterdam, Brussels, and Java. This great house was founded by R. S. Stockvis in 1844, and three generations of the family have contributed their energies to putting it in its present high position. The main warehouse and the offices of the company are in Rotterdam, where they have a long frontage on one of the principal canals, the Leuvehaven. They cover a superficial area of 776,000 square feet, and most of the buildings are five or six stories in height. The stock on hand has a mean value of never less than $1,250,000. It consists mainly of machine tools and lighter articles of hardware merchandise. Although the machine tool business is one of the recent activities of the concern, it is already one of the most important. The concern as a whole is highly organized, and a long article could be written about its various departments, systems and connections extending throughout the whole civilized world.



S. R. Stockvis.

The accompanying half-tone illustration shows Mr. S. R. Stockvis, director and chairman. Mr. Stockvis is the son of the head, R. S. Stockvis, the founder of the house. Although Mr. Stockvis celebrated his eightieth birthday a few months ago, he still takes the most active interest in the management of the concern's affairs. Associated with him as directors are his two sons Felix and Hugo, and his three nephews, Charles, Louis and Theodor The whole capital of the company is held by the six directors, and the concern, therefore, is a close corporation, its stock never being on the market.

* * *

CONSERVATION OF NATURAL RESOURCES—APRIL MEETING OF THE A. S. M. E.

A meeting of the engineering profession was held in the auditorium of the Engineering Societies building on the evening of April 14, to consider the conservation of our natural resources. The meeting was held under the auspices of the American Society of Mechanical Engineers. It was presided over by Mr. J. W. Lieb, Jr., vice-president of the society, who opened the meeting. Addresses were made by Dr. W. J. McGee, Chief of the Bureau of Soils, Washington, D. C., who spoke on the "Conservation of the Water and Woods," calling attention to the danger of stripping the country of its forests. Dr. W. F. M. Goss, dean of the College of Engineering, University of Illinois, spoke on the "Conservation of the Nation's Fuel Supply," and mentioned that the process of conservation could not successfully begin with coercion; it must begin with education. Prof. G. F. Swain, of the Massachusetts Institute of Technology, Boston, spoke on the subject of "Stream Flow, Water Power, and Navigation," thereby also bringing in the subject of preservation of the forests. This subject is highly important to all industries, as the devastation of the forests threatens some of our greatest natural resources—not the lumber resources alone; to conserve the forests means to save the water power, to prevent the erosion of the soil, and the silting of navigable rivers and harbors. The American Society of Mechanical Engineers is to be commended for the interest it has taken in this matter, and all engineers and manufacturers should realize that this subject is of more vital importance to them and to the future of the industries of the whole country than may be appreciated at first sight. The concluding address at the meeting was made by Dr. H. S. Pritchett, president of the Carnegie Foundation, who spoke of the attitude of the engineer toward the public, calling attention to the fact that engineering has become a profession which must consider not only the serving loyally of employers, but also the public interests.

* * *

AN APRIL FOOL JOKE IN A TECHNICAL JOURNAL.

The front page of a recent issue of a contemporary, whose name we forbear to mention, is decorated with a large cut of a new diving apparatus by the use of which it is expected that men will be able to work at depths of 100 feet or more without difficulty. This apparatus consists of a water-tight operating chamber, suspended from a barge and connected with it by a flexible, collapsible tube, strengthened by steel ribs to resist the pressure of the water. This tube and operating chamber are left in full communication with the open air so that the diver works under normal conditions and under atmospheric pressure. He does his work by inserting his hands in long sleeves and mittens, which project from domes in the side of the operating chamber. Lenses of strong glass are provided on all sides so that he can see clearly what he is doing.

We wonder if it occurred to the inventor of the device or to the editor of the paper in which it is illustrated that this long sleeve and mitten would be a most unhandy thing to operate. The "arm-hole" by which the sleeve is fastened to the chamber appears to have an area of at least 150 square inches. At a depth of 100 feet or thereabout the pressure on this opening would be more than 40 pounds to the square inch, or over three tons in all. This would naturally mean that the mitten and its sleeve would be blown inward with this pressure, being turned inside out, projecting into the operating chamber. We would defy the strongest "strong man" that ever drew a salary from a circus company to turn the mitten right side out again and use it in doing any useful work in the water outside.

Another interesting feature of the apparatus is that the barge from which this tube is suspended is provided with hoisting apparatus for lifting the chamber to the surface when the work undertaken has been completed. We would humbly make the suggestion that a mechanism for pushing it into the water would be more appropriate than that described for pulling it out. Would it not require a mechanism unusually powerful to force this chamber to a depth of 100 feet against the upward pressure of the water? The proper thing to do would be to fasten a block and tackle to the solid ground at the bottom, and *pull* it down. If by chance this block and tackle broke, we surmise that the chamber would be blown up through the bottom of the barge with results disastrous to everyone on board.

However, since the description of this apparatus appeared in that issue of the journal referred to nearest April 1st, it is in all probability merely a joke appropriate to the season, and the editor is doubtless enjoying a quiet laugh over the perplexity of his subscribers.

* * *

PRACTICAL IDEAS FROM AN ADVERTISING MANAGER.

The Chicago Trade Press Association and the Space Club of that city held a joint meeting on April 6th, at which Mr. C. S. Redfield, advertising manager of the Yale & Towne Mfg. Co. of New York, and Mr. J. J. Rockwell of the National Fireproofing Co. furnished the practical ideas from the standpoints of both the advertiser and the publisher.

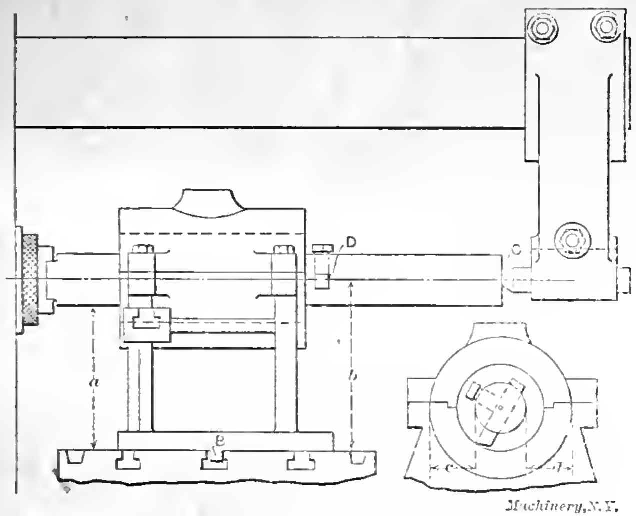
The subject matter of the addresses was naturally more interesting to people in the advertising business than to techni-

Supplement to MACHINERY, June, 1908.

Operations for the Article in this number entitled "Machine Shop Practice—Machining a Fixture Casting."

SHOP OPERATION SHEET NO. 64.

H. A. S. Howarth. MACHINERY, June, 1908.



To Set Up and Bore a Fixture Bearing in a Milling Machine.

1. Set up the fixture on the milling machine table with the tongue B against one side of a T-slot, and clamp the fixture in place. Put the boring-bar in the spindle.

2. Be sure that the center C lines up with the end center of the bar. While it is free, test the end of the bar by revolving the spindle slowly, using an indicator to detect any error. If the bar runs true, the center C must be set so that as it enters the center of the bar it does not spring it.

3. Set the table vertically so that the height a of the under side of the bar above the table, added to half the diameter of the bar, will equal the distance b from the center of the bearing of the fixture to its base.

4. Set the bar central with the bosses on the ends of the bearing, making the distances c and d equal. Clamp the knee and table, leaving the cross feed free.

NOTE.—The power cross feed of the machine should be greater, by at least two inches, than the length of the bearing to be bored. The boring tool D must be so located that it will pass clear through the bearing and extend far enough out at either end to be adjusted readily.

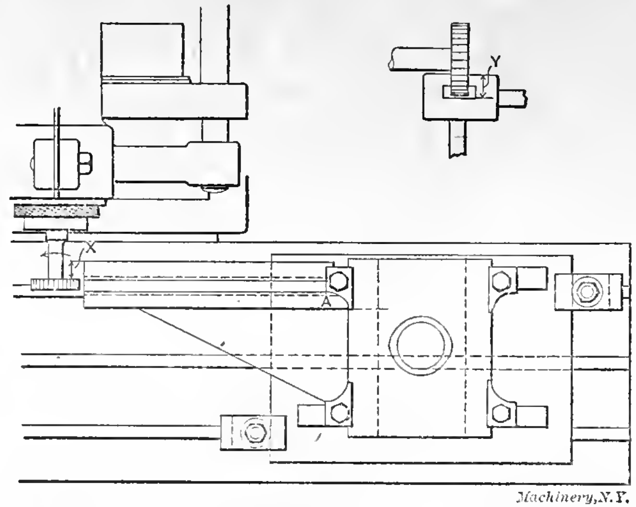
5. Set the tool point so that it will just clear the rough interior of the bearing as it passes through, and note the places where the cut will be heaviest. Set the tool to take as heavy a cut as is safe, and take a roughing cut.

6. Take the cuts in both directions when practicable. The last few cuts should be very light, removing from 0.002 to 0.004 of an inch. The finishing cut should just scrape the hole smooth.

7. Remove the bar, unclamp the knee and the table, but leave the fixture set up for the next operation.

SHOP OPERATION SHEET NO. 65.

H. A. S. Howarth. MACHINERY, June, 1908.



To Mill a T-slot. First Operation.

NOTE.—It is assumed that the fixture bearing was left set up on the milling machine table on the completion of the last operation.

1. Insert the shank of the milling cutter into the spindle of the machine. The cutter and shank may be solid, or the cutter may be mounted on an arbor and held in place by a key and nut. The diameter of the shank or arbor next to the cutter should be small, so as to permit the use of a small cutter; this will enable the cut to be run close up to the bearing as at A.

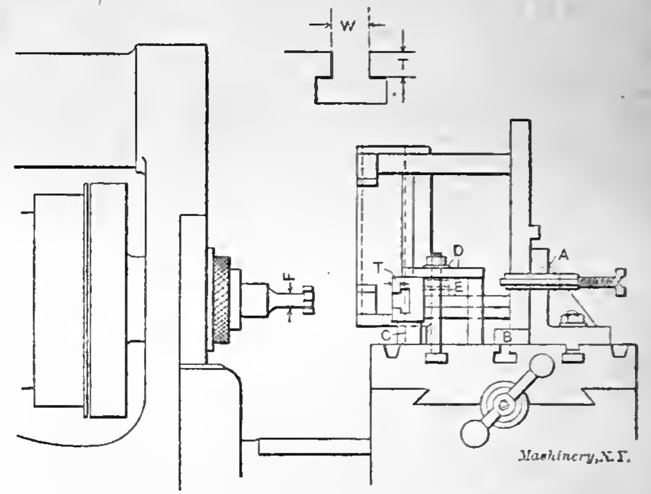
2. Adjust the table of the machine so that the cutter will be set as shown in the illustration, the distance X being equal to the required dimension. The depth of the cut should be equal to the depth Y of the T-slot.

3. Start the machine and mill the slot to the required width and depth in one cut unless the width of the slot needs to be very accurate, when two cuts may be taken, the one with a roughing, and the other with a finishing cutter. The cutter in this instance should be rotated as indicated by the arrow, as the work will then be fed against the cutter, and all slack or back lash between the nut and the feed-screw will be taken up.

NOTE.—By using an end mill, this operation could be done at the next setting of the fixture, but the foregoing method is preferable, as a very slow feed must be used with the end mill to keep it from springing. Then again, it is essential that this part of the T-slot be exactly in line with the tongue on the base of the casting, and exactly square with the bore of the bearing; therefore, it is better to partially mill the T-slot at this setting.

SHOP OPERATION SHEET NO. 66.

H. A. S. Howarth. MACHINERY, June, 1908.



To Mill a T-slot. Last Operation.

1. Remove the bearing cap from the fixture so that it will not be in the way when finishing the T-slot. The slot is supposed to have been finished to the width W, as described in the previous operation.

2. Bolt an angle plate A to the milling machine table, placing the tongue on the plate against one side of a T-slot.

3. Set up the fixture as shown, with its planed edge resting on a parallel B. Clamp the base to the angle plate with C-clamps, and insert blocks C under the casting, one beneath the end of the bearing, and another near the end of the slotted arm. These blocks should just fill the space between the table and the casting. With the clamps D and E, fasten the work securely to the table, and then, using a square, test the base of the casting to see if it is square with the table.

4. Insert a standard T-slot cutter into the spindle of the machine. The diameter F of the shank of the cutter should be slightly less than the width W of the T-slot. The cutter itself should be of a size to finish the T-slot at one cut.

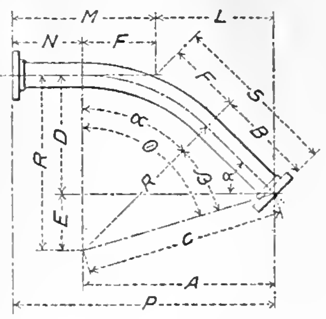
5. Adjust the table of the machine so that the cutter will be central with the slot which was milled during the previous operation, and also so that the cutter will mill the T-slot to the required thickness T.

6. Start the machine, and feed the cutter through the slot carefully. As a T-slot cutter is somewhat delicate, and as it is almost wholly surrounded by metal during the cut, a moderate feed and speed should be used to prevent springing and overheating the cutter.

NOTE.—For very accurate work, first a roughing and then a finishing cutter should be used.

I.—FORMULAS FOR PIPE BENDS.

Angle Bends. Given dimensions P, N, D, R.



$A = P - N$; $E = R - D$

$C = \sqrt{E^2 + A^2}$ or $C^2 = A^2 + E^2$

$B = \sqrt{C^2 - R^2}$

$\text{Cot. } \theta = \frac{E}{A}$ or $\text{Tang. } \theta = \frac{A}{E}.$

$\text{Cot. } \beta = \frac{R}{B}$ or $\text{Tang.} = \frac{B}{R}$

Angle $\alpha = \theta - \beta$

$F = R \times \text{Tang. } \frac{1}{2}\alpha$

$M = N + F$; $L = A - F$

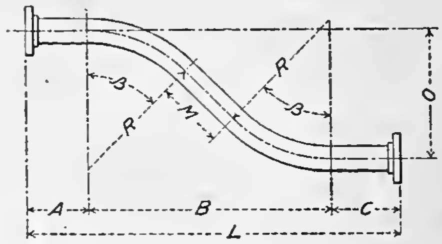
Given dimensions P, N, A, R, B.
$C^2 = B^2 + R^2$; $E = \sqrt{C^2 - A^2}$; $D = R - E$.
$\text{Tang. } \theta = \frac{A}{E}$; $\text{Tang. } \beta = \frac{B}{R}$; $\alpha = \theta - \beta$; $F = R \times \text{Tang. } \frac{1}{2}\alpha$;
$M = N + F$; $S = F + B$; $L = A - F$.

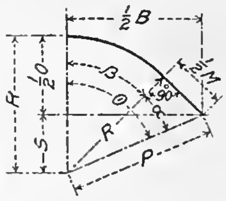
Given dimensions P, N, A, α, and R.
$F = R \times \text{Tang. } \frac{1}{2}\alpha$. $L = A - F$. $\text{Tang. } \alpha = \frac{D}{L}$. $D = \text{Tang. } \alpha \times L$.
$S = \sqrt{L^2 + D^2}$ or $S = \frac{D}{\text{Sine } \alpha}$. $B = S - F$.
$M = N + F$. Dimensions β, θ, C, E not required.

Given dimensions P, N, A, D, and α; to find R, B, and F.
$L = \frac{D}{\text{Tang. } \alpha}$. $F = A - L$. $R = \frac{F}{\text{Tang. } \frac{1}{2}\alpha}$. $B = \sqrt{A^2 - 2RD + D^2}$.

Standard radius R = 6 pipe diameters.
Minimum radius R = 3 pipe diameters.
N, or B, should not be less than 1 pipe diameter.
When R = 3 diameters, use extra heavy pipe.
When R = over 3 diameters, use full weight pipe.

Offset Bend with Straight Between Arcs.





D = Diameter of pipe.
Standard radius R = 6D.
Minimum radius R = 3D.

Given dimensions L, R, O, A, M.

To find β, B, and C.

$S = R - \frac{1}{2}O$ $\quad P = \sqrt{R^2 + (\frac{1}{2}M)^2}$

$\text{Tang. } \alpha = \frac{\frac{1}{2}M}{R}$. $\quad \frac{1}{2}B = \sqrt{P^2 - S^2}$

$\text{Tang. } \theta = \frac{\frac{1}{2}B}{S}$. $\quad$ Angle $\beta = \theta - \alpha$

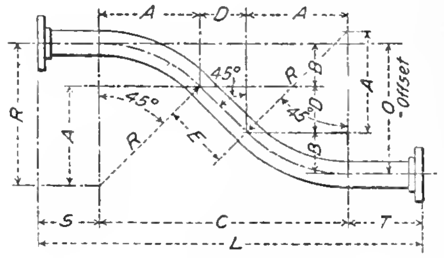
$C = L - (A + B)$

M, is usually made 12".
A or C should never be made less than D when good bends with tight flanges are required.
When R = 3D, use extra heavy pipe.
When R = over 3D, use full weight pipe.

Contributed by Wm. F. Fischer.

II.—FORMULAS FOR PIPE BENDS.

45-Degree Offsets.
Given offset O, radius R, length L and S.

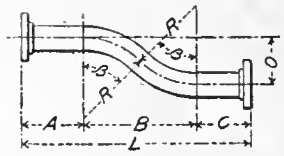


$A = R \times 0.707$
$B = R - A$
$D = O - 2B$
$E = D \times 1.414$
$C = 2A + D$
$T = L - (C + S)$

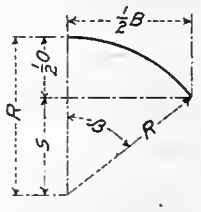
Length of each arc on center line equals $0.7854 \times$ rad. R.

Note:-
Standard radius R = 6 x diam. of pipe.
Minimum radius R = 3 x diam. of pipe
S, or T, should not be less than 1 x diam. of pipe.
When R = 3 x diam. of pipe, use extra heavy pipe.
When R is over 3 x diam. of pipe, use full weight pipe.
When possible, keep S, or T, equal to at least $1\frac{1}{2}$ x diam. of pipe or more, when screwed flanges are used.

Offset Bend.
No straight between arcs.



D = Diameter of pipe
Standard radius R = 6D.
Minimum radius R = 3D.



Dimensions given L, O, R, A.
To find β, B, C.

$S = R - \frac{1}{2}O$

$\frac{1}{2}B = \sqrt{R^2 - S^2}$. $\quad B = 2 \times \frac{1}{2}B$.

Tangent $\beta = \frac{\frac{1}{2}B}{S}$.

$C = L - (A + B)$.

When it is necessary to keep L as short as possible, make A and C each equal to one diam. of pipe. (This should be the limit for good bends), and make radius R = 3D.
To find dimensions L, B, and angle β:
$S = R - \frac{1}{2}O$. $\quad \frac{1}{2}B = \sqrt{R^2 - S^2}$ $\quad B = 2 \times \frac{1}{2}B$.
$\text{Tang. } \beta = \frac{\frac{1}{2}B}{S}$ $\quad L = A + B + C$.
When R = 3D, use extra heavy pipe.
When R = over 3D, use full weight pipe.

Contributed by Wm. F. Fischer.

I.—SPEED, HORSE-POWER, AND CAPACITY OF CENTRIFUGAL FANS.

Height of Casing in Inches	Diameter of Fan in Feet		Speed, horse-power, and capacity in cubic feet per minute for centrifugal fans discharging into free air. ✳						
			¼ oz.	⅜ oz.	½ oz.	⅝ oz.	¾ oz.	⅞ oz.	1 oz.
40	2	R.P.M.	493	605	698	780	854	923	986
		H.P.	0.4	0.8	1.2	1.7	2.5	2.9	3.5
		Cu.Ft.	2585	3165	3653	4084	4472	4829	5161
50	2½	R.P.M.	395	484	558	624	684	738	788
		H.P.	0.7	1.2	1.9	2.6	3.8	4.3	5.2
		Cu.Ft.	3877	4747	5480	6126	6708	7244	7741
60	3	R.P.M.	328	403	465	531	570	615	657
		H.P.	1.0	1.9	2.8	3.8	5.0	6.4	7.9
		Cu.Ft.	5690	6960	7380	8980	9840	10600	11350
70	3½	R.P.M.	282	345	398	446	488	526	562
		H.P.	1.5	2.5	3.8	5.4	7.0	8.8	10.8
		Cu.Ft.	7750	9490	10950	12250	13400	14500	15500
80	4	R.P.M.	247	302	349	390	427	460	493
		H.P.	1.8	3.3	5.0	6.9	9.1	11.5	14.0
		Cu.Ft.	10350	12650	14600	16350	17900	19300	20650
90	4½	R.P.M.	219	268	309	346	379	410	438
		H.P.	2.3	4.0	6.3	8.8	11.5	14.5	17.8
		Cu.Ft.	12950	15850	18250	20400	22350	24150	25800

✳ For schools, churches, etc., reduce capacity and horse-power 20 percent for given speed.
For shops and factories reduce capacity and horse-power 40 percent for given speed.

Contributed by Charles L. Hubbard.

II.—SPEED, HORSE-POWER, AND CAPACITY OF CENTRIFUGAL FANS.

Height of Casing in Inches	Diameter of Fan in Feet		Speed, horse-power, and capacity in cubic feet per minute for centrifugal fans discharging into free air. ✳						
			¼ oz.	⅜ oz.	½ oz.	⅝ oz.	¾ oz.	⅞ oz.	1 oz.
100	5	R.P.M.	196	242	278	312	342	369	394
		H.P.	2.8	5.0	7.8	10.3	14.3	17.9	21.9
		Cu.Ft.	16050	19600	22650	25500	27750	29950	32000
120	6	R.P.M.	164	201	232	260	285	307	328
		H.P.	3.9	7.3	11.1	15.3	20.4	25.8	35.1
		Cu.Ft.	23250	28600	32900	36750	40250	43450	46450
140	7	R.P.M.	140	172	199	223	243	264	282
		H.P.	5.3	10.0	15.3	21.3	27.9	35.1	42.3
		Cu.Ft.	31550	38600	44600	49800	54550	58950	62950
160	8	R.P.M.	123	151	175	195	213	230	246
		H.P.	7.0	13.0	20.0	28.0	36.7	46.4	56.8
		Cu.Ft.	40850	50000	57750	64550	70650	76300	81550
180	9	R.P.M.	110	134	154	172	189	205	219
		H.P.	8.8	16.1	25.0	34.8	45.6	57.5	70.4
		Cu.Ft.	53200	63950	73750	82500	90350	97500	104250
200	10	R.P.M.	98	121	139	156	170	184	197
		H.P.	11.0	20.3	31.1	43.5	57.1	72.0	88.0
		Cu.Ft.	64100	78500	90600	101300	110950	119800	128000

✳ For schools, churches, etc., reduce capacity and horse-power 20 per cent for given speed.
For shops and factories reduce capacity and horse-power 40 per cent for given speed.

Contributed by Charles L. Hubbard.

MACHINERY.

June, 1908.

THE WESTINGHOUSE DOUBLE-FLOW STEAM TURBINE.

DETAILS OF RECENT DEVELOPMENTS IN THE PARSONS TYPE.

An interesting example of the greatly increased power capacity per unit of floor area, made possible by the use of steam turbines in place of reciprocating engines, is found in the Brunot Island station of the Pittsburg Railways more than the original plans had called for. An installation of Westinghouse double-flow turbine has been placed in the space originally assigned to the three reciprocating engines, and instead of gaining only 4,500 K.W., 18,000 K.W. has been added

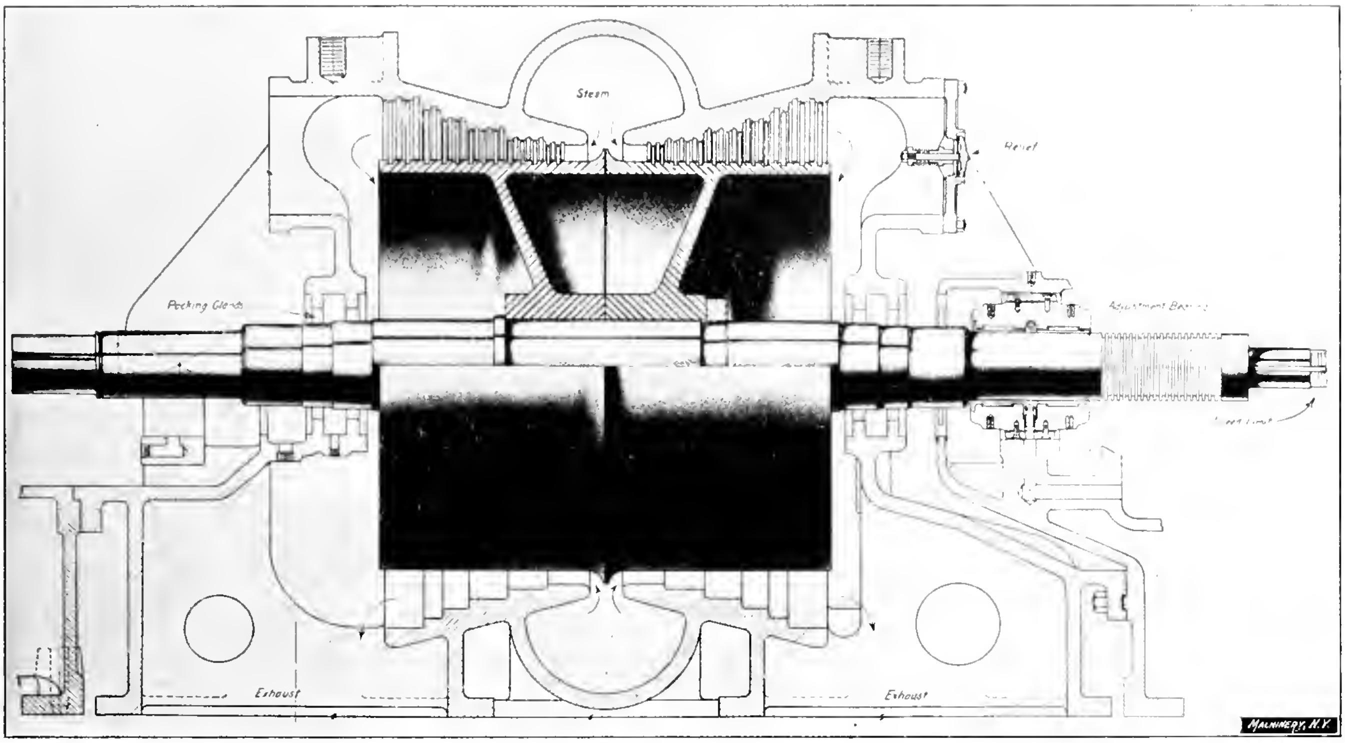


Fig. 1. The Westinghouse Low-pressure, Double-flow Steam Turbine.

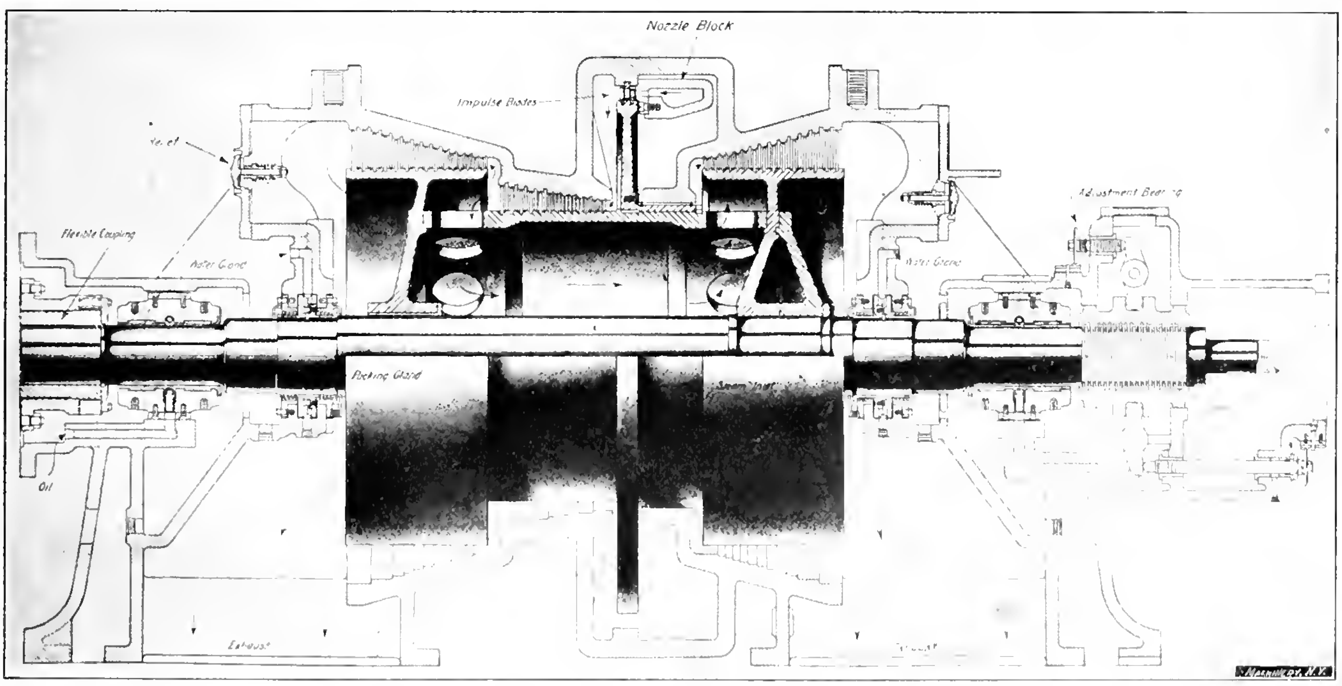


Fig. 2. The Westinghouse High-pressure, Double-flow Steam Turbine.

Co. This station is one of the scores of street railway power stations in which it has been found necessary to increase the capacity far beyond the original plans, in response to the extraordinary growth of urban and interurban transportation lines. In this station, space had been provided for three additional 1,500 K.W. cross-compound condensing engines, but the demand for power made it imperative to immediately provide much in the shape of one 3,000 K.W. and three 5,000 K.W. double-flow units, with space still remaining for another 5,000 K.W. unit. When this unit is placed there will be 23,000 K.W. developed, or *fifteen times* the power of the original lay-out in the same space.

The following description deals with the development of the double-flow Westinghouse turbine in considerable detail, inas-

much as this turbine has not been described to any extent in the American technical press. The double-flow principle as embodied in these large machines is a development brought about entirely by considerations of mechanical construction. It is not by any means without precedent—in fact, the original Parson's turbine, constructed in 1880, was of the simple double-flow type—and in hydraulic work the double-flow principle is largely used to produce a rotor running in perfect axial equilibrium. In small machines, however, the advantages of the double-flow principle are not as preeminent as in the large, principally because of the absence of the necessity therefor from a mechanical standpoint, and by reason of the fact that the economy of two small machines is not likely to be as good as one of twice the capacity. In turbines of very large size, however, where proportions exist more favorable to the attainment of high economy, the latter advantage does not obtain.

The double-flow turbine may thus be regarded as the result of an insistent demand for turbine-generating units of great capacity at high speeds. The 5,500 K.W. unit installed several years ago alongside the huge Corliss units at the Manhattan elevated station, New York City, proved to be only the beginning, and to-day 10,000 K.W. units have been built, while even larger ones are contemplated. For these large machines, the advantages of the combined impulse and reaction principle of steam expansion, together with the double-flow construction, are so important that the practical result, as embodied in the machine under description, is most fortunate, and for machines above 5,000 K.W. capacity, the double-flow construction will become standard in all Westinghouse work. For smaller capacities, the single-flow Parsons principle, as before, predominates, and in sizes below 3,000 K.W., the familiar Westinghouse-Parsons construction, therefore, remains standard.

From a thermodynamic standpoint, the Parsons is still the most efficient turbine system ever devised; but owing to the mechanical advantages inherent in the double-flow type, the net result is that as the two types are now built, they are practically upon the same basis as regards economy. This condition is largely brought about by the higher relative speeds permissible in large capacity machines with which the Parsons element works to so much better advantage as to compensate for the poorer inherent economy of the impulse section. In fact, this impulse element may be considered somewhat as a power producing reducing valve from which a lower efficiency may be countenanced.

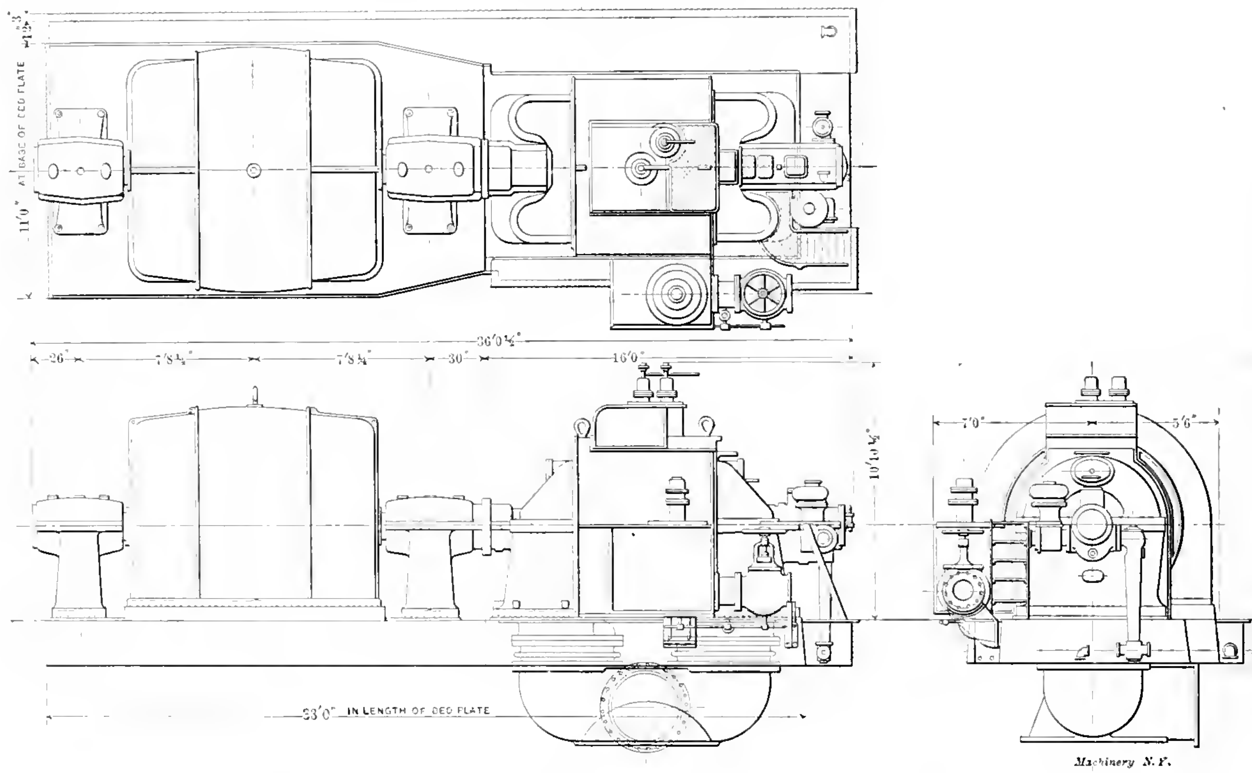


Fig 3 Plan and Elevation of the Westinghouse 5000 K. W. Double-flow Steam Turbine.

Elemental Construction.

The advantages of the double-flow construction will probably be most clearly understood by first considering the low pressure double-flow turbine shown in Fig. 1. Here we have a turbine of the simplest possible construction, consisting entirely of two identical Parsons turbines placed end to end, taking steam at the center and exhausting at both ends. It will be evident by an examination of the illustration, that since the two elements are identical, and the steam flows through them in opposite directions, the axial thrust of the steam on the blades, due to the difference of pressure between the inlet and outlet of each element, will be exactly the same in both sections. Therefore, perfect steam balance under all conditions of pressure, vacuum and load, is obtained without the use of dummy or balance pistons. As these low pressure turbines are designed to utilize all the exhaust steam from a non-condensing reciprocating engine, it is possible to tie the engine and turbine together electrically, thus making the use of a governor on the low-pressure turbine unnecessary. With the exception that, as mentioned, the governor may often be omitted from the low-pressure turbine, it is practically identical with the high-pressure double-flow turbine. In fact, the high-pressure machine is directly evolved from the low-pressure by the simple addition of a high-pressure impulse element mounted at the center of the rotor, this simple element serving in a capacity closely analogous to the high-pressure cylinder of a triple expansion reciprocating engine. Fig. 2 represents the final step in the evolution of the present complete high-pressure machine.

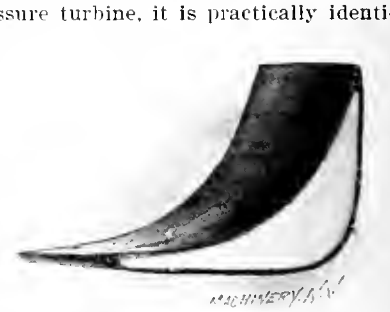


Fig. 4. Section through a Blade showing the Copper Sheathing which is chemically welded to a Steel Core.

Features of the Double-flow Construction.

At this point it may be well to review some of the features of the double-flow turbine.

1. Large reduction in bulk and in weight of individual parts to be handled in assembling. These follow from:

2. Increased speed permissible, due to reduced span between bearings.

3. Low-pressure section in two parts opposed in position and resulting in axial equilibrium, permitting the use of low-pressure blading of moderate length.

4. Cylinder not exposed to high-pressure and high-temperature steam; maximum pressure encountered about 75 pounds.

5. Relatively large volume per pound of steam at admission to first Parsons section avoids necessity of very short blades otherwise necessary with large diameters.

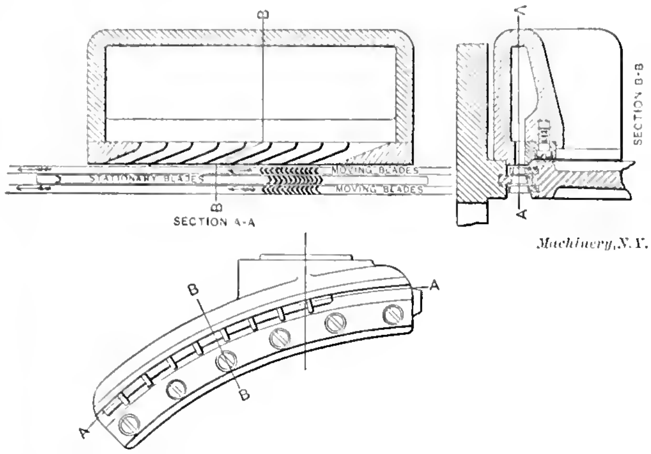


Fig. 5. Arrangement of the Blades and Nozzles.

6. Only one balance piston required, this being of moderate diameter.

7. Impulse element well suited to high-pressure and superheat; works well into dimension scheme, and reduces shaft length nearly 50 per cent.

8. Exhaust connections passing through bed plate largely reduced in size due to divided flow.

General Description.

Steam enters the turbine through a flanged opening in the lower half of the casing from which it is piped directly to nozzle blocks. For convenience in illustrating, the nozzle block, Fig. 2, is shown at the top, whereas, it may be located at any point in the periphery nearest the inlet. Expanding in suitable nozzles, the steam impinges upon the impulse blades, enters the impulse wheel chamber, and is distributed evenly around the casing so as to enter the intermediate Parsons section of the turbine, around the entire periphery of the rotor. As in the single-flow turbine, the steam then divides along two separate paths, one-half entering the left-hand section of low-pressure Parsons blading, the other passing through the interior of the rotor shell which forms the connecting passage to the remaining low-pressure section of Parsons blading at the right-hand end of the turbine. Discharging from the last rows of low-pressure blading, the steam passes into the exhaust connections and to the condenser in the normal manner.

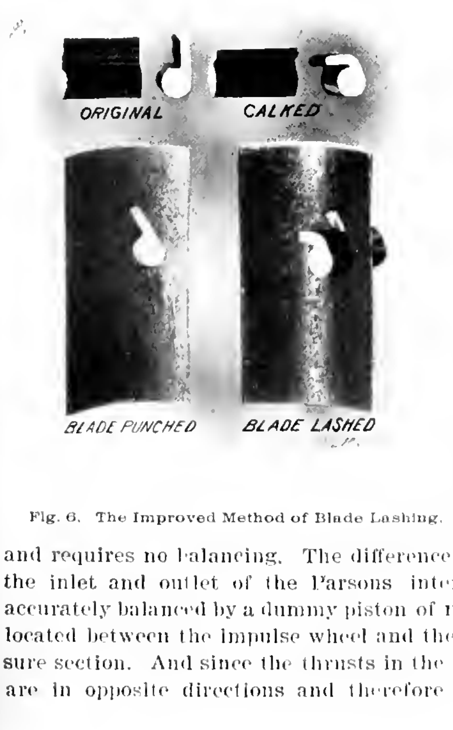


Fig. 6. The Improved Method of Blade Lashing.

As the same pressure exists on both sides of the impulse wheel disk, this is not subjected to end thrust and requires no balancing. The difference of pressure between the inlet and outlet of the Parsons intermediate section, is accurately balanced by a dummy piston of moderate dimensions, located between the impulse wheel and the right-hand low-pressure section. And since the thrusts in the low-pressure sections are in opposite directions and therefore balanced, the entire turbine runs in perfect equilibrium under all conditions of vacuum, pressure and load. It is, of course, necessary to provide means for accurately fixing the axial position of the rotor, and for this purpose, an adjustment bearing on the right-hand end of the shaft, is, as usual, fitted. It consists of a number of collars turned in the shaft, into which fit corresponding brass rings fixed in the adjustment blocks. The upper and lower halves of the adjustment bearing may be moved by means of micrometer screws, as shown, thus permitting the axial position of the rotor to be accurately known at all times.

Double-flow Cylinder.

All double-flow cylinders are made in two parts, the upper and lower halves each being a one-piece casting. The design is symmetrical throughout, devoid of longitudinal flanges except those at the center required for bolting the two parts together. The castings are first rough-bored, after the flanges have been planed and drilled, and are then "seasoned" with high-pressure steam for a number of hours to remove any local casting strains in the metal. They are then given the finishing cut, assembled, and with boring-bar running in the bearing housing so as to insure a truly concentric bore. Manholes are provided at each end of the cylinder to permit access for interior examination, and relief valves are fitted in each of the manhole covers to prevent the pressure in the exhaust passages rising to a dangerous point in case of failure of the condensing apparatus and sticking of the atmospheric relief valve. A steam- and air-tight packing gland is fitted at each

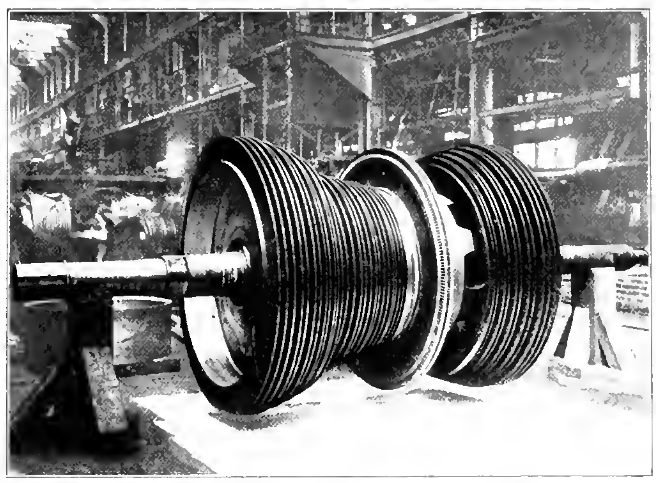


Fig. 7. View of the Rotor showing the Uniformity of the Blading

end of the cylinder where the shaft enters, and will later be described in detail.

A Y-connection fitted with two corrugated copper expansion joints located below the base of the turbine, connects the separate exhausts to the main exhaust nozzle. This is clearly shown in the longitudinal elevation of the 5,000 K.W. Brunot Island turbo-generator shown in Fig. 3. By means of these expansion joints, the desired freedom of movement of the turbine casing, due to expansion and contraction, is provided for. It will also be noted that an atmospheric exhaust nozzle opens out of the side of the exhaust Y to permit non-condensing operation.

The Rotor.

Referring again to Fig. 2, it will be seen that the rotor consists of five cast steel members mounted on a through shaft. Note that the shaft carries its load at one-third distance from the points of support, thus permitting a lighter shaft than required for distributed loading, and practically eliminating the possibility of deflection. The rotor is firmly pressed on the shaft and locked to prevent movement. To the left end of the rotor is fitted a bronze bushing surrounding the shaft, permitting it to move axially without appreciable resistance under any differential expansion of shaft and rotor body.

The impulse element consists of a flanged cast steel disk forced onto the rotor body with a pressed fit and securely keyed. The flange at the base is grooved and forms the dummy or balance piston for the intermediate Parsons section

A typical arrangement of blading and nozzles is shown in detail, Fig. 5. Note that the nozzle block is an independent casting quite separate from the turbine cylinder. This restricts the high pressure and high temperature of the steam received from the governor valve to a comparatively small casting which is free to expand and contract with changes of temperature, and may easily be designed with ample strength.

As the steam is not expanded in the impulse element to less than about half of the initial pressure, divergent nozzles are unnecessary and simple straight-sided nozzles are used. The entire nozzle block may be removed in one piece, and the construction is such that the nozzle walls may be readily renewed if necessary, at a very nominal cost, independently of the block. As practically no difference of pressure exists on the two sides of the element, the area through the bucket increases, to provide for the decreasing steam velocity in each rotating wheel. As in all high-pressure impulse turbines, the nozzle blocks cover but a small portion of the periphery of the impulse wheel, so that ample space is left around the remaining portion of the wheel to permit the free circulation of steam in all parts of the impulse wheel chamber before entering the Parsons element.

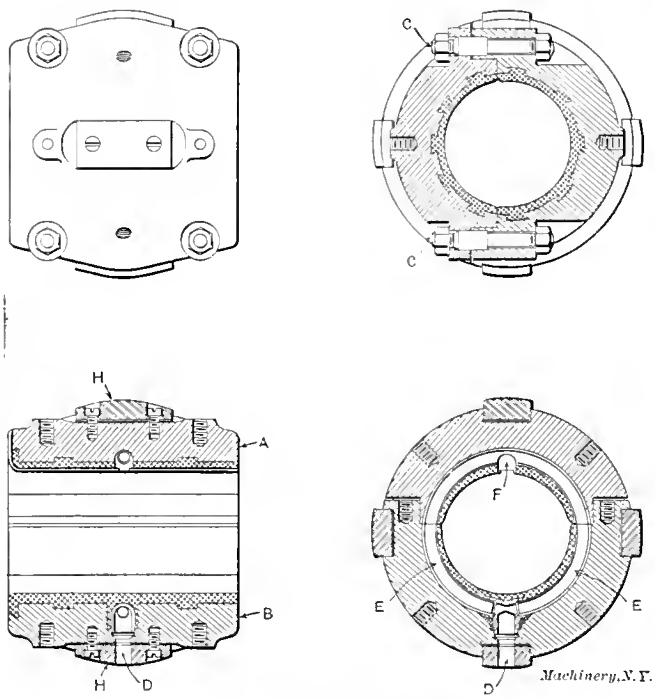


Fig. 8. The Self-aligning Babbitt-lined Bearing, which does not require Forced Lubrication.

Parsons Element.

Except for the division of the low-pressure Parsons section, this part of the turbine is identical with the single-flow construction, consisting of a series of rows of moving and stationary blades, increasing in height to allow for the increased volume of the steam. In the Parsons section, it will be recalled, the velocities from stage to stage remain practically constant. The blades are inserted in grooves cut in the spindle and cylinder body, and are securely held in place by calking the soft spacers or distance pieces inserted in the grooves between the blades. It will be noted that the diameters of the low-pressure section are chosen so as to permit the same size blades being used in both intermediate and low-pressure sections, thus simplifying the blading considerably. As there are a number of improvements in the Westinghouse-Parsons blade construction used on both the single-flow and double-flow turbines that have not been previously described, they will be of interest.

The Blading.

No one metal has all the physical characteristics desirable in a blading material. But recently a special, compound metal has been developed, which is exclusively used in Westinghouse turbines. This material, known as "Monnot," or duplex metal, consists of a steel core covered with a thin copper sheathing chemically welded to the steel in such a perfect manner that the blades may be drawn cold from the original ingot into the required finished section without in any way affecting the bond between the copper and steel. The advantages of this blade material will at once be evident, as experiments have shown that pure copper offers the maximum resistance to chemical corrosion resulting from bad feed water carried over in the steam during priming. At the same time the integrity and great strength of the steel core is maintained. How uniform the copper sheathing of the finished blade is, may be clearly seen in Fig. 4, showing an enlarged section of a duplex metal blade, the end of which has been etched to show the true thickness of the copper covering.

Fig. 9. Westinghouse Low-pressure Double-flow Turbine.

The Blade Lashing.

The original method adopted for reinforcing long blades was to insert a heavy brass wire in saw slots cut in the entrance edge of the blade, the brass wire being securely laced to the blades by a thin copper wire, and the whole then rigidly brazed together. This method has been greatly improved upon in the present blade lashing now used in all Westinghouse turbines, shown in detail in Fig. 6. First, comma-shaped holes are punched in the blades at any desired point of reinforcement. The blades are then strung onto a comma-shaped lashing wire laced through these holes. After the blades have been calked into the rotor or stator, the tail of the lashing is sheared over by a tool, as shown in the accompanying engraving, Fig. 6. This process wedges the tail of the lashing (comma section) into the contracting space between the face and back of the adjacent blades, acting as a strut, while the lashing wire itself acts as a tie, thus securely interlocking the blades and preventing vibration. Moreover, the short section remaining in the blade after being sheared off, acts as a key to prevent a broken blade from injuring adjacent rows. The quality and uniformity of the blading secured by these improved methods, is indicated in the view of a rotor, Fig. 7.

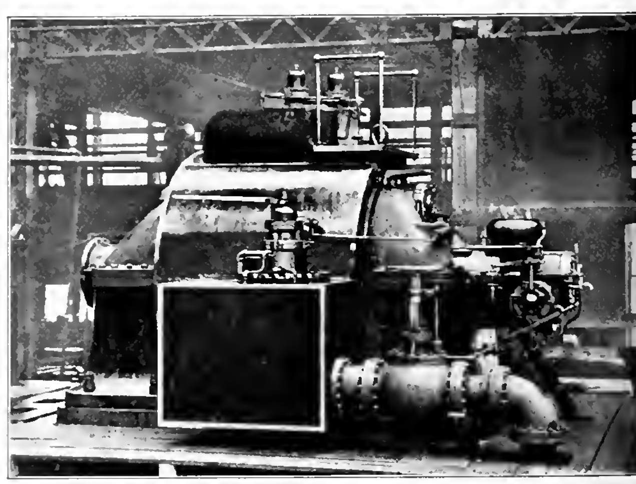


Fig. 10. One of the 5000 K.W. Double-flow Turbines installed at the Brunot Island Station of the Pittsburg Railways Co.

The Packing Glands.

A water-sealed gland is fitted on each end of the turbine shaft where it passes through the exhaust casings. This pack-

ing consists of a small centrifugal pump propeller running in an enclosed chamber to which water is supplied under a head of about ten feet, which is slightly in excess of the head due to the centrifugal force acting on the water in the impeller blades. At starting, any external leakage water is caught in circular troughs and drained away. The action of this gland is to always maintain a solid mass of water around the periphery of the impeller which effectually prevents the entrance of air to the condenser or the escape of steam to atmosphere when running non-condensing.

The Bearings.

As in all Westinghouse turbines running at or below 1,800 R. P. M., self-aligning babbitt-lined bearings are used, of sufficient area to operate without the use of a forced-lubricating system. One of these bearings is shown in detail in Fig. 8. It is made in two parts, supported in a spherical seat by four pads, by means of which the bearing and rotor can be accurately centered to preserve uniform clearances. The oil supply to the bearings is delivered at the top of the journal at the point of minimum pressure, which assures an even distribution of oil. All the bearings are supplied with oil from a central reservoir, under a static head of about 5 feet.

* * *

The Standard Oil Co. has been the chief exponent of subterranean business methods. Its greatest success has hinged largely on the policy of secretiveness, though John D. Archbold, the vice-president and chief spokesman of that great business machine, asserted in the *Saturday Evening Post* some months ago that the policy was not, in his opinion, the best one to follow. He stated that while perhaps the financial returns would not have been quite so vast, the concern would stand in much better repute to-day if a franker policy had been followed. We mention this because there is a marked tendency among certain small concerns to seclude their work with more or less mystery. They assert it is more to their advantage not to let their activities be widely known. The less there is known about their work the less fierce will the competition be. While we do not deny that there is some truth in this claim, we believe that it is an unsafe policy for the average small producer to follow. Working under cover, his product will necessarily be known and bought by comparatively few customers. So long as these customers absorb all his product, well and good, but when some of these customers drop out, as they inevitably will, the producer will be stranded high and dry until he can secure new customers, and these are not always readily picked up. When they are found it is quite probable that they will demand changes that will be very costly. If, on the other hand, the concern was generally known, the loss of one customer would not be so serious a matter, and moreover, the business would be conducted more closely in accordance with the general development of the art.

* * *

A new technical high school is being erected in Cleveland, Ohio, and will be completed next September. It is claimed that this institution is the largest of its kind in the United States. It will have accommodation for about 1,000 regular students, and is well equiped with laboratories for physics and chemistry, a forge shop, a machine shop with heavy equipment suitable for the best of trade instruction, an iron and brass foundry, completely equipped with core-room, core ovens, etc., a power plant for generation of the electric light and power required in the building, a pattern-making shop, and departments for instruction in joinery, wood turning, and cabinet making, etc. The mechanical equipment will cost in the neighborhood of $100,000. All machines will be driven by individual motors. An innovation in the instruction will be that, by eliminating the long summer vacation, a saving of an entire year in the high school course will be accomplished, so that a three-year course will be offered in which work usually covered in four years can be completed. In addition to the day classes, there will be night classes for men and women already engaged in the trades. These night classes will be divided in two sections, each accommodated three nights a week from 7 to 9:30. In this way the night trade school can give instruction to 1,400 men and 600 women.

ALIGNMENT TESTS OF LE BLOND MILLING MACHINES.

In the April, 1904, issue of MACHINERY a general description was published of the then comparatively new plant of the R. K. Le Blond Machine Tool Co. in Cincinnati, and in the article a set of boring-bars and reamers for boring the

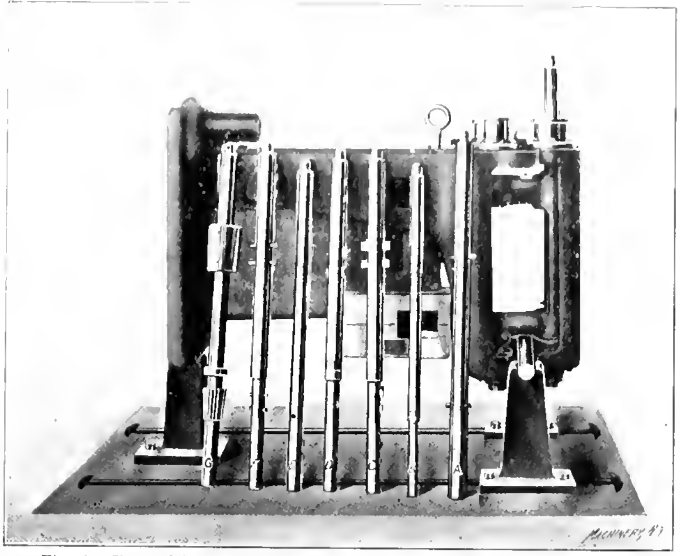


Fig. 1. Jig and Boring-bars used for Boring Bracket Holes, Spindle Bearings, and Over-arm Hole.

bracket holes, main spindle bearings and the over-arm holes of the Le Blond milling machines was illustrated. These tools, whose proper working is so necessary to the accurate alignment of a milling machine, are again reproduced in Fig. 1 in connection with illustrations of the alignment tests to which all Le Blond milling machines are subjected on the

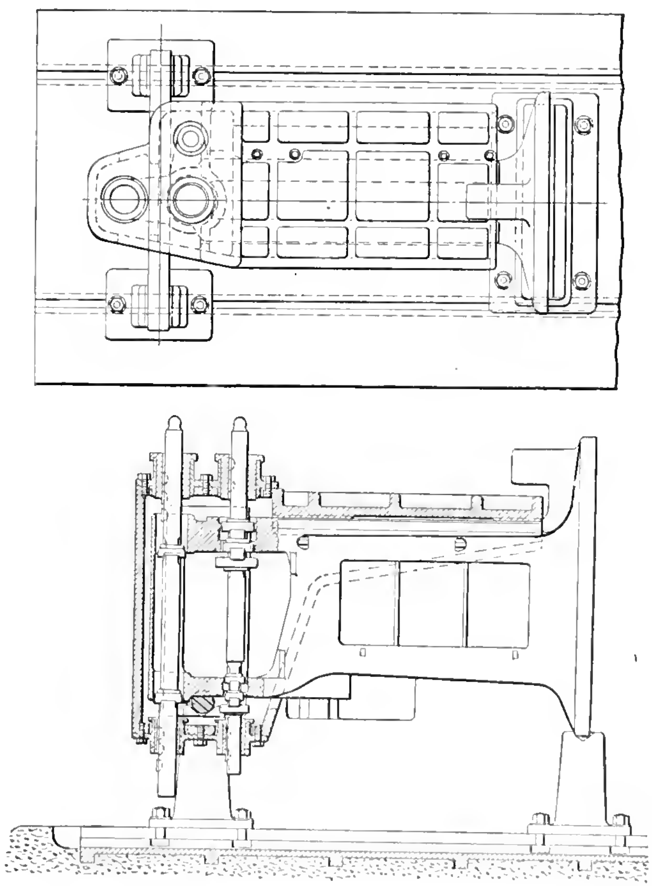


Fig. 2. Plan and Elevation of Milling Machine Column Mounted on Floor-plate for Boring

testing floor. For the description of these tests we are indebted to Mr. William F. Groene, the superintendent of the company.

Before passing to the alignment tests, attention is called to the manner of supporting the machine column during the boring operation, and to the construction of the boring jig

shown in section in Fig. 2. Formerly the milling machine column was supported on a three-wheel truck for convenience in transporting to and from the drill press, but now the truck is displaced by an electric traveling crane, and the support is a cast iron floor-plate, bedded in concrete and provided with suitable pedestals for the column casting. It may be said in passing that the boring-bars are entirely supported by the boring jig, and that the power from the radial drill press is transmitted by a "floating" or universal joint connection. The jig bushings are mounted in protected bearings, proof against chips and drill dust, and are keyed so as to revolve with the boring-bar, thus eliminating the wear of the bars and preserving a close fit. The jig encloses the upper part of the column and is supported by the front face of the column and produces holes at right angles to this face.

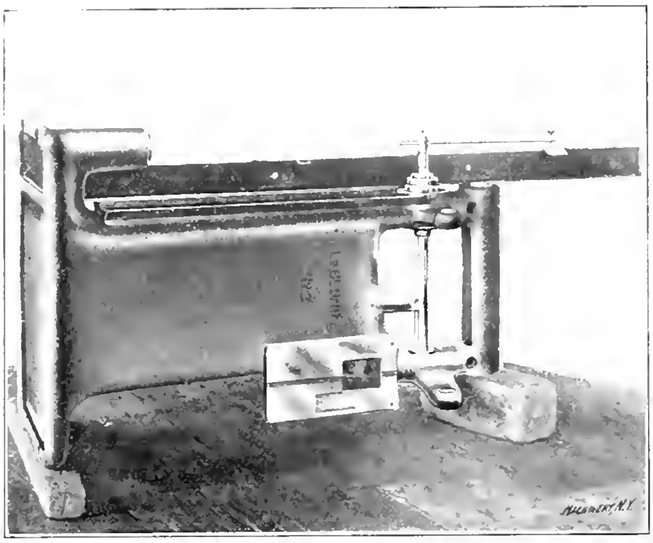


Fig. 3. Aligning Test made when Scraping Boxes Square with Face of Column. The Test is made Alternately at Top and Bottom by Drawing Tissue Paper between Straight-edge and Tram.

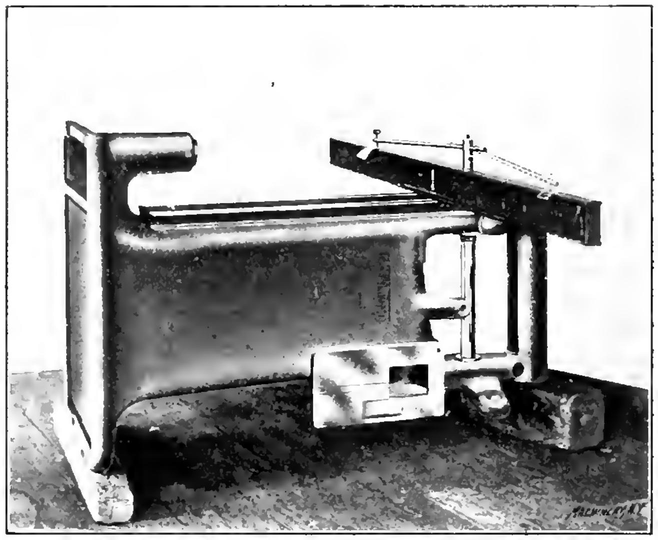


Fig. 4. Aligning Test made when Scraping Boxes Square with Face of Column. Same Test as in Fig. 3, except that Straight-edge is Laid across Column.

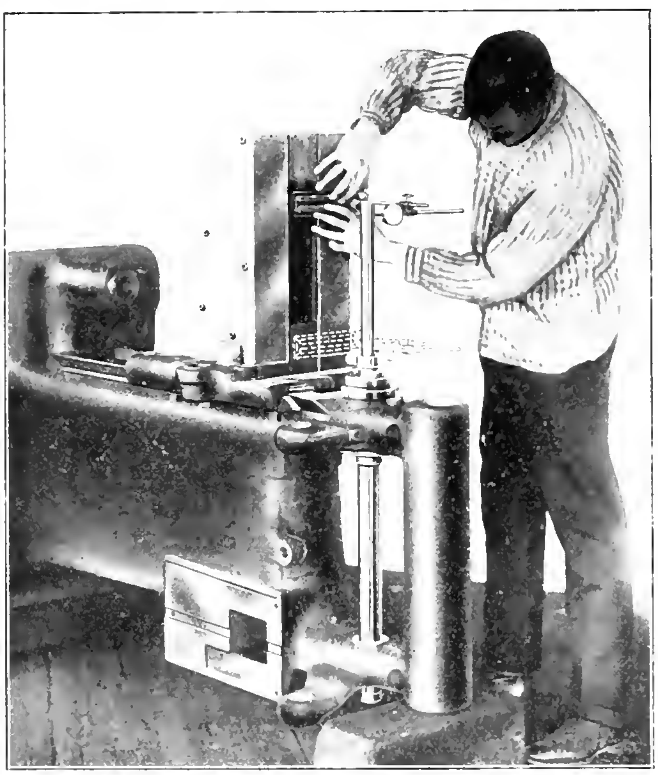


Fig. 5. Aligning Test used in Scraping Knee to Column, to determine the Alignment of the Side Bearing Surface of the Knee with the Spindle

Fig. 6. Aligning Test used in Scraping Knee to Column, to determine the Parallelism of Top of Knee with Spindle.

It is one thing to design a jig for boring holes at right angles to a given surface and perfectly parallel, and quite another thing to get the desired result, especially in the case of a milling machine column casting. Eternal vigilance is necessary to keep the tool equipment in order, and rigid tests are required of each casting. No ordinary jig, no matter how carefully planned, can produce an invariably correct alignment in long holes, especially in irregular castings, which are cored and shaped to save weight, and in which shrinkage strains are always present to some extent. The slight changes of shape caused by the removal of metal from the holes would in themselves require some corrective work, even if the jig always provided perfect guidance to the boring tools, and the fine touch of the experienced fitter is employed to correct these and other minor defects of important influence on the alignment. The tests to be described are employed to show where the scraper should be applied, as well as to prove that the work is finally worthy of acceptance.

The columns are scraped to surface-plates before boring. Boring-bar *A* and the bar shown in the jig in Fig. 2 are the over-arm finishing and roughing bars, respectively. The bar designated as *B* is for roughing out the back-gear bracket holes, and *E* is the finishing bar. The boring and reaming bars for the spindle bearings are *C*, *D*, *F*, and *G*, *C* being the roughing bar. This bar has extra slots for receiving larger cutters to do the counterboring, and *F* is the finishing bar. Bar *D* is used for boring the holes to the correct taper, the

cutters having their faces chamfered to the required taper of the bearings. These cutters are set opposite to each other to balance the cut. *G* is a bar with adjustable taper reamers for finally reaming both bearings true at one operation.

face of the column by scraping the bearings of the front and back boxes. No error is allowed in this alignment and the trams must show the same in the test when in the four positions shown.

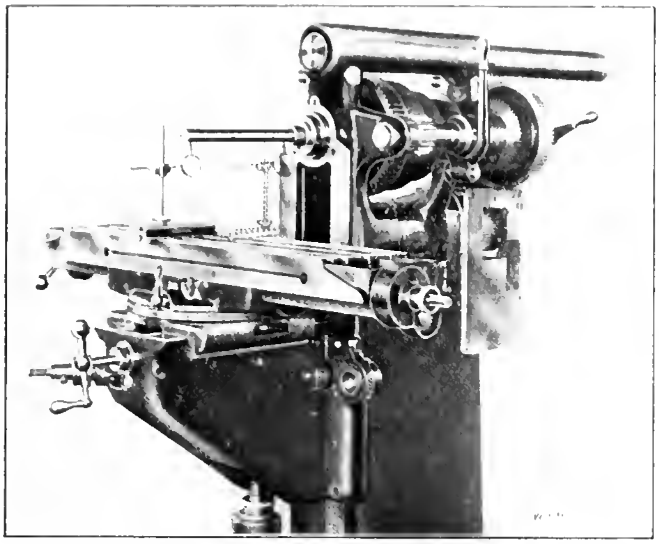


Fig. 7. Test to show Parallelism of Table with Spindle, and to indicate if Taper Hole runs True. Test is made by shifting Indicator across Table.

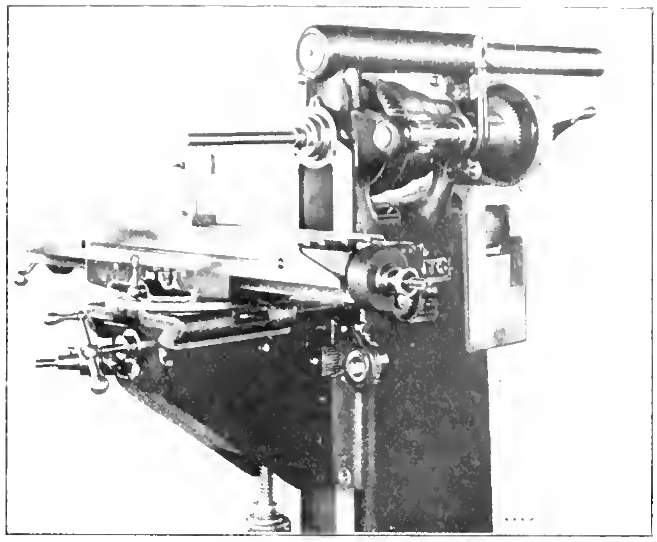


Fig 8. Test to show Parallelism of Knee with Spindle. Test is made by clamping Indicator to Table and moving Saddle across Knee with Screw.

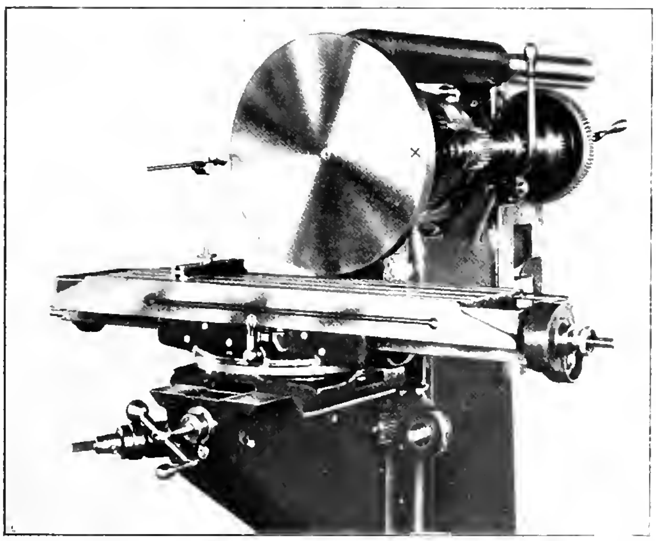


Fig 9. Testing Alignment of T-slot with Spindle. Reading taken as shown, and on other Side of Spindle at X, with Plate turned One-half Revolution.

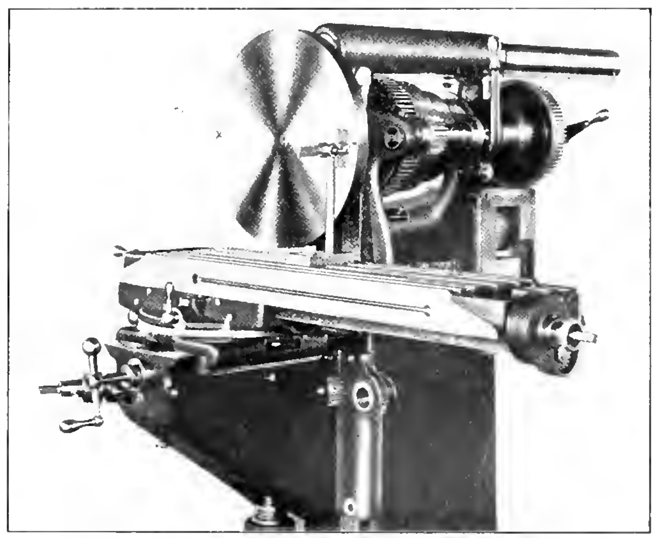


Fig. 10. Testing Alignment of Table Feed with Spindle. Indicator clamped to the Table and traversed past the Test Plate. Test otherwise made as in Fig. 9.

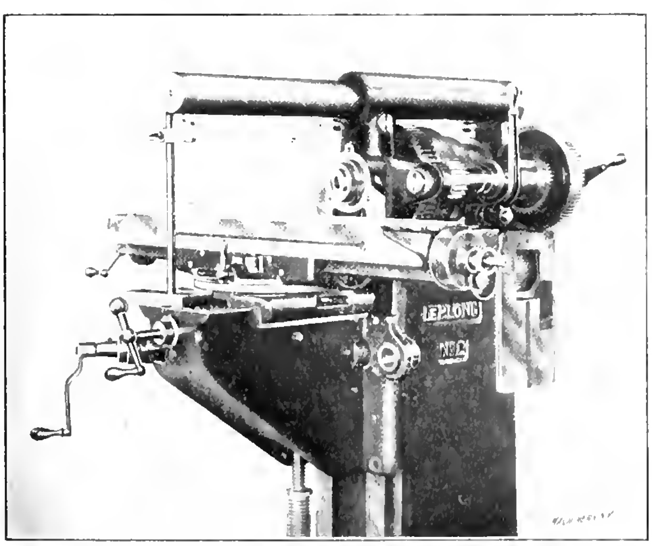


Fig. 11. Test to determine Alignment of Over-arm with Top of Knee. Indicator is passed under Arm on Each Side of Saddle.

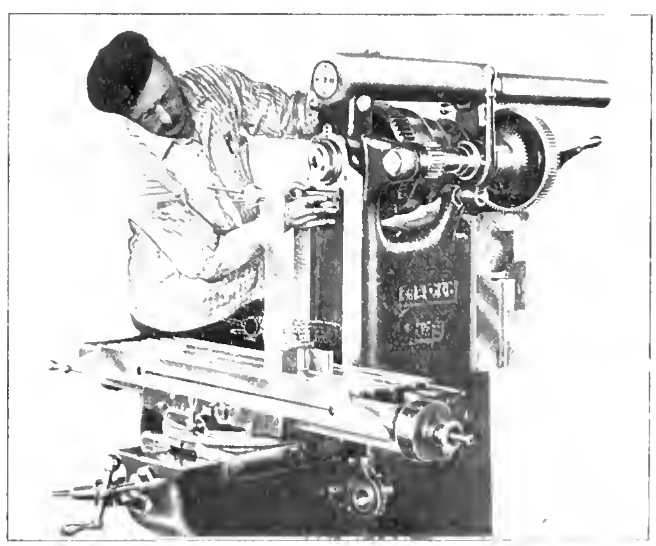


Fig 12. Testing Truth of Table Top with Side of Column. A Test for Truth with Face of Column is made with Square Clamped at Right Angles to Position shown.

The columns, as bored, come within an included error of about two thicknesses of tissue paper, or say 0.003 inch, when tested with the 18-inch trams and straight-edge, as shown in Figs. 3 and 4. The spindle is then lined square with the

Figs. 5 and 6 illustrate the test made while scraping the knee to the column. The test bar is inserted in the spindle and the knee is tested both with the face and side of the dovetail with the dial indicator. The base of the indicator has a

shoe which bears against the side of the column when making the test.

Fig. 7 illustrates testing the top of the table for parallelism with the spindle. In this case the indicator is set to the under side of the test bar and is moved across the table, the error being read in the two extreme positions as indicated in the illustration.

Fig. 8 shows the indicator clamped to the table while both the saddle and table are moved across the knee. This test proves the parallelism of the knee with the spindle.

Referring to the test card, it will be seen that the limit of error is 0.0015 to 0.003 inch high in front for No. 1 to No. 2½ machines, and 0.0025 to 0.004 inch high in front for Nos. 3 and 4 machines. The knee and table are designedly made high in front, the object being to more nearly approximate

TEST CARD

No. 2½ Universal MILLER

No. 315 Date completed 3-19-08 Insp. Niebush

Shipped to Dodson Mfg. Co. Torreon Mexico

Front Spindle Bearing adjustment	✓
Rear " " "	✓
Spindle revolves freely without shake	✓
Taper hole has good bearing	✓
Back Gears run quietly	✓
Overarm Locking Plugs have good bearing	✓
Feed Box properly fitted up	✓
Feed Box Gearing run quietly	✓
Feed works in Knee properly fitted up	✓
Crank Handles fit squares in all positions	✓
Dividing Head Change Gears fit stud freely	✓
Knee Saddle and Table Gib Screws properly adjusted	✓
Movements as specified by Catalog	✓
Automatic Table, Cross and Vertical Feed trip to a line	✓
Safety Trip Dogs properly set	✓

	Limit of Error	Test
Table Screw, test every 4"	.0005	.00025
Vertical " "	.0005	ok
Cross Feed "	.0005	ok
ALIGNMENTS:		
Taper hole in spindle runs true—error at outer end with 16" test bar	.001	.001
Knee parallel with spindle—test full cross movement of saddle	.0015-.003 high in front for No.1-2½; .0025-.004 high in front for No.3 & 4	.0015
Top of Table parallel with spindle—test at extremes 16" test bar	.0015-.003 high in front.	.002
Top Table square with side of column test at extremes 24" precision square	.0015-.003 in favor	.002
Top Table square with face of Column test at extremes 24" precision square	.0015-.003 high in front for No.1-2½; .002-.004 high in front for No 3 & 4	.002
Table travels at right angles to spindle test at extremes 20" test plate	.0015-.003 in favor	.0015
Table T-slots at right angles to spindle test at extremes 20" test plate	.0015-.003 in favor	.0015
Overarm parallel with spindle & knee test at each end of knee	.002-.003 low in front	.0025

Fig 13. Test Card giving Required Tests and Maximum Permissible Errors.

correct alignment after the machine has been in use a few months and has worn down to full bearing under the pressure of the cutters.

The testing of the alignment of table T-slots with the spindle is illustrated in Fig. 9. The indicator base has a tongue which fits into the T-slots. The indicator point is set against the test plate, screwed onto the spindle, which is then given half a turn, and the indicator is moved to the opposite side to read the error. A cross mark is made on the face-plate, as shown in the illustration, to note the testing point. Fig. 10 shows the same test as Fig. 9, but in this case the indicator is clamped to the table which is traversed across the test plate, and the difference of reading in the two positions is noted as before. This test gives the error of the table at right angles to the spindle with reference to the table dovetails. It will be noticed in the test card that allowance 0.0015 to 0.003 inch is permitted at the extreme of a 20-inch test plate in favor of the direction against the feed. This allowance is for the same reason noted before. When the machine has been in use a few months it will have worn down under the pressure of the cut until nearly perfect right angle position has been obtained.

This practice is worthy of further mention because it is of much importance to users of machine tools and to buyers of second-hand machinery. It means that a well-constructed milling machine is actually in better shape after it has been used for a short time than when new. Given data of tests made on used machines, it would be possible to plot the matter graphically and show the probable condition as regards accuracy of alignment for several years. Starting with 0.0015 to 0.003 inch inaccuracy, the conditions would be plotted probably as a reverse curve, rising from a position below the zero line in three or four months daily use, and then with ordinary good care paralleling and nearly coinciding with the zero or dead accuracy horizontal line for several years use. The departure of the curve from this zero line upward into the zone of negative inaccuracy, if we may name it so, would be relatively rapid or slow, depending on the care the machine receives and the class of work assigned to it.

The test of the aligument of the over-arm with the top of the knee is shown in Fig. 11, and in Fig. 12 two tests are indicated which are made with a 24-inch precision square to determine whether the top of the table is at right angles to the face and side of the column.

The test card we reproduce shows all the tests regularly made and the maximum permissible error allowed for the various sizes of machines built by the company. This card was made for machine No. 315 and is the one from which the photographs here reproduced were made.

* * *

An interesting kink in hack-sawing was shown to the editor in the shop of the National Tool Co., Cleveland, Ohio, by Mr. E. A. Noll, the manager. Most users of hack-saws have trouble in sawing large diameters of stock, especially tool steel, by the saw "running" and perhaps breaking before the end of the cut is reached because of becoming cramped. Mr. Noll has found that the saws will run dead true if they are slightly twisted when tightened up in the saw frame. Milford saws are used on hard tool steel stock and the blade is twisted very slightly in the frame when tightened up. Twisting a hack-saw to produce a straight cut is contrary to all preconceived notions, but the explanation seems logical. The explanation is that the saw being slightly twisted to begin with resists any tendency to deflect it from its plane of action much more strongly than it would if it were put perfectly straight in the frame. The initial twist given is so little as to have little or no effect on the cut, but it is sufficient to prevent the saw being twisted out of its plane by slight differences in the hardness of the material and other influences which tend to cause a saw to run out.

* * *

In the March, 1908, issue of MACHINERY we described the Automobile Club of America's dynamometer for testing automobiles, and mentioned that the mechanical efficiency of automobiles in general was rated at 75 per cent, but many of those tested on the dynamometer showed less efficiency. The consensus of opinion is that mechanical efficiency should be higher than 75 per cent, if anti-friction bearings were used, and it is interesting to note the results of efficiency tests made by the H. H. Franklin Co. recently. The car tested was the Franklin model G standard touring car. It gave on direct drive for 15.75 H.P. developed by the motor, 14.75 H.P. delivered at the ground. On intermediate drive the figures were 15.75 H.P. and 14.40 H.P. The loss in transmission between motor and rear wheels was 6 2/3 to 8 1/2 per cent, thus making the efficiency for the total mechanism 93.5 per cent on direct drive and 91.5 on intermediate gear.

* * *

No experienced mechanic needs to be told that the universal milling machine is a complete machine shop in itself. With the various attachments now provided it is possible to produce circular, plane and helical surfaces and combinations in almost every conceivable arrangement. Milling, turning, slotting, spur, spiral and bevel gear cutting, forming, cam cutting, drilling, reaming, boring, splining, knurling, thread cutting, thread milling, originating jigs, hobbing, etc., are all readily accomplished. Instead of being called a universal *milling* machine, it should be called the *universal* machine.

GEAR-CUTTING MACHINERY—6.

RALPH E. FLANDERS.*

As explained in the last installment of this article, in the May issue of MACHINERY, the molding-generating principle is the only one for accurately forming the teeth of worm-wheels. The principle involved is shown in Fig. 111. The forming worm (or hob) is connected by gearing with the plastic worm-wheel blank to be formed, in the same ratio as given by the finished worm gearing. While the blank and the forming worm are rotated together in this ratio, the latter is fed into the blank slowly, its threads forming the proper shaped tooth in the wheel. As the worm revolves, an axial section would give the appearance of a rack like that shown in section *A-A*, of Fig. 109, moving continuously and forming suitable gear teeth in the wheel below it. Any other section, such as *B-B* in Fig. 109, would also act as a distorted rack, forming correspondingly distorted gear teeth in that portion of the worm-wheel in the same plane. The process is thus seen, as previously explained, to be identical with that in Fig. 7.

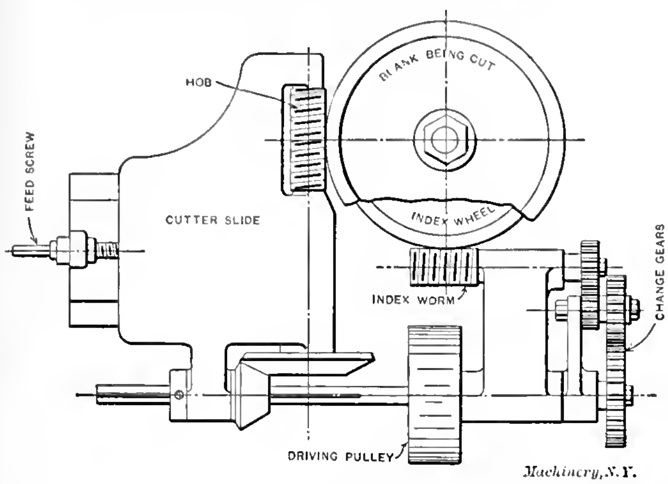


Fig. 111. Diagram showing the Principle of the Hobbing Process for Cutting the Teeth of Worm-wheels.

Of the various methods of operation, shaping or planing is of course impracticable. Milling is the method generally employed. Grinding or abrasion is used to a limited extent, it being sometimes employed in the case of "grinding in" a worm with a wheel already roughly cut to shape. In this operation the worm and wheel are run together in place under considerable pressure, the teeth of the gear being liberally supplied with oil and emery, which acts as an abrasive and forms the teeth of the gear and worm to fit each other.

In the commonly employed milling operation, the process is that known as "hobbing," and the milling cutter or tool used is a "hob," of which an example is shown in Fig. 112. The hob (barring modifications required for relief or clearance, and allowance for regrinding) is practically a replica of the worm which is to be used, but with grooves cut in it so as to form teeth. This hob is rotated in the proper ratio with the work, exactly as shown in Fig. 111, and fed slowly down into it, cutting out the tooth spaces in the wheel as it does so. When it has reached the proper depth, the teeth are all formed to the proper shape.

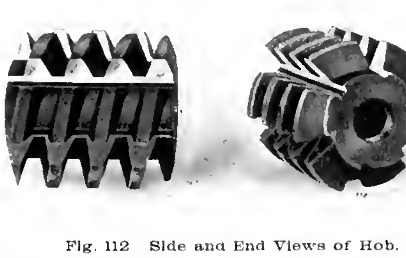


Fig. 112 Side and End Views of Hob.

Hobbing Worm-wheels in the Milling Machine.

The simplest method of rotating the hob and the work in the proper ratio with each other is that in which the work is first gashed, as shown in Fig. 110, and then finished with the hob in such a way as to be driven by the latter, the work and the hob thus furnishing their own driving mechanism. The same wheel which is being gashed in Fig. 110 is shown having its teeth finished to the proper shape with the hob in Fig. 113, the hob driving the work as described. The latter is mounted so as to revolve freely on dead centers. This is the simplest method of making correct worm-wheel teeth. It does not require special appliances of any kind, being done in an ordinary milling machine with a gashing cutter and a hob.

In cases where it is desired to hob worm-wheels directly from the solid without preliminary gashing, it is necessary to provide some special device for rotating the hob and the work in unison as in Fig. 111. Such a case is shown in Fig. 114, which illustrates the worm-wheel hobbing attachment built by the Wanderer Fahrradwerke, Schonau, bei Chemnitz, Germany. This attachment, which is self-contained, is clamped to the table of the milling machine. The device carries a vertical work spindle, driven by a worm and worm-wheel which are connected by change gearing with a horizontal shaft carrying a gear meshing with a gear on the spindle of the machine. The hob, which is carried by the spindle of the machine, is thus positively connected through the change gearing with the work in the same way as in Fig. 111. Change gearing is set to give the proper ratio between the hob and the work. The hob is fed to depth in the work by the operation of the regular table feed-screw.

In Fig. 115 is shown a hobbing attachment applied to another form of miller, in this case a horizontal spindle machine of the planer type made by the Newton Machine Tool Works, Philadelphia, Pa. The attachment consists primarily, as in the previous case, of a base provided with bearings for a vertical spindle, which is revolved by a worm-wheel enclosed within the base. The worm is connected by change gearing with a splined shaft, driven through a train gearing from the spindle. The machine is set to the diameter of the work, and the hob is fed to depth by the operation of the regular longitudinal feed-screw. A special feeding mechanism is provided, operated from the attachment instead of from the regular feed cones.

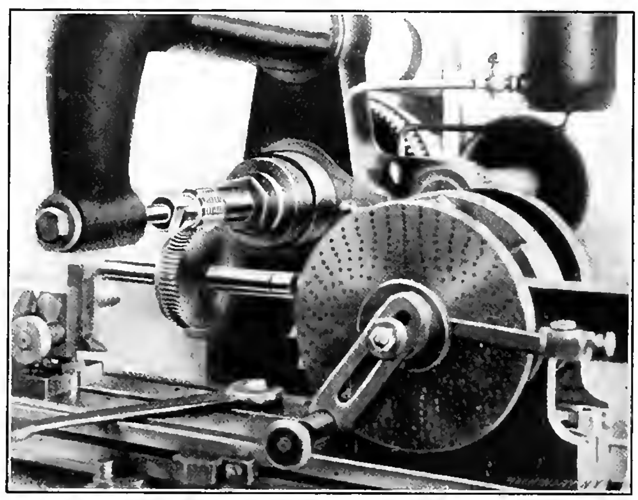


Fig. 113. Hobbing a previously Gashed Worm-wheel on Dead Centers in the Milling Machine.

Hobbing Worm-wheels in Machines Designed for Cutting Other Forms of Gearing.

With slight changes, the orthodox spur gear cutting machine can be adapted to hobbing worm-wheels. An example of such an adaptation is shown in Fig. 116, the machine adapted in this case being an automatic gear-cutter made by Eberhardt Bros. of Newark, N. J. In this machine the indexing mechanism is operated from the same splined shaft by which the spindle is driven, so that, to obtain the proper ratio of movement between the hob and the work, it is only necessary to connect the index gearing positively with the driving shaft, instead of using the intermittent indexing motion ordinarily employed. With the index gearing thus permanently connected with the spindle driving mechanism, proper change gears may be selected to give the required ratio of movement between the worm-wheel to be cut (which is, of course, mounted on the work arbor) and the hob, car

* Associate Editor of MACHINERY.

ried on the cutter spindle in place of the regular spur gear cutter. Another provision that has to be made is that for feeding the cutter into the wheel as the work progresses. This is effected in this case by lugs on the arms of the index wheel, which, rotating continuously, act on a link mechanism which operates an adjustable ratchet motion for the vertical

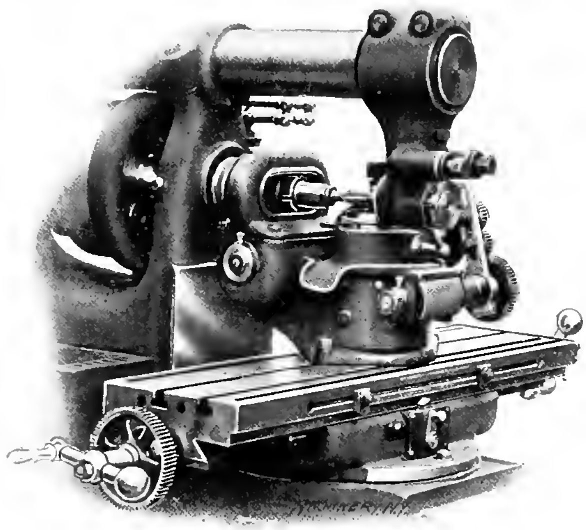


Fig. 114. Hobbing a Worm-wheel without Previous Gashing, in a Positively-driven Attachment in the Milling Machine.

feed shaft. This ratchet motion may be varied to give any rate of feed desired. By this means the work is fed down into the cutter as the operation progresses.

In Fig. 117 is shown a gear-cutting machine, made by Gould & Eberhardt, Newark, N. J., arranged for hobbing worm-wheels. In this case, also, the hob and the work are connected by means of the splined driving shaft and the index gearing, so that they revolve in unison and in the proper ratio. It will be seen that the work in the machine is so heavy as to make it advisable to support the outer end of the work arbor by means of the outboard bearing regularly pro-

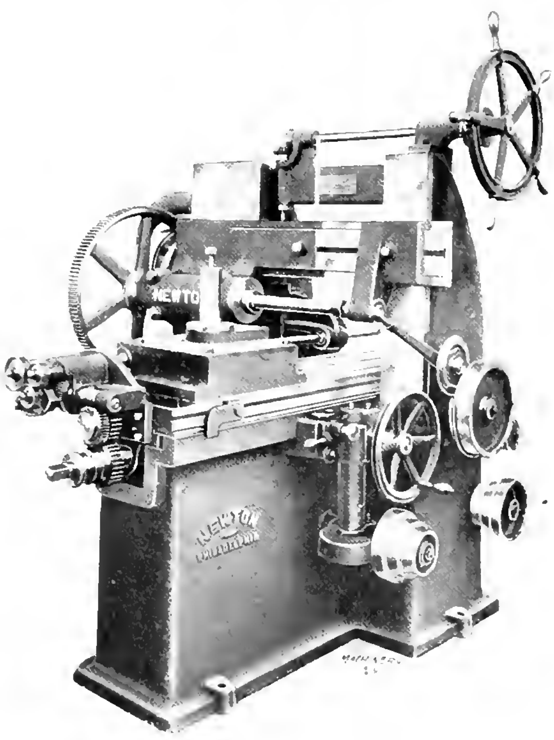


Fig. 115. Positive Hobbing Attachment used in the Newton Milling Machine.

vided for that purpose. To permit the downward feeding of the wheel, necessary to sink the cutter in to depth, the adjusting screw of this outboard bearing and the elevating screw of the work spindle head are geared together, so that they work in unison. The feed movement is applied to these two screws in such a way as to gradually lower the work into the cutter as the two revolve together.

All of the various gear-hobbing machines we have shown in Figs. 51 to 57 and 98 to 108 are adapted to the hobbing of worm gears without requiring special attachments of any kind. The only requirements in addition to the mechanism needed for hobbing spur gears, is the provision of a feed mechanism for sinking the cutter in to depth. The work saddles or tables of all these machines are, we believe, provided with this feed movement. The gearing for revolving the work and the hob in proper ratio with each other is of course embodied in the design of this type of machine. In Fig. 118 is shown one of these hobbing machines (the Grant-Lees machine of Fig. 104) engaged in hobbing a worm gear.

In addition to the machines we will describe later in which, though the hobbing process may be used, different movements are involved than in the cases we have been considering, special hobbing machines have been built from time to time, identical in their action with the various machines shown in Figs. 114 to 118. Most of these machines have been specially

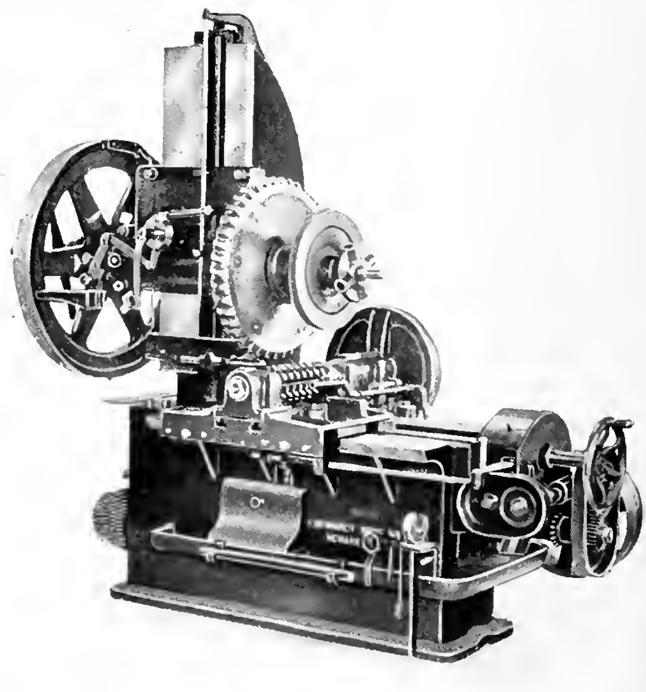


Fig. 116. Eberhardt Bros. Gear-cutting Machine arranged for Hobbing Worm-wheels, with Rachet Feed operated from Index Wheel.

built to suit the requirements of the user, without conforming to any settled type or design; very few of them have been built as a commercial product to be placed on the market.

The Fly-tool Method of Cutting Worm-wheels.

By providing suitable driving and feeding mechanism, it is possible to use a simple fly-cutter for forming the teeth of worm-wheels in place of the expensive hob used in the operations previously described. The movements required for this method will be understood from a study of Fig. 119. Here is shown in dotted lines a worm meshing with a worm-wheel, a portion only of whose periphery is seen. As previously described in referring to Fig. 109, such a worm, properly located with reference to a plastic blank and rotating with it in the proper ratio, will form accurate teeth in the latter by the molding-generating process. As we have also previously described, gashing this worm makes of it a cutter by means of which the same form may be given to a blank of solid metal. The teeth of such a gashed hob coincide with the outlines of the thread of the worm.

In Fig. 119, in full lines, is shown a cutter bar with a blade T_1 of the same outline as the thread of the worm and the tooth of the corresponding hob. In order to permit this single cutting tool to perform the function of the worm as it molds the plastic substance, or of the hob as it cuts its shape in the metal, it must be fed helically as the bar and work revolve, following the outlines of the imaginary worm from one end to the other as the cutting progresses. Beginning at the left, for instance, the blade may be fed helically in the line of the thread, passing through positions T_1 and T_3, until the feed finally runs out at the extreme right.

The methods of giving this progressive helical change of position to the fly-cutter are various. It would be possible, for instance, to so connect the feed-screw by which the cutter-bar is advanced with the rotating mechanism for the bar, through differential and change gearing, that a rotating movement due to the axial feeding of the latter would be added to or imposed upon the rotation due to its connection with the work, just as, in Fig. 97, the rotation due to the downward feed of the cutter slide is combined with that due to the connection with the cutter spindle for rotating the work. If the proper change gears were selected so that, with the spindle- and work-driving mechanisms stationary, the feeding forward of the cutter bar would rotate the latter at the proper rate to give the lead of the work, the blade would evidently follow the path of the thread of the imaginary worm, as shown at T_1 and T_3 in Fig. 119. Owing to the action of the differential

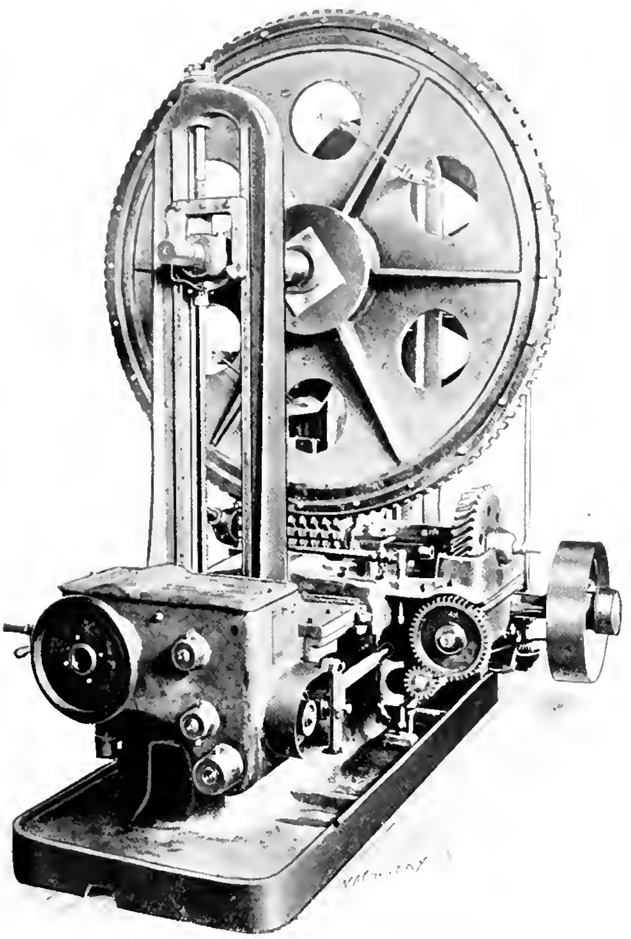


Fig. 117. Gould & Eberhardt Gear-cutting Machine arranged for Hobbing Worm-wheels.

mechanism, it would still follow the thread of the imaginary worm, even if the latter, with the spindle- and work-driving mechanism, were in motion.

Another method consists in combining in the work, also by differential gearing, a rotation due to the revolving of the cutter with a rotation due to the axial feed of the cutter bar. That this produces the same effect as the previous arrangement will also be understood from Fig. 119.

First, let the rotation of the cutter be arrested. If the cutter-bar with a worm mounted on it, such as shown by the dotted lines, be now fed axially in the direction of the arrow, the positive connections between the feed and the work spindle through the change gearing and the differential gearing, will cause the work to rotate uniformly with it. If the feed is arrested after a time, and the bar is started revolving, the imaginary worm mounted on it will still be kept in proper mesh with the work, owing to the change gear connections between the cutter-bar and the work spindle, acting through the differential gearing. As we have previously explained, the office of the differential gearing is to combine in the work the rotation due to the feeding and that due to the rotation of the worm, in such a way that they can take place simultaneously as well as separately; so that it will be seen that if the connections are properly made, the worm may be fed endwise and revolved at the same time, always keeping in perfect step with the work.

Now, the imaginary worm and the fly-tool are both firmly fixed to the cutter bar, so that the fly-tool must always follow the movements of the imaginary worm. Being set to coincide with the outlines of the worm thread at the start, it must always coincide with those outlines, and since the worm is never out of step with the work, the fly-tool will never be,

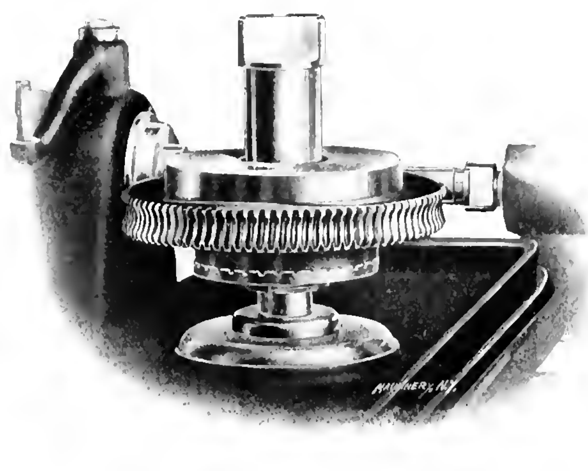


Fig. 118. Worm-wheel being finished in Grant-Lees Gear-hobbing Machine.

either. It will thus be seen that it will always follow the helical path of the dotted lines in Fig. 119, in moving, for instance, from T_1 to T_3. Revolving in the position T_3, T_4, T_2, etc., the work, as shown in the dotted lines of T_2, will always be in proper relation with the fly-tool, as it is with the imaginary worm.

With this arrangement, if the change gearing connecting the driving mechanism of the cutter-bar and the work were disconnected while the bar was fed through from left to right, the rotary motion given by the connection of the feed of the bar with the work would shape one tooth. If, on the other hand, the gearing connecting the feed of the bar with the rotation of the work were disconnected while the connections between the drive of the bar and the work were in operation, the cutter would partially shape each tooth of the work. By combining the two movements in the differential gearing, the cutter perfectly forms all the teeth.

Machines for Cutting Worm-wheels by the Fly-tool Method.

The first machine we show employing the progressive fly-tool principle was also, so far as the writer is aware, the first

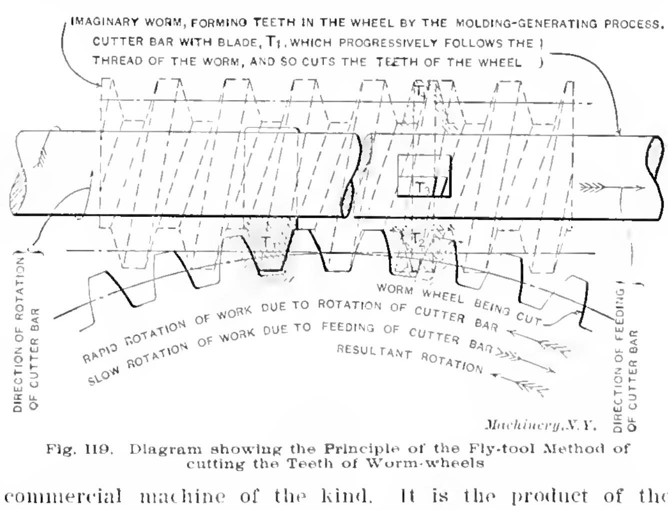


Fig. 119. Diagram showing the Principle of the Fly-tool Method of cutting the Teeth of Worm-wheels

commercial machine of the kind. It is the product of the Nya Aktiebolaget Atlas, of Stockholm, Sweden. This is the same machine that we have previously described, and illustrated in Fig. 34; in Figs. 120 and 121 it is shown set up for cutting worm-wheels. The machine is driven from cone pulley *A*. Shaft *B*, to which this pulley is keyed, is connected by the bevel gearing shown with vertical splined shaft *C*, from which, through change gears *D* and driving gear *E*, the fly-cutter arbor *F* is driven. Gearing in case *G* connects shaft *C* with horizontal driving shaft *H*, which rotates the worm

for revolving the work table and the work. Change gears D thus furnish the means for rotating the work and the hob in the proper ratio with each other.

Pulley J is connected inside the frame to the feed shaft K, seen in the end view. K is connected through change gears L and M with shaft N, which also leads to casing G. Change

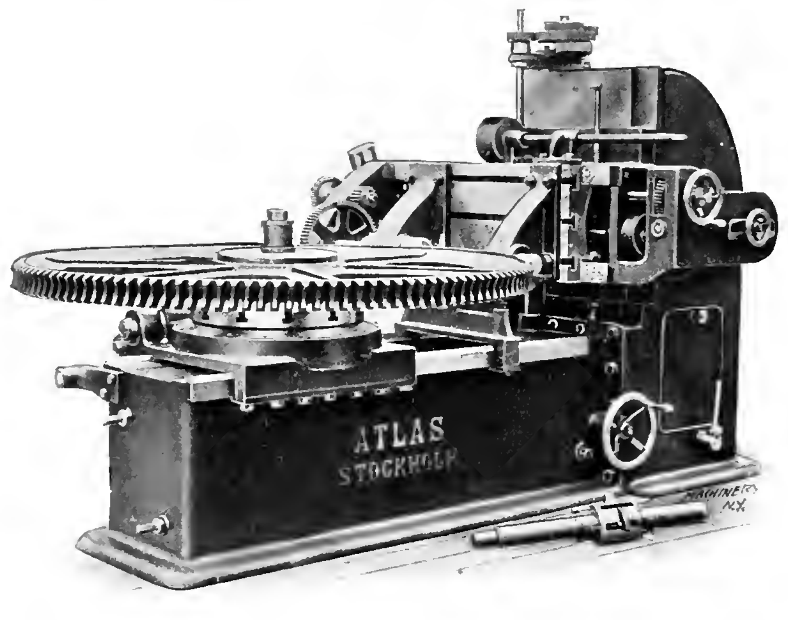


Fig. 120. The Atlas Gear-cutting Machine, also shown in Fig. 34, arranged for Cutting the Teeth of Worm-wheels by the Fly-tool Process. Note Quadruple Fly-tool on the Floor opposite the Machine.

gears M are not altered for cutting worm gearing, being employed for indexing in the case of spiral and spur gears. Change gears L, however, are set to the lead of the worm. Shaft K, besides being thus connected to shaft N, drives, through suitable shafts and gearing, feed screw O, by means of which is traversed on the cross rail the slide on which the fly-cutter arbor is carried, this arbor F being driven by a spline in the hub of gear-wheel E. Casing G contains differential gearing which combines the movements of shafts C and N in shaft H. It will thus be seen that by setting change gears D the work will be given a rotation to correspond with

throughout, being of pleasing design and simple construction, considering the variety of work it is intended to perform. This work includes, as we have before mentioned, the cutting of spiral, internal, spur and worm gears.

Another machine of the same class (which we have previously described in MACHINERY*) is shown in Figs. 122 and 123, built by Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J. In this tool the work table is stationary as to its position on the bed, while the column carrying the cutter slide is adjusted in and out to suit the diameter of the work, thus reversing the conditions that obtain with the Atlas machine in Fig. 120. Another change in the construction is in the provision for the axial feeding of the cutter-bar. In the case of this machine, instead of supporting the cutter on a slide which is fed along the cross-rail, as in Fig. 120, the supports for the bar are stationary, the latter being fed through them by a sliding head (P in Fig 123) at the outer end of the cross slide. By this means, the cutter-bar is brought much closer to the face of the column, and one of the sliding joints between it and the column is eliminated. Both of these features tend toward rigidity and consequent increase in output.

The mechanism will be easily understood from a study of the diagrams of Fig. 123. Driving pulley A is connected by gears B (which are changed to give the desired spindle speeds) with shaft D, which, by means of bevel gears C, in turn drives vertical splined shaft W, by means of which connection is made with the worm and worm-wheel E which drives the cutter-bar. Shaft D is continued along the bed to change gears F, which are changed to give the proper ratio between the rotation of the cutter and of the work. These gears drive one of the members of the differential gearing X.

Feed cone J is connected by gearing K with shaft Q. The latter, through two sets of worm gearing and vertical shaft L, drives horizontal shaft M on the cross rail. From here, through gears N, the movement is led to feed-screw O by which head P is traversed to feed the cutter bar axially. Q

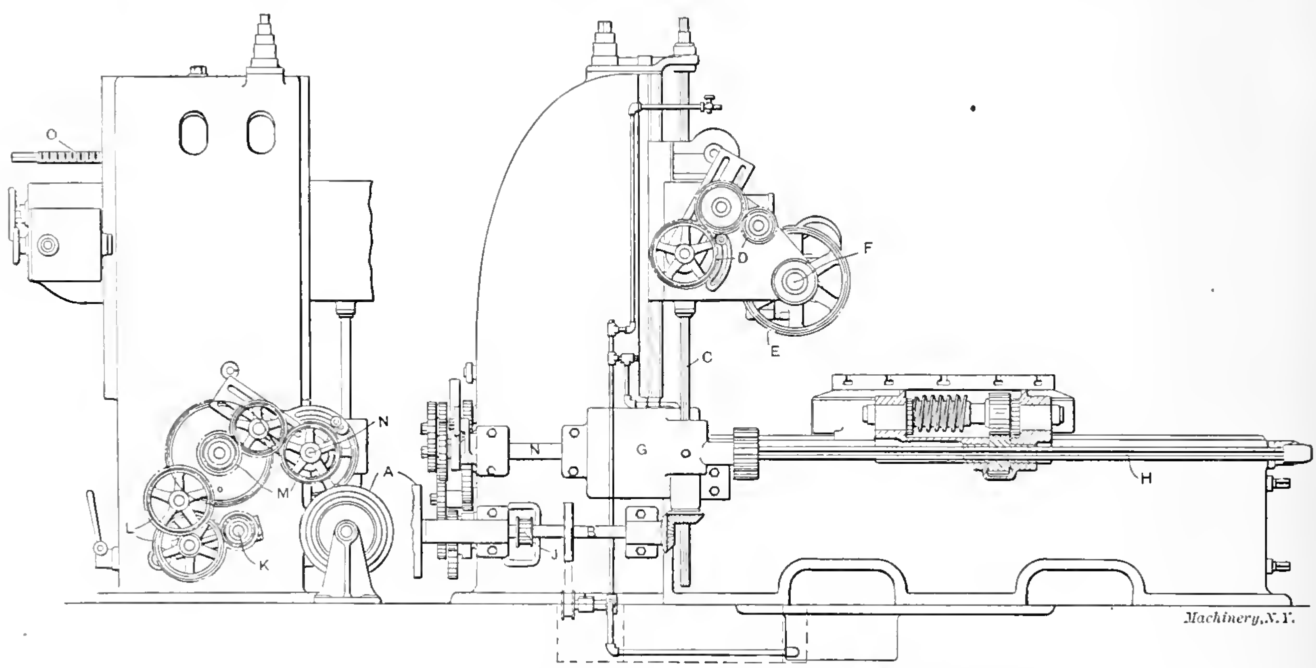


Fig 121 Diagram of the Driving Connections of the Atlas Gear-cutting Machine shown in Fig. 120.

the ratio of the number of threads in the worm and the number of teeth in the gear, while by setting change gears L properly, the work will be rotated in unison with the axial feeding of the cutter-bar as in moving T_1 to T_2 in Fig. 119, thus filling the necessary conditions.

Aside from the ingenuity of the mechanical movements thus described, this well-known machine is carefully planned

is also connected by change gears R and the worm gearing shown with differential gearing X; gears R are selected to agree with the pitch diameter of the work. In differential gearing X, motions from shafts D and Q are combined to rotate the work table and the work in the same way as in the

* See article "Generating a Large Worm-Wheel" in the October, 1907, issue of MACHINERY, Engineering edition; and "New Tools of the Month" in the December, 1904, issue of MACHINERY.

Atlas machine, and as required in Fig. 119. For small blanks, the spindle is rotated through spur gearing at H. For heavy work, however, a driving pinion is directly connected with

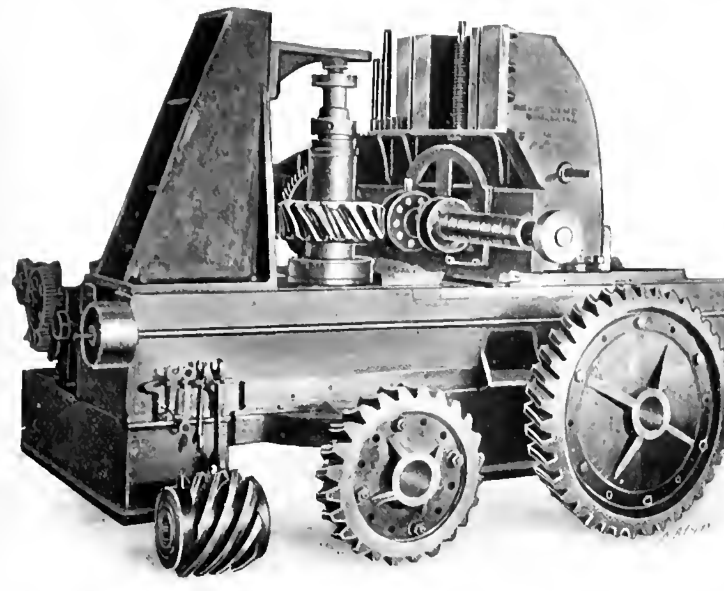


Fig. 122. Eberhardt Bros. Fly-tool Worm-wheel-cutting Machine, with Samples of Work.

teeth on the inner rim of the work table, so that a very powerful drive is obtained.

This machine can also be arranged to use the ordinary cylindrical hob, in which case the feed of head P is thrown out, and the column U is fed inward on the bed by means of screw V, so that the hob enters the blank in the same manner as for the machines in Figs. 113 to 118.

In Figs. 124 and 125 are shown half-tone and line engravings of a fly-tool gear-hobbing machine built by Henry Wallwork, Ltd., Redbank, Manchester, England. The action of the fly-cutter on the work is identical with that in the machines previously described. The work is carried by the face-plate and vertical spindle A, while the fly-tool B is mounted in the cutter spindle C. This latter is supported in slide D which is adjustable on the top of the bed for the diameter of the work, and is fed by screw E. The fly-tool starts in at one side of the work and feeds longitudinally through it, the work and tool revolving together, as in previous cases. A peculiarity of this machine, however, is that no differential mechanism of any kind is employed. The way in which this is avoided may be explained thus:

Suppose that in the Eberhardt machine in Fig. 123, the fly-cutter be engaged in hobbing a worm-wheel of 100 teeth, to mesh with a single threaded worm. If, then, the fly-cutter makes 100 revolutions per minute, the worm will make one revolution per minute. If now the cutter spindle be fed longitudinally with a certain definite feed, the differential mechanism will modify the rate of rotation of the worm, making it slightly more or slightly less than one revolution per minute, depending on the rate of the feed, and its direction as compared with the direction of rotation of the work. We may say, then, that if the cutter revolves at a certain number of revolutions per minute and feeds at a certain fraction of an inch per minute, the work will rotate at a certain number or fraction of a number of revolutions per minute. Where the gearing required with the Eberhardt machine would give a ratio of 100 to 1 between the hob and the work, as modified by the feed this ratio might be 100.0073 to 1, for instance. It will thus be seen that since these conditions remain constant until the work is completed, the differential mechanism may be dispensed with entirely, if we select the change gears connecting the hob and the work to agree with the new rate of turning of the work, as modified by the feeding of the hob.

This is what is done in the Wallwork machine. The driving shaft F is connected with the driving cone G either directly or through back gears, as may be required. This shaft, through worm-wheel H and change gears shown in Fig. 124, drives feed-screw E. It also has keyed to it worm J, meshing with the indexing worm-wheel by which the work on the vertical spindle A is rotated. At the extreme right in Fig. 125 this driving shaft is connected with cutter spindle C by change gears K, mounted on a sector which is provided with a worm-wheel adjustment at L for setting it, owing to its great weight. It will thus be seen that the feed, the work, and the cutter-bar are all connected by positive gearing. For setting up the machine, suitable change gears for connecting screw E with the driving-shaft mechanism are used to give the desired rate of feed. Then change gears K are selected to give the

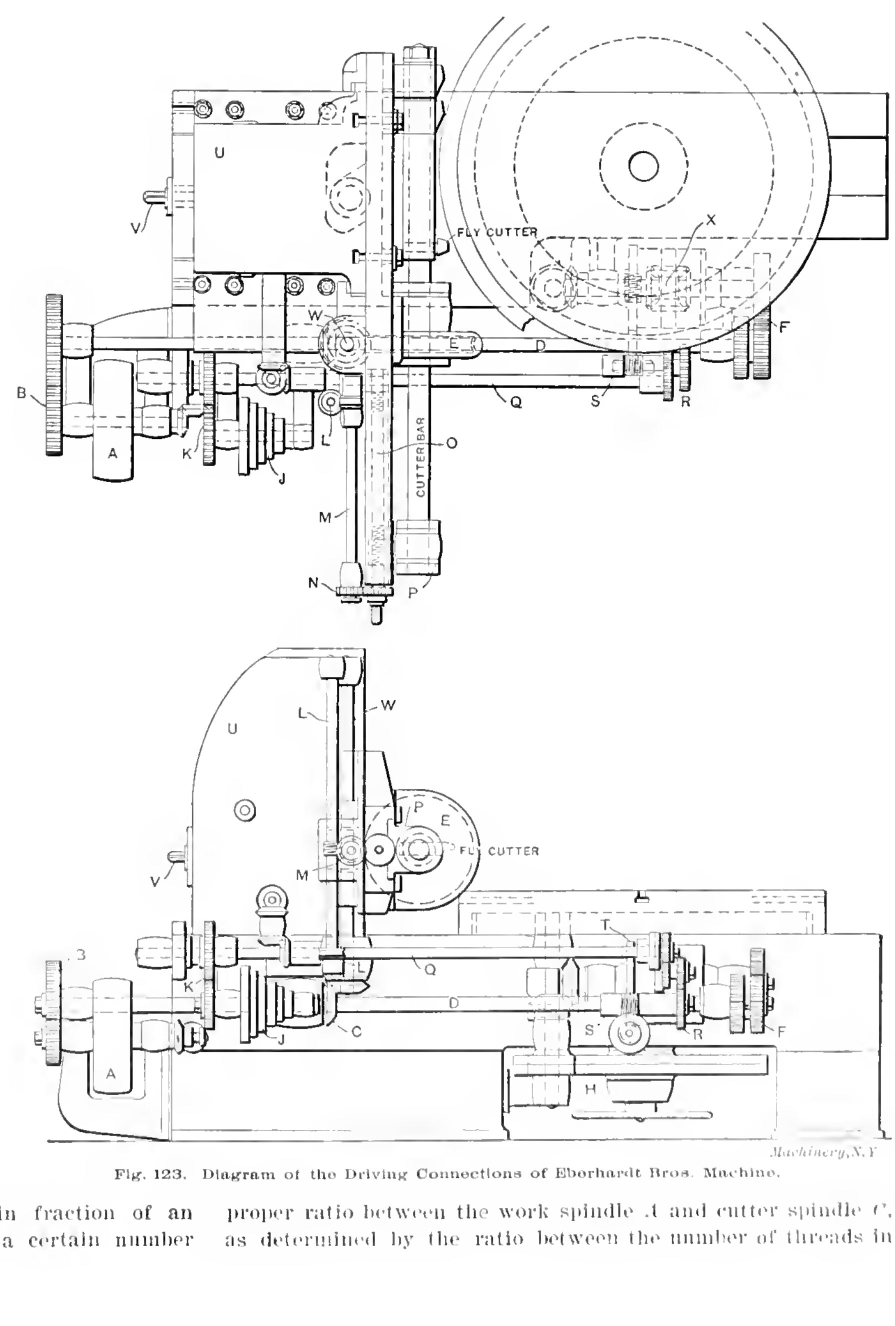


Fig. 123. Diagram of the Driving Connections of Eberhardt Bros. Machine.

proper ratio between the work spindle A and cutter spindle C, as determined by the ratio between the number of threads in

the worm and the number of teeth in the worm-wheel, modified (as explained) by the rate of feed. These change gears K are calculated by a formula which is somewhat puzzling to derive, but not difficult to use.

This arrangement would seem to possess both advantages and disadvantages as compared with the differential scheme. It results in a much simpler mechanism, but it makes it impossible to change the feed without changing, as well, the gearing connecting the work spindle and the hob, so that changes of feed are not easily made.

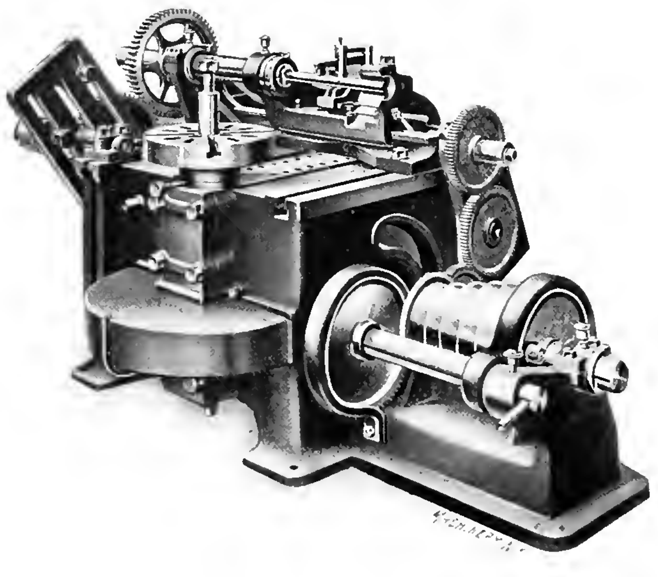


Fig. 124. The Wallwork Machine, which cuts the Teeth of Worm-wheels with a Fly-tool without using Differential Gearing.

Cutting Wheels for Multiple Threaded Worm by the Fly-tool Process.

The method of cutting multiple threaded worms was not described in discussing the principle of the fly-tool process. At the base of the machine in Fig. 120 is shown a form of tool which may be used for cutting wheels to match with multiple threaded worms. In this case, in which a quadruple thread has to be provided for, a cutter head is provided in which four blades are carried, spaced equidistant. The feeding through of these four blades simultaneously finishes the worm-wheel complete in one operation. An alternative method would be to index the cutter bar with relation to its driving gear, giving it three positions for a triple-threaded worm, four for quadruple threads, etc. This could be done by a notched index plate and locking bolt, or by unmeshing the gearing from engagement at some point in the driving train, and shifting it the required number of teeth before re-engaging it.

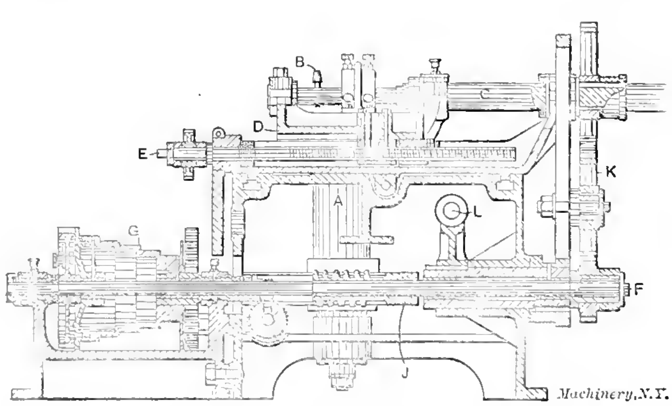


Fig. 125. Vertical Section through Wellwork Worm-wheel Generating Machine.

The Tapered Hob for Cutting Worm-wheels, and Machines for using it.

In Fig. 126 is shown a gear-hobbing machine built by J. E. Reinecker, of Chemnitz-Gablenz, Germany. This machine has the movements required for performing the work of the Atlas and Eberhardt machines, since it combines in the rotation of the work a movement due to the longitudinal feed of the cutter spindle and a movement due to the rotation of the cutter spindle. It is ordinarily used, however, with a hob instead of a fly-cutter, the hob being of the special form shown in Fig. 127. This hob, as shown, is tapered. It is placed on the cutter spindle and fed axially past the work in the same way that the fly-tools in the previous cases are fed. The combined movements cause the hob to follow spirally in the path of the thread of the imaginary rotating worm. The small end of the hob first commences to work and as the cutter spindle is fed forward, the cut is taken successively on larger and larger diameters until finally, when the tool has passed clear through, the full-sized teeth at the rear end of the hob complete the work. The machine is practically identical with the universal gear-cutter by the same maker, previously shown in Figs. 85 and 86, it being adapted, as there shown, to cutting worms by the same process. The differential mechanism used is the same as in Fig. 86, the axial feed of the cutter spindle being applied to shaft M, while the rotative movement of the cutter spindle is connected with shaft H, the two being combined in gears J, L, and N to rotate the indexing wheel G.

The original machine for this purpose, built by Mr. Reinecker, employed a different form of combining or differential movement. It is shown diagrammatically in Fig. 128. In this case, the tapered hob is connected by change gearing with the worm driving the indexing wheel, as before. The worm, however, is mounted on a slide, allowing it a considerable range of axial movement. This axial movement is controlled by a screw and nut, as shown. This screw is connected by change gearing with the screw by which the taper hob is fed. It will thus be seen that the feeding of the hob rotates the work by shifting the index worm lengthwise, while the rotating of the hob rotates the work through the rotation of the index worm and worm-gear. The two movements are independent of each other, but are combined with the same effect as produced by the "jack-in-the-box" differential gearing previously described. With this arrangement, the ratio of table movement and lengthwise worm movement should be proportioned in the ratio of the pitch diameters of the worm-wheel being cut, and the index worm-wheel. The reason for abandoning this construction was doubtless its limited range of movement, which, though enough for the hobbing of worm-wheels, was not enough (when applied to the universal gear-cutting machine) for cutting spiral pinions of great helix angle.

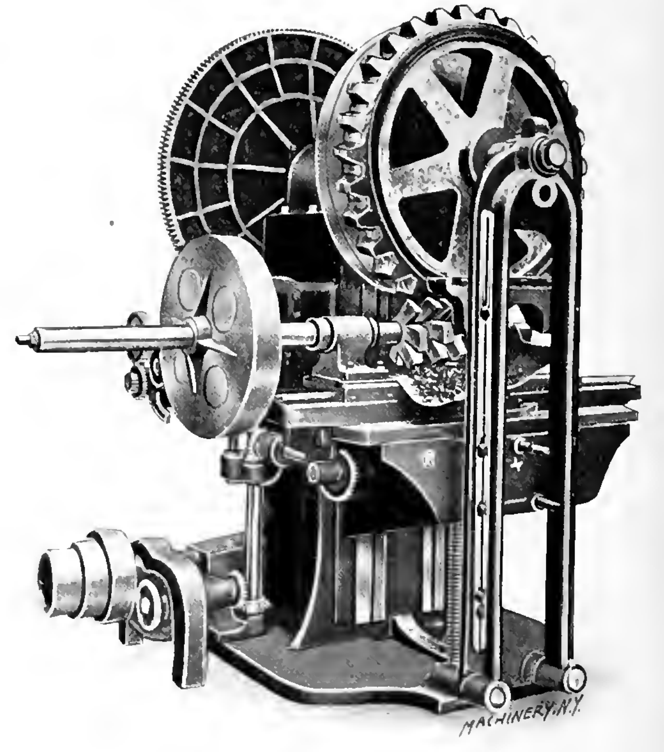


Fig. 126. Machine for Generating Worm-wheels with a Taper Hob; built by J. E. Reinecker, Germany.

The tapered form of hob and the method of using it are of course as applicable to the Atlas, Eberhardt, and Wallwork machines as to the one we have just been describing, and it has doubtless been used on all of them.

The Various Methods Compared.

Each of the various methods of cutting worm-wheel teeth which we have described has its field of usefulness. Gashing, as we have seen, is applicable either to cheap, rough-and-ready work on the one hand or, on the other hand, to the cutting of worm-wheels which are not required to transmit a great amount of power, but in which the highest degree of accuracy is required. The process of hobbing previously gashed blanks requires the least degree of specialization in the machinery used, the ordinary milling machine having all the movements and adjustments required. This process is perhaps the one followed in most shops in making worm gearing of small size. The arrangement (such as shown in Figs. 114 to 118) in which the work and the hob are positively geared together so that previous gashing is not required, is quicker than the last mentioned method, but requires special machines or attachments. The fly-tool method requires a still more elaborate machine, but is the least expensive of all in the matter of cutting tools. A large hob is an exceedingly costly appliance, and raises the cost of production to an alarming degree, particularly when but one worm-wheel has to be cut. The use of a simple fly-cutter, which may be ground accurately to size after hardening so that all inaccuracies are avoided, is thus the cheapest as well as the most accurate means of cutting a large worm-wheel. Where many large wheels of the same size are to be cut, the taper hob method would seem to be a most satisfactory one. A high degree of accuracy could be maintained, as the full size teeth at the back end of the hob do not come into play until the finishing cut is reached, so that they tend to preserve their shape indefinitely. Another item that tends to accuracy in this method of hobbing is the fact that the distance between the work arbor and the cutter spindle, is fixed at exactly the distance between the axis of the worm and the worm-wheel in the finished gearing. This is a refinement of greater importance than is usually realized, and one that is not always looked out for in hobbing operations in which the cutter spindle is fed in toward the work. Hobbing by this method is, of course, more rapid than by the fly-tool process employed on the same machines, though the latter is not a tedious operation by any means, as a solidly supported and powerfully driven tool can be given a heavy feed, taking off chips of respectable thickness.

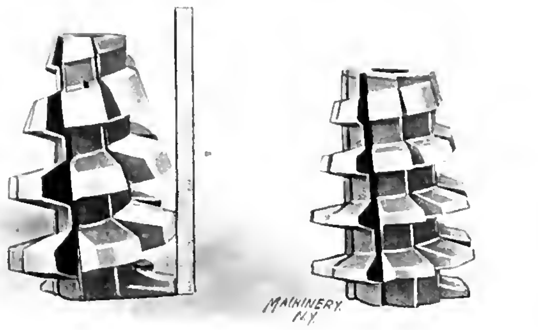


Fig. 127. Style of Hob used for Machine shown in Fig. 126

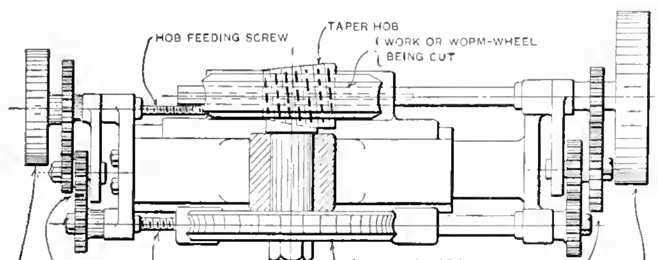


Fig. 128. Diagram of Original Form of Mechanism for Generating Worm-wheels with Taper Hob.

The methods followed in cutting the other member of this form of gearing, the worm, have already been described in connection with the machine for cutting helical and herringbone gears.

The Manufacture of the Hindley Worm Gearing.

A form of gearing which has come into extensive use of late years in elevator service and other applications in which considerable power has to be transmitted, is shown in Fig. 129. This is commonly known as the Hindley "worm" gearing, though it is not worm gearing at all, being entirely different in its action. It should properly be classed as "globoid" gearing, a term which, so far as the writer knows, was first employed by Prof. Reuleaux. The characteristic feature of its action is the fact that contact takes place on or near the axial plane of the worm, as shown in the engraving. Unlike other forms of gearing, neither member of this pair has a pitch line or a pitch diameter. The form of gearing is an old one, but it has only recently come into practical use.

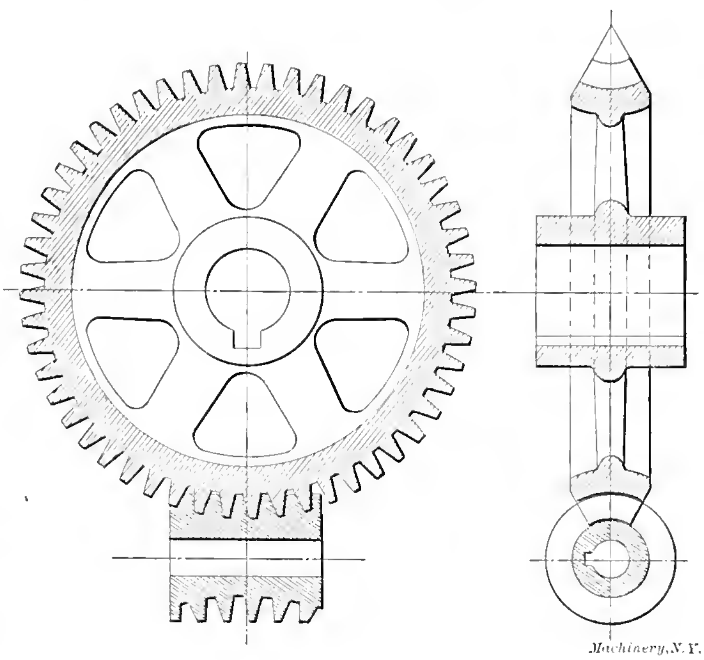


Fig. 129. The Form of Globoid Gearing generally known as Hindley Worm Gearing.

It is often stated that this style of gearing gives surface contact, but this statement can scarcely be true. The impression doubtless arose from a consideration of sections on the two planes shown in Fig. 129, in which it may be seen that the wheel is curved to fit the worm, and the worm is curved to fit the wheel, thus giving the appearance of intimate contact over the whole face of the tooth. It is probable that the surfaces more nearly match than in ordinary worm gearing, giving a nearer approach to surface contact.

Any positively operated worm-wheel hobbing attachment or machine, such as shown in Figs. 114 to 118, may be used. The manufacture begins with the cutting of the worm, which is effected as shown in Fig. 130. The blank is mounted on the spindle of the machine ordinarily occupied by the hob, while a large diameter disk provided with cutting tools clamped to its face is mounted in place to represent the worm-wheel. The cutting tools mounted on this disk each represent a tooth of

the wheel, being of the same shape and cutting on the same diameter. They are clamped to the face of the disk in such a way that the whole arrangement represents accurately a central section of the worm-wheel, of which (in this particular case) only every other tooth is used. This cutter and the worm to be cut are geared together, and slowly fed toward each other as when hobbing worm-wheels. The teeth, cutting deeper and deeper into the blank, finally form it into the characteristic "hour-glass" shape of the Hindley worm.

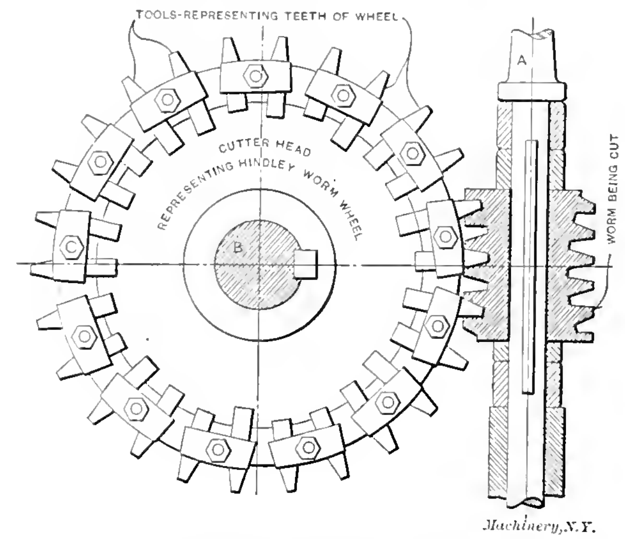


Fig. 130. Method of Cutting Hindley Worm with Rotary Cutter having Teeth corresponding with those of the Wheel.

In cutting the wheel, the process is reversed, as shown in Fig. 131. A hob cut in the same way as the worm in Fig. 130, but with its teeth relieved, is fed into the wheel blank and cuts the teeth in a way exactly identical with the method followed in hobbing worm-wheels, the only difference in the process being the difference in the shape of the hob and in the shape of the teeth produced.

The actual operation of hobbing the worm and the gear is a little more complicated in practice than is indicated here, as certain corrections have to be made for interference that require cutting the worm first with a cutter head of the same diameter as the wheel in the way we have shown, and a second time with a head of somewhat larger diameter. The necessity for this it would take too long to explain in an article which deals particularly with machines and tools, rather than with the theory of gearing.

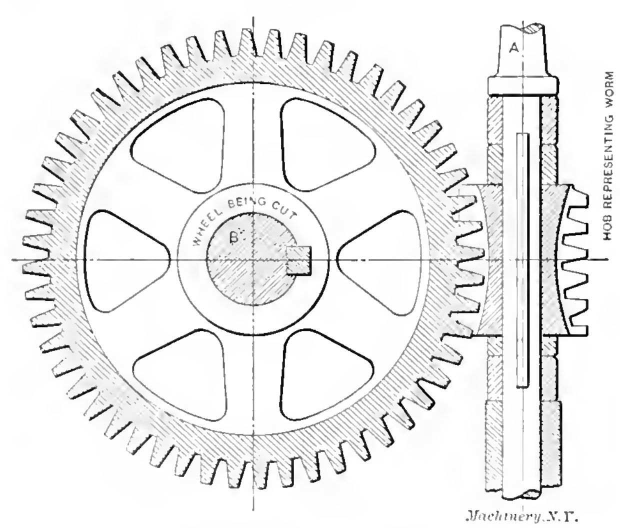


Fig 131. Cutting the Teeth of the Wheel with a Hob corresponding with the Worm.

This concludes a discussion of machines and methods for cutting the teeth of worm-wheels. The next installment will deal with bevel gear cutting processes.

On page 592 of the May installment of the series of articles on gear-cutting machinery, a record was given for hobbing spur gear teeth in which it was stated that the time for cutting a cast iron wheel of 84 teeth, 4 inches circular pitch and 2½ inches face, was 1 hour and 21 minutes. There was an error in this statement in that the pitch should have been given as 4 *diametral*. This, of course, makes the achievement somewhat less spectacular.

It should also be noted that a misprint occurs in the title of Fig. 103. The word "Pfauder" should read "Pfauter."

* * *

RELIABILTY OF MOTOR DRIVES FOR MACHINE TOOLS.

The reliability of the individual motor drive for machine tools is indicated by an item in the *American Engineer and Railroad Journal*. Probably a greater proportion of the machine tools in the McKees Rocks shops of the Pittsburg & Lake Erie Railroad are equipped with individual motor drives than in any other railroad shop in this country. During the year 1907 the average delay to tools, due to motor troubles, was about seventeen minutes. There are 84 motors in use for driving machine tools, and during the year there were only 93 delays, or an average of 1.1 per motor per year. The longest delay was 1¼ hour. The total time of all delays during working time was 26½ hours. Assuming an average rate of 27½ cents per hour for the machinist's wages and a surcharge on each machine of 50 cents per hour, would bring the total loss due to delays to only about $20.00 for the year. These delays include all time lost due to the failure of electrical apparatus at the machine. As a matter of fact the greater part of the time lost was due to trouble with the controllers and not with the motors themselves. When it is considered that these motors operate on the multiple voltage system, the controllers furnishing 21 speed steps over a range of about 3 to 1, it is remarkable that so little trouble occurred, especially as these controllers were among the first of this type that were placed in operation.

* * *

VACUUM BRAKE EXPERIMENTS.

Extensive experiments have been carried out on the Austrian government railways with automatic vacuum brakes on freight trains. A long train, composed of 70 cars loaded with coal and weighing 44,000 pounds each, was fitted with automatic brakes. Numerous trials were carried out with this train on lines having different road conditions, and, in order to ascertain the effect on steep grades, the trials were repeated on a line with gradients of from 3 to 3.1 per cent. In this experiment the train was composed of 70 freight cars and 5 passenger cars, interspersed for observation purposes. Twenty-nine of the total 75 cars carried load, and 46 carried no load. The weight of the train including locomotive and tender amounted to 1,201.7 metric tons (1,322 short tons) and the total length of the train was 2,620 feet, or nearly half a mile. To enable observations and simultaneous readings to be taken, the locomotive and each of the 5 passenger cars were fitted with telephones and measuring apparatus. The results are said to have been very satisfactory, and will form the subject of a publication shortly to be issued by the Austrian government railways. Considering the length of the train, the brake valve on the last car came in action very rapidly, only 2.2 seconds being required for the brakes to be applied on the last car after they had been applied on the locomotive. This corresponds to a brake speed of 1,191 feet per second.

* * *

The old, time-honored division of the study of mathematics into algebra, analytic geometry, and differential and integral calculus has been discarded by the Massachusetts Institute of Technology, and the whole field of the science of mathematics will be covered simultaneously. The principles of each of the old subjects are to be introduced, and all subjects developed, together. This change has been deemed advisable in order to give the students a better grasp of mathematics as a whole, and an adequate idea of the interdependence of the various branches, and also in order to accustom the students to the use of judgment in the selection of methods best adapted to the problem in hand. Undoubtedly this early introduction of calculus and analytic geometry will be found very advantageous. The whole system is intended to develop a more thorough study of mathematical principles and to do away with that kind of mathematical study which consists in mere mechanical training of the use of formulas.

MAKING WATCH PARTS IN THE COMMERCIAL AUTOMATIC SCREW MACHINE.*

Watchmaking by automatic machinery is essentially an American development. Previous to the inaguration of the industry in Waltham, Mass., Switzerland held the lead in the manufacture of watches on a large scale. The hand processes there followed are the result of long experience and careful study, and the work is highly organized so far as the division of labor is concerned, separate workmen specializing on single operations, which they repeat day after day, as long as they live and work. Swiss watches are not hand-made in the sense in which we apply that term to custom-made footwear, for instance. Of course, lathes, presses, gear- and pinion-cutters and other power-operated machines are used in the various operations required. These tools have, however, been largely operated by hand in the same way that ordinary engine lathes are operated, as distinguished from the mechanically controlled movements of the automatic gear-cutter or screw machine.

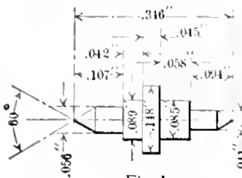


Fig. 1. Blank for Watch Pinion made by Forming, from Tool Steel Stock.

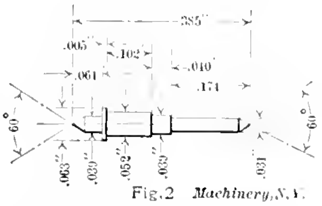


Fig. 2. Blank for Watch Wheel Staff made by Turning, from Tool Steel Stock.

In American watchmaking practice the automatic principle has been developed to an extent that is little short of marvelous, the parts not only having complicated operations performed on them in single machines, but even being transferred from one machine to another automatically, through a long series of operations. The various manufacturers of watches in this country have, as a rule, each developed their own machinery, employing competent designers and mechanics for the purpose.

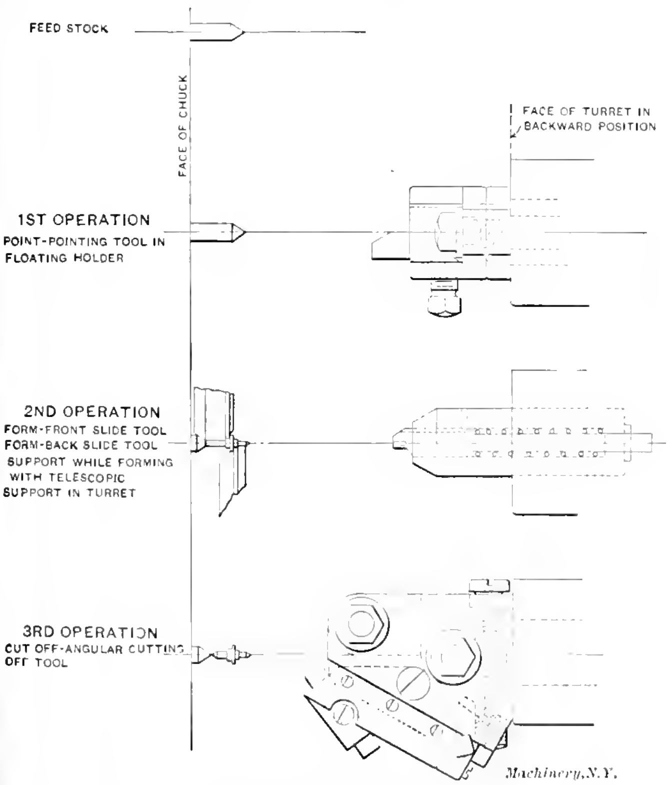


Fig. 3. Tools Used and Order of Operations Followed in making the Pinion Blank shown in Fig 1.

A notable exception to this general rule, however, may be instanced in the case of the automatic screw machine made by the Brown & Sharpe Mfg. Co., of Providence, R. I., which has been invading this highly specialized field of watch making, and has been very successful in the work it has been called on to perform. Curiously enough, considerable favor has been met with by this machine in the Swiss watchmaking field, committed though it is by years of precedent, to the use of the hand-operated machine. This interest in the American automatic screw machine may therefore be taken as an evidence of the inroads of American ingenuity on Continental conservatism.

The Work for which the Machine is Used.

The particular work for which this tool has been applied is in the turning of the larger pinion blanks and staffs (the slender shafts or spindles on which gears and pinions are mounted). These parts have to be made, it goes without saying, with a high degree of accuracy, both as to their dimensions and as to their concentricity, or the trueness with which they run on centers. Accuracy of dimension is largely a matter of careful, close fitting of the machine, so as to have all the slides and their movements accurately aligned and moving freely, yet with the smallest possible allowance for lubrication. This matter is carefully looked out for in the tool under consideration, though it is probable that for the most minute of the minute work used in watches, it would be impossible to make the fitting close enough on so large a machine. The space required for oil for the journals, for instance, would involve inaccuracy which could not be permitted. For work, however, of the size shown in Figs. 1 and 2, this machine has been found eminently satisfactory. We will illustrate and describe the methods and tools used in producing these pieces, these matters being fully as important as the design and workmanship of the machine in producing the accurate results required.

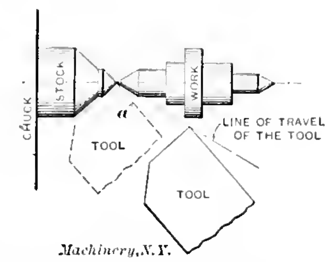


Fig. 4. The Cone Point Turning and Cutting-off Operation.

Tools and Operations for Making a Pinion Blank.

We will first follow the tools and operations used in making the part shown in Fig. 1. This is one of the larger pinion blanks used in a Swiss watch. In making it by the old-fashioned methods, a blank is cut off and formed at each end with the cone points shown, which are supported in female centers in the lathe, where successive cuts are taken to bring it to the required dimensions, the same as would be done for much larger work in the engine lathe. This operation is practically duplicated in the automatic screw machine, so far as turning on centers is concerned.

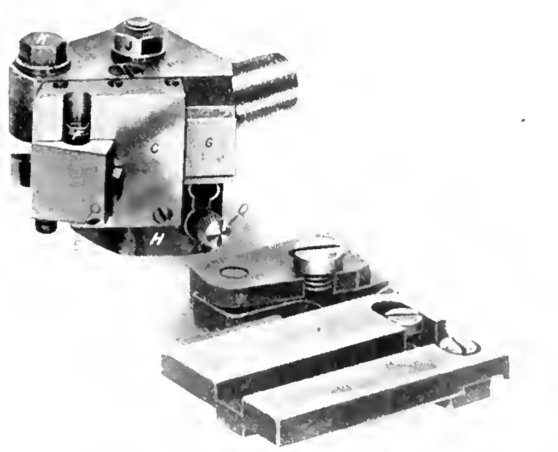


Fig. 5. Cone Point Turning and Cutting-off Tool for Pinion Blanks and Staffs, and the Pusher by which it is operated from the Cross Slide

The order of operations and the tools used for each of them may be followed from Fig. 3, which is a reproduction of the operation sheet furnished to the purchaser of the machine. The first thing that is done is the feeding of the stock. No stop is used for the stock to feed against, the feeding mechanism being accurate enough to always leave a few thousandths of stock for the first operation, which is that of pointing the end of the bar to form the outer cone-shaped pivot

* For a description of this machine see the article published in the September, 1903, issue of MACHINERY, on "Directions for Camming the Brown & Sharpe Automatic Screw Machine."

point of the work. This is done by a tool mounted in a "floating" holder, which may be firmly clamped in the proper position for forming an accurately pointed pivot each time the machine is set up. With this tool the accurate alignment of the turret with the axis of the spindle is not absolutely necessary; in fact, no alignment accurate enough for this purpose could be permanently maintained.

This piece of work is short enough and stiff enough so that it can be turned entirely by circular forming tools

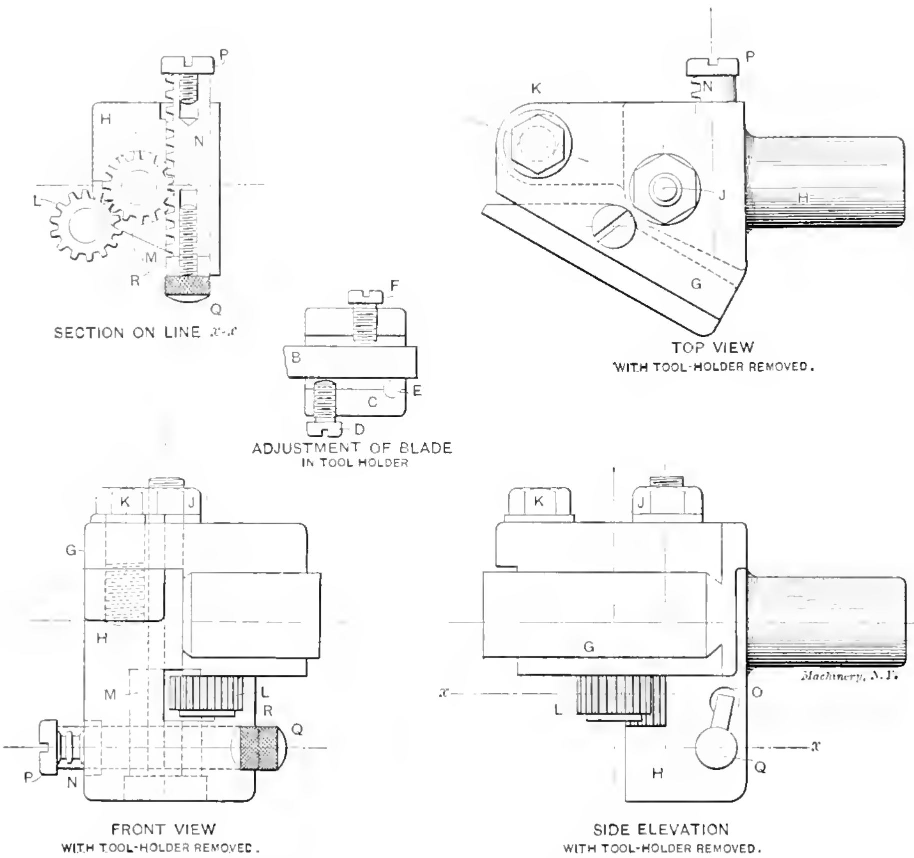


Fig. 6. Details of Construction of the Cone Point Turning and Cutting-off Tool shown in Fig. 5.

mounted in the cross slide. These forming tools are shown at work in the second operation in Fig. 3. The one in the front cross slide turns the two diameters forward of the largest diameter on the work, while the rear cross slide turns the two diameters on the other side of the collar, and rough turns the projecting end of the stock for the cone point of the next part to be made. While these operations are in progress, the outer end of the work is supported in a delicate female center, in a spring plunger held in the turret.

It was stated that this part is practically turned on centers. The significance of this statement will be understood by studying the second operation, and the succeeding or third operation. Since the outer end of the work is supported by the center while the forming is in progress, the diameters thus turned must be true with that center. In the third operation the center at the other end of the work is formed. The forming of this center, as shown in Fig. 4, is done by an operation which has been previously described in MACHINERY (see "Methods of Delicate Turning," in the September, 1907, issue of MACHINERY). The blade follows a diagonal line of travel, so that the center is turned to the right angle. Face *a* is beveled so that it clears the work entirely, and the point is quite sharp. The cutting action is thus entirely on the face of the stock, and the work is not subject to any pressure whatsoever, but remains attached to the stock until the tool has progressed so far that it separates and falls off by its own weight, leaving the point so sharp as to be for all practical purposes a perfect one. We have already seen that the outer center is true with the turning. The center formed in this operation is also true with the turning, as the work is, at this point, so close to the chuck that the operation must be concentric. The outside diameter of the piece is left stock size. This large diameter has the pinion teeth cut in it and runs true enough for all practical purposes.

Cone Point Turning and Cutting-off Tool.

The construction of the point turning tool can be readily followed from Figs. 5 and 6. The cutting-off blade *B* is held in a slot in tool slide *C* resting on adjusting screw *D* and pin *E*. It is clamped in position by screw *F*; by adjusting screw *D*, the blade is rocked about pivot *E* to bring the point higher or lower as may be required to accurately center it with the axis of the work. Slide *C* is gibbed to a dove-tail guide on slide carrier *G*. This member is pivoted to the body of the tool *H* about the axis of bolt *J*, and is clamped by screw *K* in the proper location to guide the slide *C* in forming the desired angle for the pivot of the work.

Tool slide *C* has attached to it a rack which meshes with the 32-pitch pinion *L*, pivoted to the under side of *G*. Pinion *L* meshes with a similar pinion *M*, pivoted in a hole in the body of the tool about the center of bolt *J*, so that the correct relations between them are preserved whatever the angular adjustment of *G* on *H*. Pinion *M* is lengthened and at its lower extremity meshes with rack teeth cut in the side of plunger *N*. This is best seen in the section on line *x x* in Fig. 6. This plunger, as may be seen in the side elevation, has at its front end a projection extending upward bearing against a plunger *O* in a hole above it, which is pressed outward by a spring. By this means, *N* is normally kept at the outer end of its movement, being limited in this direction by the seating of screw *P* in the recess provided for it in the body *H* of the tool. In this position the tool slide is withdrawn so that the blade clears the work.

The front end of *N* is provided with knurled screw *Q* and lock-nut *R*. These are so located as to be in line with the pusher *S*, attached to the front cross slide of the machine, when the turret has brought the tool to the proper position for cutting off. The cutting off is effected by the movement of

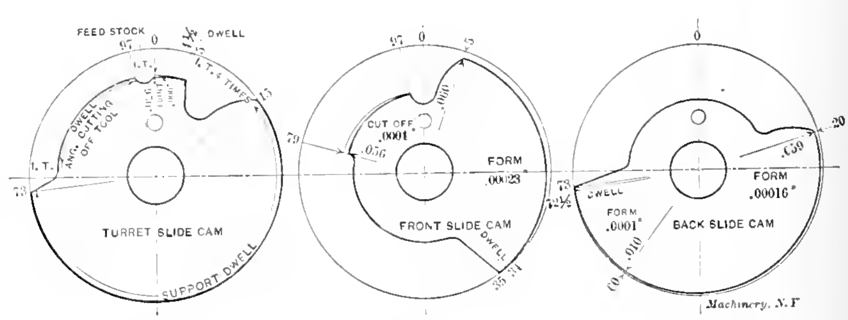


Fig. 7. Turret and Cross Slide Cams used for Making the Pinion Blank shown in Fig. 1.

the cross slide and pusher *S*. This bears on screw *Q*, presses plunger *N* inward, revolving pinions *M* and *L*, which, in turn, acting on the rack attached to the tool slide, move cutter *B* inward, severing the work from the bar and forming the pivot point, as shown in Fig. 4. The length of the inward travel of the tool is adjusted by screw *Q* and lock-nut *R*. The swiveling adjustment shown for *S* is not needed for this job.

The operations can be further studied from Figs. 3 and 7. In the latter figure are shown the cams by which the feeding

movements of the machine are effected. As is well known, the Brown & Sharpe automatic screw machine has a front and a back cross slide and a turret slide, each controlled by its own separate plate cam. In Fig. 7 the various radial lines are figured to show their distance from the starting point 0, in hundredths of a circle. The various acting surfaces of a cam have legends on them indicating the operations performed by them. The material used for this pinion blank is tool steel. The spindle revolves 1,320 revolutions per minute, giving a surface speed to the work of about 58 feet per minute, which is suitable for the material used with the heavy flow of oil directed on the cutting edges of the tools. It takes 770 revolutions to make a piece, so that each hundredth of a revolution of the cam represents 7.7 revolutions of the spindle. Knowing this, the various feeds can be

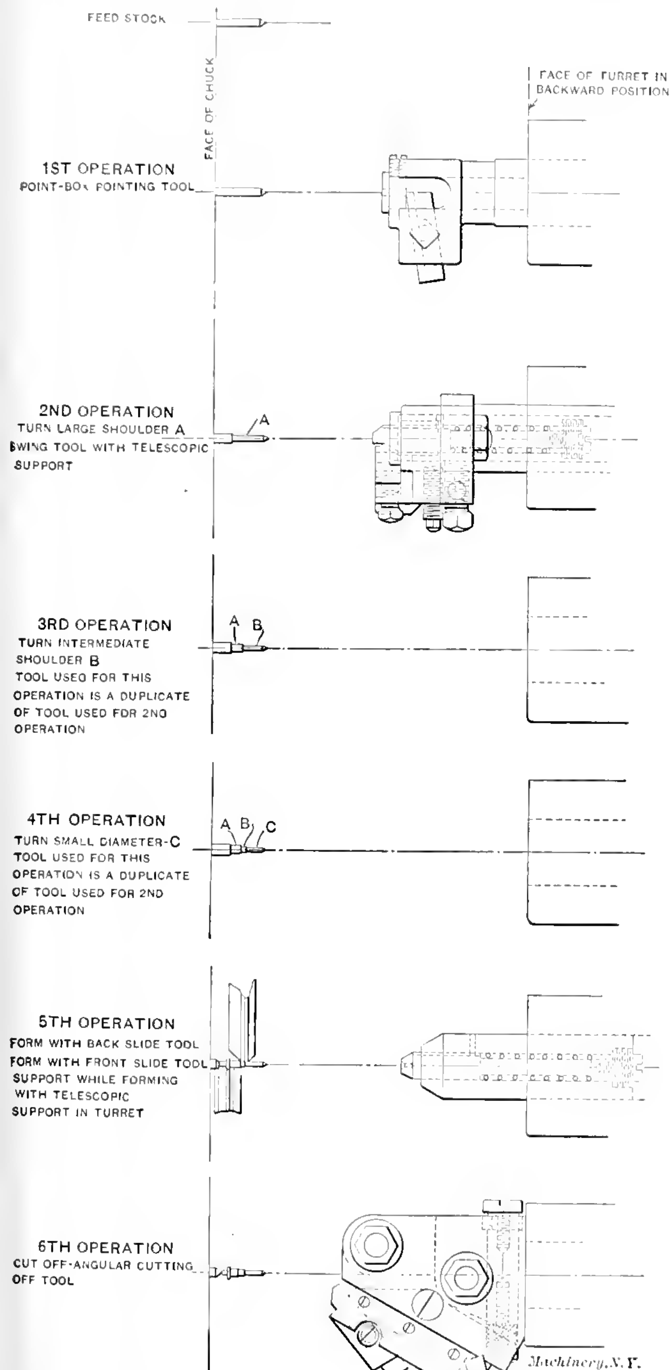


Fig. 8. Tools Used and Order of Operations Followed in making the Staff shown in Fig. 2.

readily figured out. It will be noticed that on the back slide cam, which takes the wider of the two forming cuts, a finer finishing feed is used between positions 60 and 72½ than for the first portion of the forming between 20 and 60. This is done to produce the finer finish which the finer feed gives. It will also be noticed that in all forming operations, such as those performed by the two cross slides, and by the turret slide in pointing the work in the first operation, the cams are provided with "dwells," or resting places where the periphery of the cam is, for a short space, a portion of the circumference of a circle, so that the slide is allowed to rest at this point while the chip runs out. This produces a smooth final finish. The net production is 900 per day, allowing time for sharpening tools, etc.

Tools and Operations for Making a Watch Staff.

The part shown in Fig. 2 has to be handled somewhat differently from the one we have just been considering. It is much longer and more slender, so that forming it by cross slide tools is out of the question. This part will have to be turned. The order of operations is indicated in Fig. 8.

The stock, having been fed to length, is pointed by the turret tool shown in the first operation. In this tool the stock is supported by a bushing while the end is being pointed, the work being too slender to support itself, as in Fig. 3. In the second operation, shoulder *A* is turned. This is done by a "swing tool," which will be described later. The pointed end is supported in a female center, a turning cut is taken over the shoulder of the finished diameter required, the cutting blade is released so that it is not dragged over the work on the return, and then the turret is revolved for the next operation. Operations 3 and 4 are also performed by the same kind of a tool and in the same way, shoulders *B* and *C* being each finished in turn. It will be noticed that the smallest diameter is finished last. This is obviously necessary. If shoulder *C* were turned first to its finished size, it would not be stiff enough to support the succeeding cuts *A* and *B*, and give assurance that they would be true with the cone pointed end.

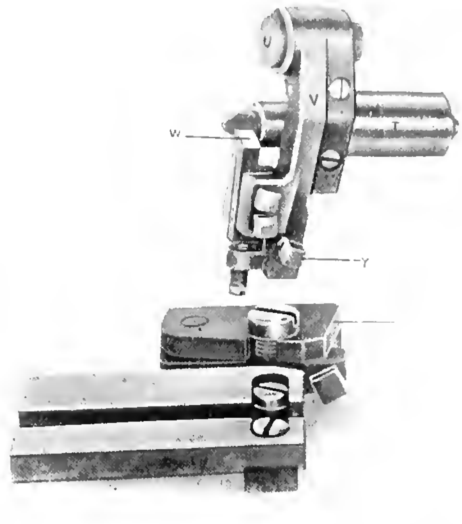


Fig. 9. Swing Tool used for Turning the Staff shown in Fig. 2, and the Pusher by which it is operated from the Cross Slide.

In the fifth operation, the work is supported in a female center (as in Fig. 3, second operation) while formed tools in the front and rear cross slides square up the shoulders already turned, and remove the burrs thrown up by the turning tools. The front cross slide tool forms the small diameter to the left of the collar and squares up the sides of the collar itself. As will be seen from a study of the cams of Fig. 11, the front cross slide tool does not commence to cut until the one in the rear has completed its work. The stock is too slender to permit of too much work being done on it at once. In the sixth operation, the same angular cutting-off tool as shown in Figs. 5 and 6 is used for severing the work from the bar and forming the cone point at the same time. It will be seen that in the operations just described, as in the previous case, the various diameters will be as concentric with the pointed centers of the work as if they had been turned on them.

Description of the Swing Tool.

The swing tool used in operations 3, 4, and 5 is shown in Figs. 9 and 10. To the body *T* of the device is pivoted (about stud *U*) the tool-holder *V*, carrying blade *W*, which is adjusted vertically and clamped by the square-headed screws shown. In a hole drilled into the body of the tool, is contained a plunger *Z* pressed outward by a spring. The opening of this hole is closed by a screw, as shown. A pin *X* driven into the side of tool-holder *V*, projects through a side hole into *T*, and bears on the face of plunger *Z*. By this means the spring keeps *V* swung outward, the movement being limited by the bearing of *Z* on the headless set-screw. Abutment screw

Y, in V, is in position to bear against pusher S, carried by the cross slide in the same manner as in Fig. 6.

In turning shoulders A, B and C (see Fig. 8), the movements of the front cross slide and turret slide cams, as may be seen in Fig. 11, are so arranged that the swing tool is brought up to the work; the cross slide is next moved in to set the tool W to the diameter desired, as determined by the adjustment of screw Y; then the swing tool is fed forward the proper distance for the shoulder desired. The front cross slide is next withdrawn, allowing tool W to swing outward under the influence of the spring and plunger Z. The turret

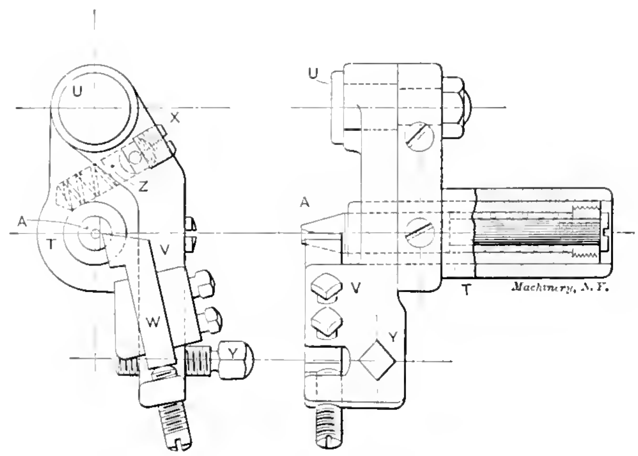


Fig. 10. Details of Construction of the Swing Tool shown in Fig. 9.

slide then retreats, drawing the blade out of the way without allowing it to drag on the work. The swivel adjustment on plate S allows either straight or taper turning to be done, as required.

The cams, shown in Fig. 11, for making this part, look somewhat complicated, but the operations may be easily followed. All the various lobes of the three cams being marked for the operations for which they are intended. Legend "I. T." means "index turret." As before, the legend "dwell" indicates a concentric portion of the cam, where the slides are at rest.

In making this piece the spindle revolves at 2,400 revolutions per minute. As shown in Fig. 2, the stock is 0.063 inch in diameter. This gives a surface speed of about 40 feet per minute, the material being tool steel as in the previous case. The net production for these pieces was 1,500

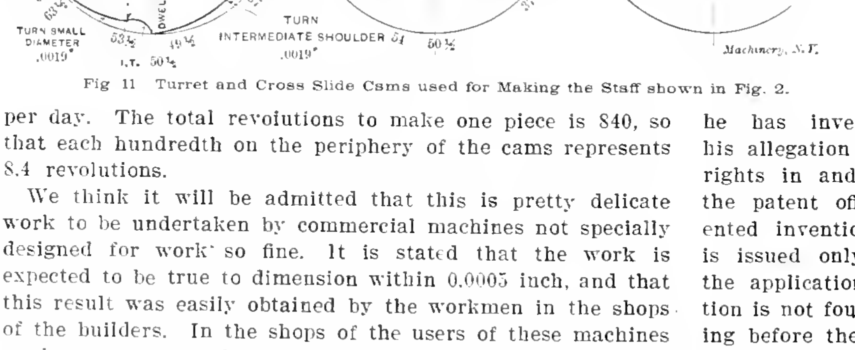


Fig. 11. Turret and Cross Slide Cams used for Making the Staff shown in Fig. 2.

per day. The total revolutions to make one piece is 840, so that each hundredth on the periphery of the cams represents 8.4 revolutions.

We think it will be admitted that this is pretty delicate work to be undertaken by commercial machines not specially designed for work so fine. It is stated that the work is expected to be true to dimension within 0.0005 inch, and that this result was easily obtained by the workmen in the shops of the builders. In the shops of the users of these machines workmen accustomed to watch machinery have been able to do much better than this, showing that the limitations of the machines were not reached in the builders' trials.

For particulars relating to the tools and operations here described, we are indebted to Mr. F. E. Anthony, head tool designer for the automatic screw machine department of the Brown & Sharpe Mfg. Co.

PATENTS AND INVENTORS.*

E. C. SMITH.†

It is written, "a man's foes are they of his own household." Equally true is it that the tribulations of the inventor arise too frequently from causes within himself—usually from insufficiency of knowledge or inadequacy of apprehension. An experience of several years in charge of a corporation patent department brought me in touch with different inventors, and indicated to me that many did not understand what constitutes an invention, or the nature of a patent. To establish an exact definition of invention, that shall serve under all conditions to distinguish invention from mere resource or skill, is practically impossible. The problem has taxed our best jurists, who have been unable to deduce a formula universally applicable under all conditions. In general, however, pure or genetic invention is creation. The phonograph, air brake, "universal" system of winding, are all good examples of genetic invention—the products of the inventor's creative genius.

Subordinate to this is what may be termed constructive invention, or the invention of development and improvement. One man conceived and reduced to practice the mechanism for reproducing human speech—a genetic invention. He and others have made contributory inventions of constructive revision. The origination of the talking machine has stimulated constructive thought in an entirely new field of activity, and thereby the original device has been modified by changes and additions which may or may not have been improvements. Unfortunately, too much of constructive invention is not stimulated by a desire to better an existing invention, but arises from predatory motives and is directed to "getting around it." Because of this fact, such inventive acts were best termed "circumventions," which word best expresses their piratical spirit. As stated by Mr. Johnston, in the March issue of MACHINERY, an inventor may secure proprietary rights in and to his invention by conforming to certain prescribed requirements. I do not agree with Mr. Johnston that the inventor's title to his invention is essentially coextensive with a land title. Land is "real" or tangible property, susceptible of explicit definition as to its boundaries, while an invention is intangible, its boundaries are not so easily defined, and it is more subject to qualifying modifications. The relation of tangible and intangible property is too extensive a subject for discussion here, but it is well to bear in mind that the land-holder and miner secure their property only because the government sees fit to grant the title, just as it sees fit to grant a title to an invention. In short, both are matters of government prerogative, and there must essentially be a wide divergence of opinion as to how the prerogative should be exercised. It does seem inconsistent, however, to propound perpetual title to invention as inherent, and in almost the same breath approve an enforced limitation of tenure.

A patent is a contract between the public, by its representative, the government, and the patentee; and the patent document is evidence of proprietary rights, duly recorded. The applicant alleges that he has invented something new and useful; provided his allegation is true, the public will accord him exclusive rights in and to his invention for a period of years. At the patent office are maintained extensive records of patented inventions, both domestic and foreign, and a patent is issued only after due investigation and comparison of the application with these records, and provided the invention is not found in the prior act or in some application pending before the patent office, and provided that no fraud has been detected in the preparation or proescution of the application. Having secured his patent, the inventor has attained two things, *viz:* a more or less uncertain asset on which he may or may not raise money, and a status or basis for suit

* For additional information on this subject, see the article "On the State of the Patent Office," published in the March issue of MACHINERY.

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before the courts. The law provides no guarantee of the validity of the invention, nor does it, as Mr. Johnston avers, provide any penalty for infringement. It provides means for securing just treatment and damages in case of injury by infringement. Judge Colt stated the position of patent litigation very clearly in Boston several years ago. Speaking for the Appellate Court, in a refusal to entertain discussion of some "legal precedents," he said, in substance, "Cases of this character (patent causes) are not matters of law, but of equity; and equity, in plain English, is simply that which is right and just between parties."

Probably the most disconcerting experience to the inexperienced inventor is the securing of a patent with its crisp parchment, ribbons and seal, and attendant cost, only to find that the invention, though "new and useful," cannot be practiced because dominated by some existing patent. Possibly the dominating patent was disclosed among the first references cited by the examiner, but because it did not show precisely the same form of construction as his own, and he did not find the broad, basic claim, and because he did not understand the law of equivalents, the inventor proceeded with his case supposing he could use his own peculiar construction. An exceptionally clear illustration of the principle of "domination" appeared in a little advertising pamphlet issued by an attorney several years ago. Assume that percussion firearms are unknown. X invents the first percussion device comprising a hammer. He applies for a patent and secures, by broad, basic claims, the sole right to make, use or vend firearms that have hammers. Y sees the disadvantage and danger of employing only a hammer, and invents the trigger, and he likewise secures, by patent, sole rights, title and privilege in the manufacture, use and sale of firearms of which a trigger is a component. But the trigger is dependent on the hammer for its usefulness, and as X has sole right to the manufacture of guns with hammers, Y's invention is useless to him unless he can sell his patent to X, or induce him to use the triggers on a royalty basis, or can secure on a similar basis the right to make guns with hammers, under X's patent, or can manufacture trigger attachments for use on guns manufactured by X. Unaware of this, many would-be inventors, unacquainted with a given field of activity, attempt, without any canvass, to devise some supposed improvement, and proceed to seek a patent.

Again, there are some who waste time with what they wrongly dignify as an invention, by applying a device invented for one purpose to some other purpose. This is done many times in a belief that the various classifications in the patent office are distinct fields of enterprise, and that the importation of an invention from one to another is as patentable as the original creation and development. Generally speaking, a patent protects its invention in all its uses, though there are exceptions when the work of adaptation involves distinct inventive ability, which is recognized. For those who study and analyze, securing information regarding the field in which they propose to work, there is ample opportunity in the realm of constructive invention. The field of purely genetic invention is becoming rapidly more limited, and patent values are differentiated on narrower margins of constructional difference. This is as it should be, because minor constructional variations are frequently productive of large commercial results. As a matter of fact, the inventor has exceptional privileges and opportunities under our patent system. If he elects to prosecute his own patent application, he may do so, bound by no fine technicalities, and, for his guidance, provided gratuitously with one of the most complete, and clearest compilations of rules and directions, clearly illustrated and supplied with skeleton forms for any and all possible actions. One of your correspondents implies that no particular erudition is required to prosecute a patent application. It is true that many inventors successfully prosecute their own cases, and it is likewise true that many professional attorneys are pitifully incompetent. Nevertheless it is also true, that just as some individuals find best expression for their abilities in mechanical conceptions, some in mechanical construction, and some in the commercial exploitation of mechanical products, so others, peculiarly able because of their command of language and resourcefulness of apt expression, can best reduce the inventor's conceptions to record form. If, however, the inventor would exercise the same diligence in delving into the realm of invention that the average business man exercises in his conduct of affairs, he would avoid many pitfalls, and his passage through what is usually pictured as a veritable slough of despond would be more expeditious and less gloomy.

Regarding the patent office, there is much to be said. That the funds earned by it are not available for its own use seems wrong. That there are deficiencies and abuses appears inevitable; they are to be found everywhere. Judged by the commissioner's report, his department seems to be doing all it physically can, as at present constituted. To me the showing is not one of incompetency, but of exceptional merit under adverse conditions. The commissioner states that the work of some of his force is frivolous, and otherwise lacking in essential qualities. What can be expected when men's work is demanded in exchange for boys' pay? It has been my good fortune to meet one or two of the examiners personally, and these were keen, clear-headed and able men. One must remember that they have little access to the concrete embodiment of the inventions on which they pass. Their knowledge of the technical ground they must cover is derived chiefly from the text and illustrations of the patent records and applications in their hands. It is always more difficult to understand a written description than to understand the embodiment of an idea. Does the inventor who desires to negotiate capital, content himself with sending a written description to his prospective financier? No, he wants *him* to see the *machine*. Whether he will see it or not is a matter of volition, and whether or not he will "back" it, likewise. With the examiner, this is not the case. He may not have opportunity to see the machine, yet he must grasp the spirit of the invention and apprehend its advantage with, too frequently, insufficient description to guide him. It is charged that examiners sometimes make immaterial and irrelevant references. Whether this is as flagrant a wrong as might appear on the surface is questionable. If actually done under stress of extreme congestion, it keeps things moving in the patent office, and may throw unexpected light on the subject in hand. Sometimes a reference is declared immaterial because it relates to a distinctly different class of articles from that which includes the subject of the application. But it may be material, nevertheless, under the doctrine of a patent protecting an invention in all its uses. The real danger arises, not from citing irrelevant material, but from failure to perceive that which is vitally relevant and liable to cause trouble to the patentee should he secure a patent and attempt to practice his invention.

In regard to delays, no one can view with complacence the proposition to delay action on the cases of those who desire delay. On the other hand, due deliberation is better than undue haste. Mr. Johnston would have us believe that a multitude of inventors are suffering from lack of funds, due to non-issuance of patents. I will venture a guess that for every one individual in such a plight, there are ninety-nine who hold issued patents and still similarly suffer. Indeed, reasonable delay is not without its advantages. Sometimes, in course of delay, an inventor finds that while he has produced the invention of his application, his analysis is at fault and his original claims inadequate. He may then be able to fortify his case, whereas, had it been immediately acted on, pushed through the office, and a patent issued, the insufficiency might have passed unnoticed until too late, resulting in reissue for correction, or what is worse, a disclosure of the weakness by which some pirate could profit and depreciate if not annul the value of his patent.

Referring again to reference patents, one fact which disposes me leniently toward the examiner is the fact that the inventor himself frequently encounters difficulty in discerning the relation of a cited patent to his own invention. Mr. Johnston suggests one action which, to say the least, seems of dubious utility, *viz:* to penalize the deferment of a request for division until after several actions. What difference does it make to the applicant when he is asked to divide his application? If he must divide it, he must pay two fees; so why throw the second fee on the examiner for any cause?

If there are any penalties to be meted out, they are due the man who wastes time in needlessly dissecting the punctuation and phraseology of an application. It has been officially decided that such criticism is ill-judged and misdirected.

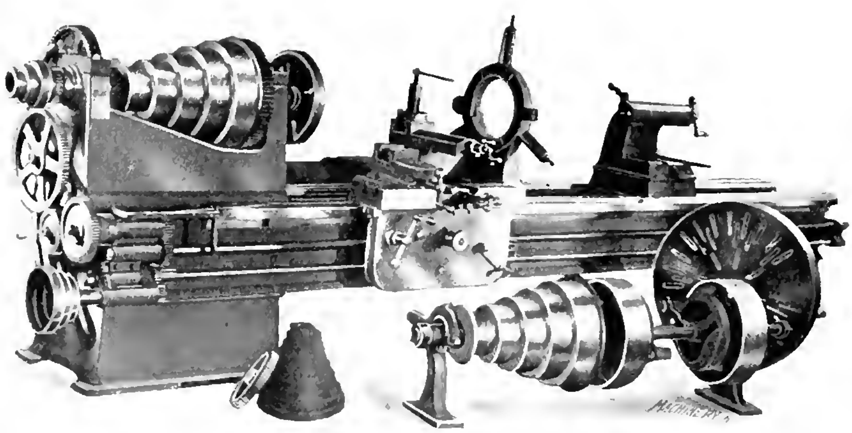
The essentials of an adequate application are simply clear, intelligible composition in the English language, according to prescribed forms. The suggestion that the commissioner be made general manager, with unlimited credit, seems untimely, when Congress is holding onto the funds earned by the patent office. It seems essential that something be done, however, and the most feasible move would appear to be a concerted action to impress Congress with the needs of the situation. The realm of invention touches every phase of our industrial welfare and development. It is not local in any aspect, but reaches and affects the uttermost parts of our land, and indeed, of the world. It should be an easy matter to convince Congress that something needs to be done and must be done.

It must be realized, of course, that we have passed through extraordinary times. The demand for skilled labor has exceeded the supply. Several engineers have graduated from the Panama Canal work. Our military establishment is depleted because men can find better inducements in the industrial world than in army life. Works managers at large have bewailed the scarcity of help. Is it any wonder that examiners resign from the patent office at the rate of one a week? As for commercial firms and their business methods, there are some from whom we purchased our supplies who didn't know the nature of a promise, and beside whose methods those of the patent office could shine with the effulgence of perfection. It is easy to make invidious comparisons, but the instability of the premises on which such comparisons are based has made be a cynic.

* * *

AN OREGON LATHE.

The accompanying illustration shows an engine lathe built by the Eugene Iron Works (G. N. Frazer, proprietor), Eugene, Ore. This shop, we believe, is the only one on the Pacific slope that builds lathes for sale. The lathe illustrated is 30 inches swing and takes 10 feet between centers. The spindle is hollow, having a $2\frac{1}{2}$-inch hole. The tail-stock is of the well-known cut-away pattern which permits the compound rest to be swung around parallel with the ways without interfering with the tail-stock. This lathe is not the first lathe built by the Eugene Iron Works. We are informed that several others have been built, one of them being 44 inches swing and 12 feet between centers. This example was built twenty-eight years ago, and is still doing good work. It was made in sections that could be planed on a 22 x 6-foot planer, and it has the much-talked-of double plate apron, now pushed as a comparatively new feature by many prominent lathe builders. We are indebted to Mr. Ed. B. Eby, of Eugene, Oregon, for the above information.



A 30-inch Lathe built by the Eugene Iron Works, of Eugene, Ore.

* * *

The English turbine-driven torpedo boat destroyer *Tartar*, during her official trials, developed a speed of 35.672 knots as a mean of six runs.

A POWER-PRODUCING PLANER.

GREBO.

I often think it is a great pity that some of the wonderful achievements of machinery, as related by certain accomplished traveling men, do not agree with the fundamental laws of mechanics. These stories sound so well that it seems they ought to be true, and if they were true, what a different world this would be! It really would be a pleasure to run a machine shop. For example, having a certain tale in mind, we would grow richer day by day by simply running a shop and selling power to our neighbors. Now you think this sounds "fishy," and I will explain how it could be done (?) much simpler than has ever been proposed before. You, of course, have heard of steam engine and boiler installations that were equipped with various improved appliances, some of which saved 10 per cent of the fuel, others 15 per cent, and still others as much as 25 per cent. By using enough of these wonderful affairs the point was reached where instead of consuming coal the plant was able to turn out half a ton of coal a day for some other fellow to burn. Now this was a very clumsy affair, not really worth the while of an up-to-date factory economist. You always have a feeling that a salesman will come along some day with a smoke-consumer or an ash-burning compound that will make all your previous economies look like thirty cents. Real improvement is in the direction of simplicity, and that is what I am going to tell you about.

I knew a salesman who sold planers—rather big planers, heavy and clumsy-looking affairs, but wonderful machines for all that. Of course his "spiel" was that these planers were better in all working points than any other planer built, or that ever would be built. But customers had heard these stories before and discounted his talk 66 2/3 & 25 & 10 & 10 & 5 per cent in approved commercial style. They would look at his pictures and his specifications and ask him about the power required to drive the big machine. Right here is where our salesman made a claim that firmly fixed his reputation. He admitted the planer would need something like 20 horsepower to start it, but when once it was started, why he had known of a great many cases where the planer ran so easily that instead of the engine running the planer, the planer was actually helping out the engine!

Now this proposition is more attractive than may be realized at first. Most manufacturers do not care for a few horse-power more or less. Power is a small part of their expenses, anyhow, but when you had bought one of these planers you had a very useful machine. It not only required no power after it was once started, but actually contributed to running the other tools in the shop. With a sufficient number of these planers running you could run your entire shop and have a surplus to light it; or, if enough planers were operated, you might run the street car lines of the town!

It is painful to record that the rosy prospects an active imagination might conjure from the unqualified statements made by our salesman did not excite the imagination of his prospective customers. They listened coldly to his eager words and his sales fell considerably below those of his fellow salesmen. Finally he was called home and asked to explain the "becauseness of the why," and his customary "spiel" was poured into the astonished ears of the general manager, who could scarcely believe what he heard. Finally, when the manager got his breath, he let out a few wrathful comments punctuated with exclamation points, on the asininity of the power claim and the ridiculous position that our smart salesman had put himself into. The salesman learned more about the conservation of energy and the limitations of machines as power producers in those few hot minutes than most of us learn in several years of schooling.

If there is any particular point to be impressed by this foolish tale it is that manufacturers should employ salesmen only who know what they are talking about.

ADVANCED DESIGNS OF GERMAN DRILLING MACHINES.

OSKAR KYLIN *

The accompanying half-tones show a few types of the extensive line of drills manufactured by the Dresdner Bohrmaschinenfabrik, A.-G., Dresden, Germany. This firm manufactured originally, in accordance with the common practice of nearly all German machine tool builders, all types and sizes of machine tools, without specializing in any; but, learning of the success of the specialization of the American machine tool makers, and clearly seeing the advantage of this, and with how much less amount of labor an equally large amount of work could be produced by systematizing the output, as compared with the old method, this firm discontinued the making of all kinds of machines except drilling machines, and devoted itself exclusively to this one line.

Figs. 1, 2 and 3 show some of the small sizes of drills, of the single spindle as well as the multiple spindle type, intended for ordinary light or medium grade work, and equipped only with hand feed. There is nothing startling in the design of these machines, as they follow the general line of design which for years has been brought out by many different machine tool builders, and proved to fill the requirements. It will be noticed, however, that in many features these machines are different in their appearance from common American types, and that the multiple spindle drills, in particular, are of a heavy and substantial design. The drills shown in Figs. 2 and 3 are also built with a greater number of spindles, if required.

In Figs. 5, 6, 7 and 8 are shown the large types of drills manufactured by this company, equipped with power feed and designed for heavy duty. The machine in Fig. 8 is equipped with a pump and arrangement for water cooling of the drill, while at work. It will be noticed that all gearing is very carefully covered with guards, forming integral parts of the machine. The radial drill shown in Fig. 7 is of particular interest. It will be seen that the design is unusually rigid and that the column as well as the arm is very heavy. The column is mounted on a base-plate provided with T-slots, which serves as a support for large work, when the small table is swung aside as shown in the half-tone. This machine is provided with single pulley, all-gear drive, the speed changing mechanism being operated by the handle shown at the back of the column. In this machine also it is noticeable how carefully all gearing has been covered. The design, in general, is clearly shown in the engraving, and may be studied directly from this without further comments.

In Fig. 4 is shown an interesting type of turret drill, which is radically different from anything else hitherto presented in drill press design. This machine is of an exceptionally heavy and rigid design throughout, in accordance with the work for which it is intended. It is provided with a single pulley, all-gear drive, the speed changing device being operated the same as in the radial drill press, Fig. 7. Power is transmitted to the top of the drill by means of bevel gearing and a shaft located centrally in the column. The drill spindles are driven through shafts connected at one end through bevel gears to the central shaft, and at the other end by bevel gearing to the drill spindles, these shafts being arranged radially, one for each spindle. There are five spindles in the turret arranged around the central column, but power can be transmitted to only one at a time; that is, to the one directly above the table of the machine. This prevents undue consumption of power, and unnecessary wear of spindles, gearing and bearings. The engaging and disengaging of the power to and from the spindles is effected by a cam and clutches, brought into operation as the turret is being slowly revolved by hand around the column. The clutches are located on the radial shaft near the outer bevel gear. The cam by which the

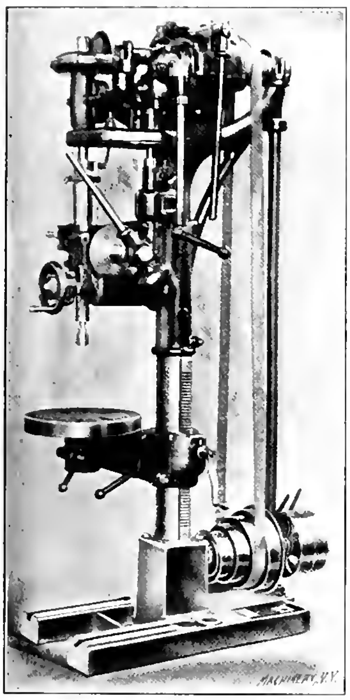


Fig. 1. Regular Type Upright Drill built by the Dresdner Bohrmaschinenfabrik.

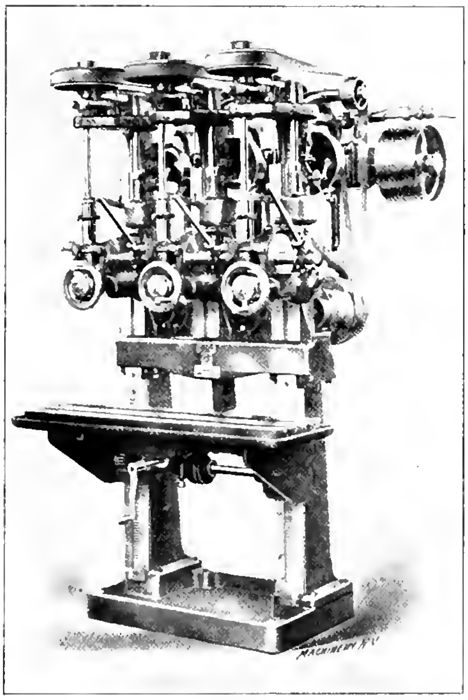


Fig 2. Three-spindle Drill, of Heavy and Substantial Design.

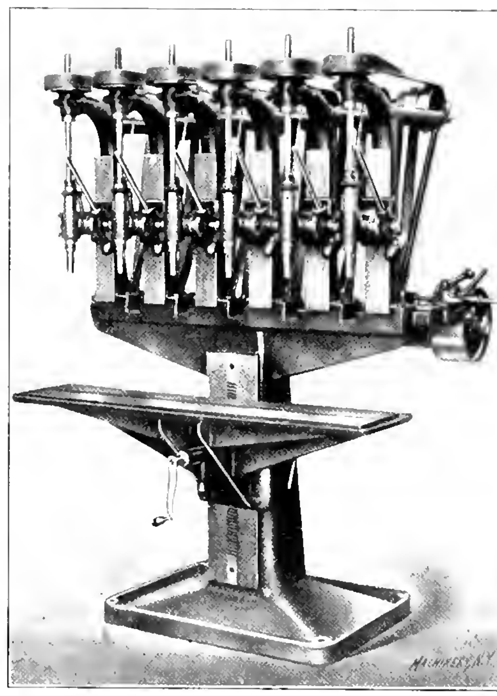


Fig. 3. Multiple Spindle Drill for Light and Medium Grade Manufacturing.

clutches are engaged and disengaged is located below the gear mechanism at the top of the drill, and immediately on the top of the column, as can be plainly seen in the half-tone. When the spindle is moved into position the respective clutch is being engaged, and when again moved out of position, the clutch is thrown out of mesh. In order to make it easy to revolve the turret, this rests on ball bearings. Attention should be called to the rigidity of the design, and to the construction of the drill table, the features of which can be seen plainly from the half-tone. This drill is equipped with pump and arrangement for water cooling. As the five different spindles are intended for different kinds of work, drilling, reaming, tapping, etc., they can be run at different speeds suitable for each kind of work. These different speeds are obtained by different sizes of bevel gears for driving the different spindles.

A feature that will be noticed in all the designs brought out by the Dresdner Bohrmaschinenfabrik is that the unit system of design is employed to the largest possible extent. One unit, as, for instance, the heads and the gear boxes, will be found to be the same on many of the different types of the machines represented in the accompanying half-tones. Many times a new type of machine is brought out by simply making new

* Foreign Traveling Representative of MACHINERY.

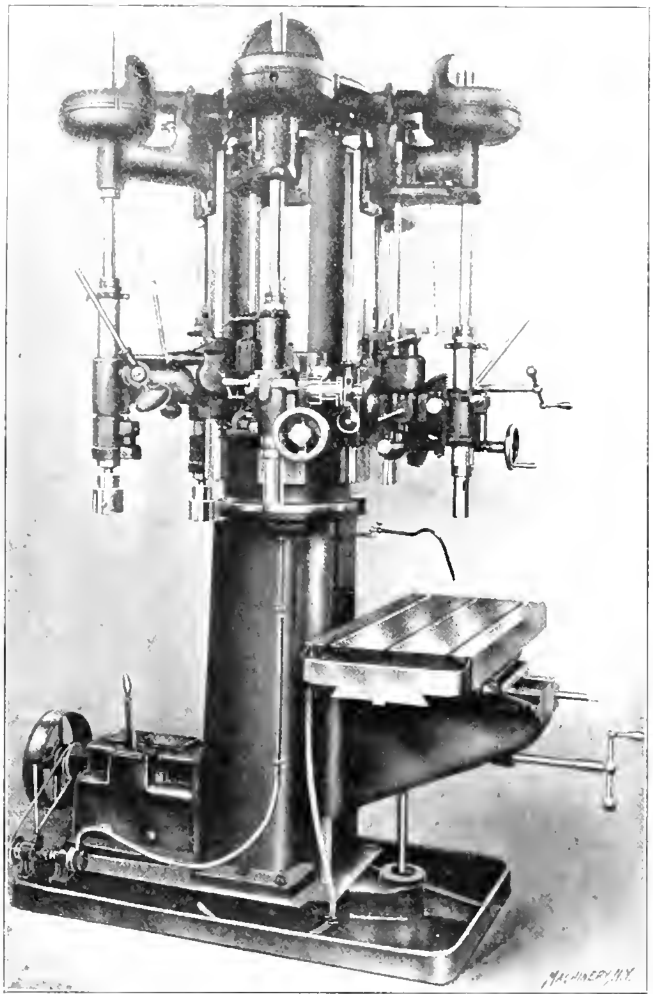


Fig. 4. Turret Type of Drilling Machine embodying Turret Principle in Drill Press Design

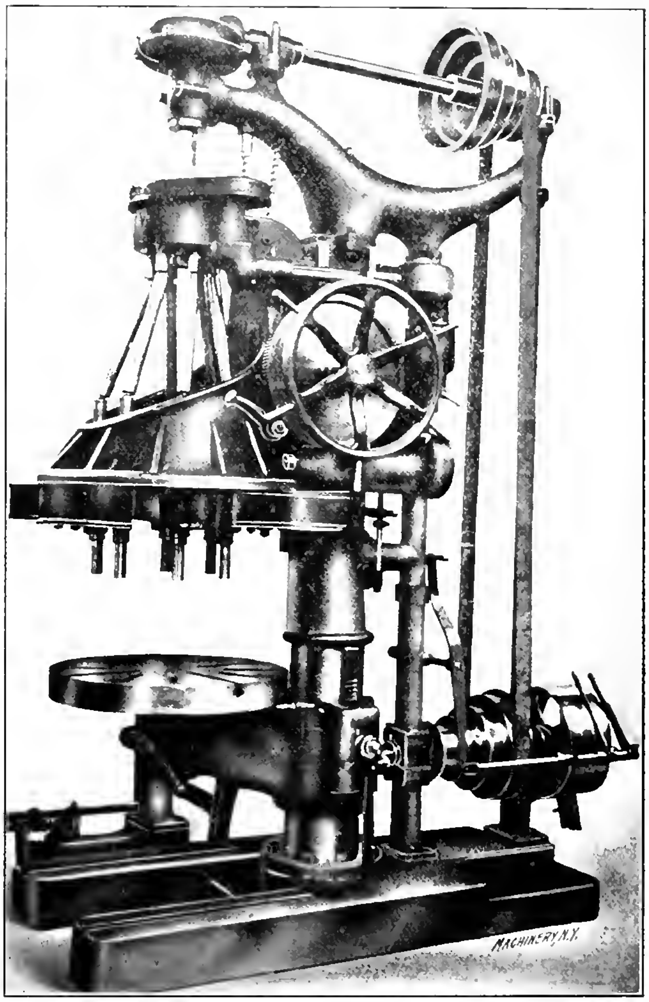


Fig. 5. Heavy Multiple Spindle Drill of Universally Adjustable Type.

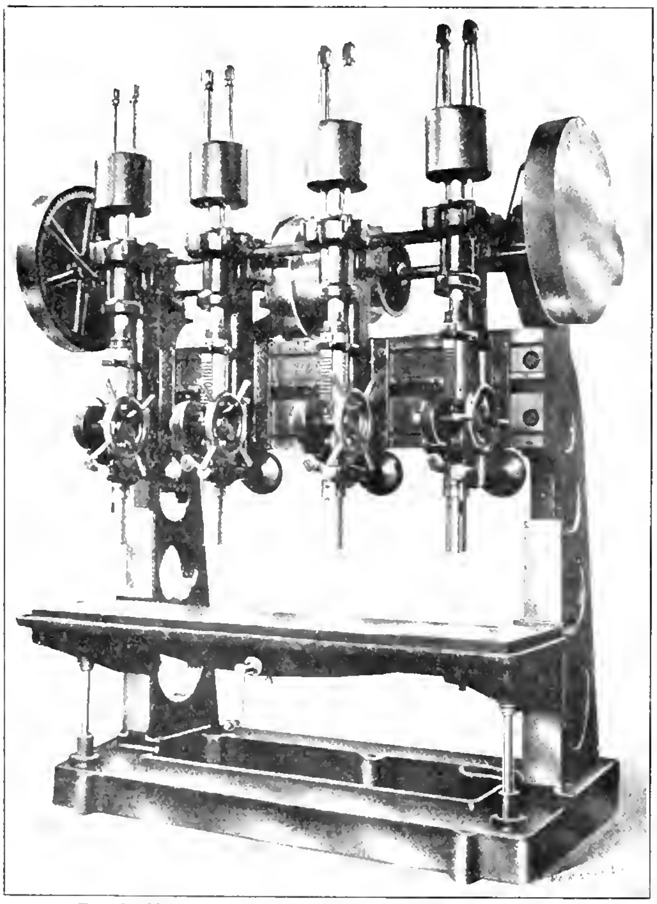


Fig. 6. Multiple Spindle Drill of Linear Adjustable Type

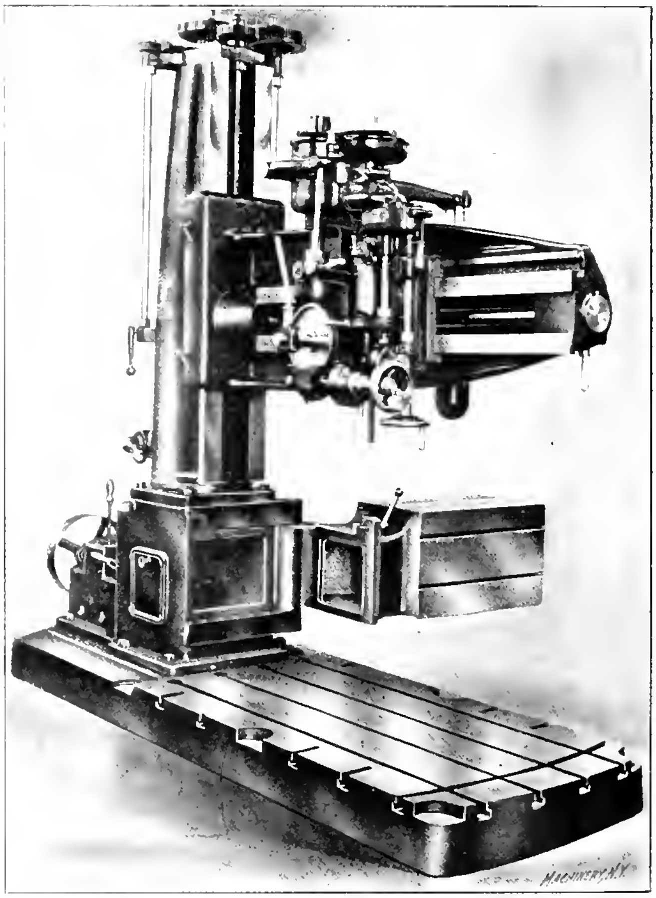


Fig. 7. Dresdner Bohrmaschinenfabrik Radial Drill, with Hinged Table.

main castings and then employing the units used for other types. Thus, a manufacturer of a special line of machine tools can afford to carry a large number of types, and still have the advantage of specialization. Various details and whole units can be made in very large numbers and kept in stock, and the building of a new machine may simply mean bringing out

and machining the main castings, and assembling the various units for making up a complete tool.

All the machines provided with power feed for the drill are provided with feed changing mechanism. This feed changing arrangement is shown best in Fig. 4, on the side of that spindle which is in position over the table, and is operated by the small handle shown. Three different feeds for each spindle speed are obtainable. A small matter, which, however, is well worth noting, is that all the nuts on the machine, which occasionally need to be loosened for the sake of setting the table or adjusting some other part, are provided with handles. This, many a time, means a great saving, as compared with having the ordinary hexagon nuts, which have to be unscrewed and tightened by a wrench, because it is well known that entirely too much time is lost in shops by hunting for wrenches.

In order to reduce the power consumption and also the wear of the machines, all principal bearings are made with

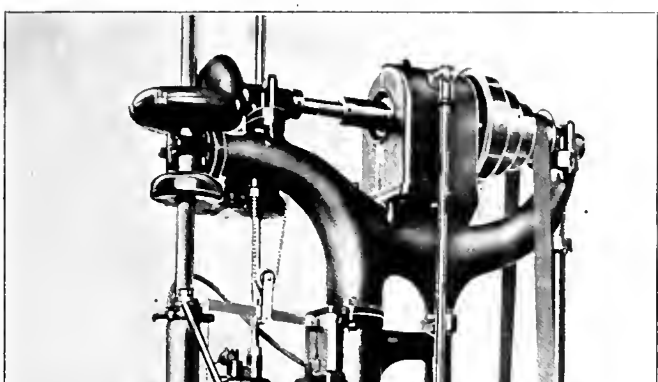


Fig. 8. Heavy Design of Upright Drill Press.

ringed oiling devices or ball bearings. It is very noticeable in many German shops that more attention is paid to the power consumption of the machine tools than is done in the average American shop. Thus, in the Dresdner Bohrmaschinenfabrik's shops, all ordinary sized and large drills are tested in regard to power consumption before being placed in the stock room, or delivered to customers, the power consumption being noted when the drill is running idle as well as when performing work.

A special and rather unique feature employed in the manufacturing of these drills is that after having been once assembled in one department, they are taken apart and re-assembled in another department by entirely different men. This is done, the company claims, in order to find all possible defects in the machines, and secure nice running conditions everywhere in the finished drill press.

JIGS AND FIXTURES—3.

EINAR MORIN.*

LOCATING POINTS.

The locating points in a jig usually consist of finished pads, bosses, seats, or lugs, cast solid with the jig, as illustrated in Fig. 18. In this engraving the surfaces marked *f* are the locating points, which bring the piece to be machined in right relation to the bushings guiding the drills, or to the gages to which other cutting tools may be set. This way of locating the work is satisfactory when the work done is finished in a uniform way, and where there is very little variation in the parts inserted in the jig.

Another commonly used means for locating the work in jigs is by means of dowel pins, as shown at *A* and *B* in Fig. 19.

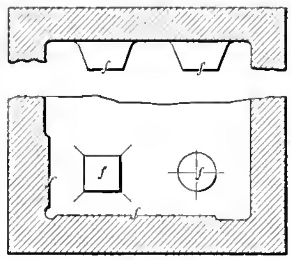
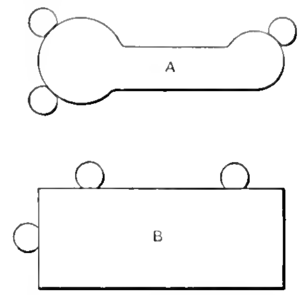


Fig. 18. Locating Pads in Jigs.



Machinery, N.Y.

Fig. 19. Pins used for Locating Work.

The sides of the dowel pins which rest up against the work are usually flattened, as indicated, so as to give more bearing than a mere line contact with the pins could give, and, at the same time prevent too rapid wear on the locating pins, as would be the case if the work should bear against the pins along a line only.

Sometimes pins or studs are inserted in jigs to act as locating points, instead of having lugs cast directly on the jig, as shown in Fig. 18. A case where a pin is used for this purpose is shown in Fig. 20, where *B* is the body of the jig, *A* the pin inserted to act as a locating and resting point, and *C* the work located against this point. Locating pins of this character should always be provided with a shoulder or collar,

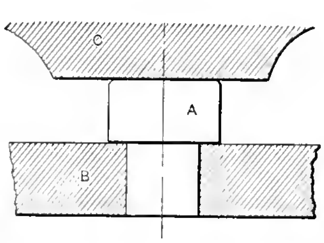
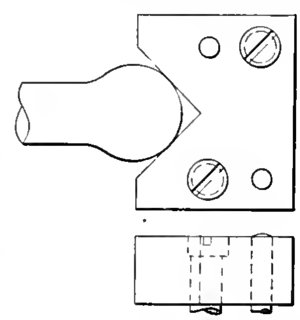


Fig. 20. Inserted Pin used for Locating and Supporting Work.



Machinery, N.Y.

Fig. 21. V-block for Locating Round Work or Cylindrical Surfaces.

so that there is ample security that they will resist the pressure of the work they support, without possibility of moving in the hole in which they are inserted.

A common method of locating cylindrical pieces or surfaces is that of placing the cylindrical surface in a V-block, as shown in Fig. 21. This V-block as a rule is stationary, and is held in place by screws and dowel pins, as indicated in the engraving, but sometimes these V-blocks may also be made adjustable, in order to take up the variations of the pieces placed in them, and also in order to act as clamps. A V-block of this character is shown in Fig. 22. In this, *A* is the adjustable V-block, having an oblong hole *B* to allow for the adjustment. The block is held down in place by a collar-head screw *C*, which passes through the elongated hole. The under side of the block is provided with a tongue *D*, which enters into a slot in the jig body itself, the V-block being thereby prevented from turning sideways. The screw *E* passes through the wall of the jig, or through some lug, and prevents the V-block from sliding back, when the work is inserted into the jig. It

* Address: 833 W. Sixth St., Plainfield, N. J.

is also used for adjusting the V-block, and, in some cases, for clamping the work. The V-blocks are usually made of machine steel, but when larger sizes are needed, they may be made out of cast iron. Little is gained, however, in making these blocks out of cast iron, as most of the surfaces have to be machined anyway, and the difference in the cost of material on such a comparatively small piece is very slight.

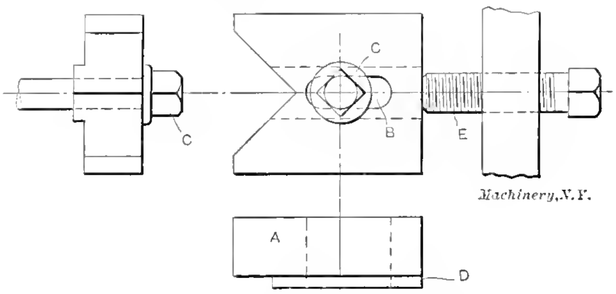


Fig. 22. Adjustable V-block used for Locating Purposes.

When it is essential that a cylindrical part of the work is located central either with the outside of a cylindrical surface, or with the center of a hole passing through the work, good locating means are provided by the designs shown in Figs. 23 and 24. In Fig. 23, the stud *A* is countersunk conically to receive the work. The stud *A* is made of machine or tool steel, and may, in many cases, serve as a bushing for guiding the tool. In Fig. 24, the stud is turned conically in order to enter into a hole in the work. These two locating appliances are always made stationary, and are only used for locating the work, never for binding or clamping.

Screw Bushings and Sliding Bushings Used as Locating Means.

Screw bushings of the type which has already been shown in Fig. 14 (May issue), may be used for locating and clamping purposes by making them long enough to project through the

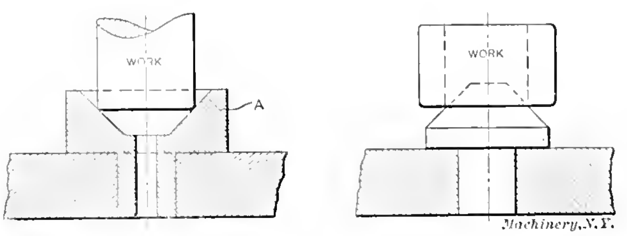


Fig. 23 Recessed Stud used for Locating Round Work.

Fig 24 Conical Stud used for Locating Work in Relation to the Center of a Hole.

walls of the jig, and by turning a conical point on them, as shown in Fig. 25, or by countersinking them, as shown in Fig. 26.

Another type of bushing which serves the same purpose as a screw bushing is illustrated in Fig. 27. This bushing, together with the forked lever *D*, and clamping bolt and wing nut shown, will serve not only to locate but also to clamp the work in place. This sliding bushing gives very good results and is preferable to the screw bushing in cases where accurate work is required, but, as a rule, where extreme accuracy would be required, this kind of bushing is not used.

In Fig. 27 the sliding bushing *A* has a close sliding fit in the lining bushing *B*. In the head of the bushing *A* there are two screws with hardened heads, which fit into elongated slots in the forked lever or yoke *D*, which, in turn, swivels around pin *E*. The eye-bolt *F* fits into a slot *G* in the yoke, and the wing nut tightens down the bushing against the work as clearly indicated in the engraving. A comparatively long bearing for the bushing is required in order to produce good results. On work that varies considerably in size this arrangement works somewhat quicker than does a screw bushing, but it is clearly in evidence that it is a rather expensive appliance, and that the construction of the jig does not always permit of its application.

In some instances it is necessary to have the screw bushing movable sideways, for instance, when the piece of work to be made is located by some finished surfaces, and a cylindrical part requires to have a hole drilled exactly in the center of a lug or projection, the relation of this hole to the finished surfaces used for locating, being immaterial. The piece of work, being a casting, would naturally be liable to variations between the finished surfaces and the center of the lug, particularly if there be other surfaces and lugs with which the already finished surfaces have to tie up, and in such a case, the fixed bushing for drilling a hole that ought to come in the center of the lug, might not always suit the casting. In such a case, so-called floating bushings, as shown in Fig. 28, are used. The screw bushing *A* is conically recessed, and locates from the projection on the casting. It is fitted into another cylindrical piece *B*, provided with a flange on one side. The piece *B*, again, sets into the hole *C* in the jig body *D*, this hole being large enough to permit the necessary adjustment of the jig bushing.

When the bushing has been located exactly concentric with the lug *E* on the work, the nut *F*, having a washer *G* under it, is tightened. It will be seen that the flanges on piece *B* and the washer *G* necessarily must be large enough to cover the hole *C* even if *B* is brought over against the side of the hole. The occasion for using this floating bushing, however,

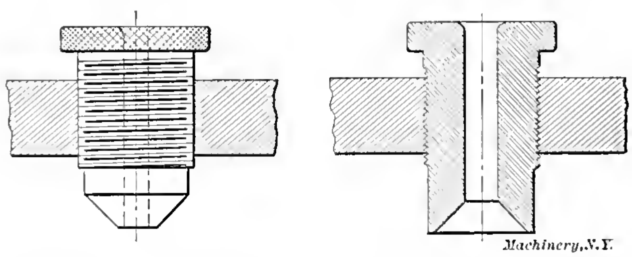


Fig 25. Screw Bushing used for Locating Work Central with a Hole.

Fig 26. Screw Bushing used for Locating Round Work by means of a Conical Recess.

does not often occur, because it is seldom that a drilled hole in a piece of work can be put in without having any direct relation to other holes or surfaces.

Adjustable Locating Points.

The most common form of adjustable locating points is the set-screw provided with a check nut, as shown in Fig. 29. The screw *A* is a standard square head set-screw, or, in some cases, a headless screw—with a slot for a screw driver; this screw passes through a lug on the jig, or the jig wall itself, and is held stationary by a check nut *C* tightened up against the wall of the jig. Either end of this screw may be used as a locating point, and the check nut may be placed on either

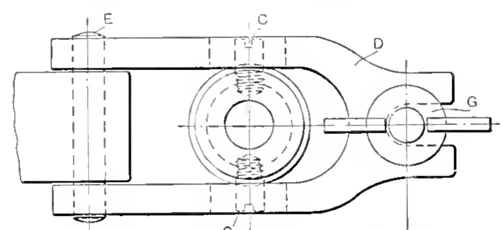


Fig. 27. Sliding Bushing for Locating and Clamping Work.

side. By using a square head screw, adjustment is very easily accomplished, but unless the operator is familiar with the intentions of the designer of the jig, locating points of this kind are often mistaken for binding or clamping devices, and the set-screws are tightened up and loosened to hold and release the work, when the intention is that these screws should be fixed when once adjusted. It is not even possible

to depend upon the check nut stopping the operator from using the screw as a binding screw. A headless screw, therefore, is preferable, as it is less apt to be tampered with.

The sliding point, as illustrated in Figs. 30 and 31, is another adjustable locating point which is used to a great extent in jig work. A flat piece of work or a plate which is not perfectly level will always rock if put down on four stationary locating points, but the difficulty thus encountered is very easily overcome by making one of the locating points adjustable, and, as a rule, the sliding point is used for this purpose.

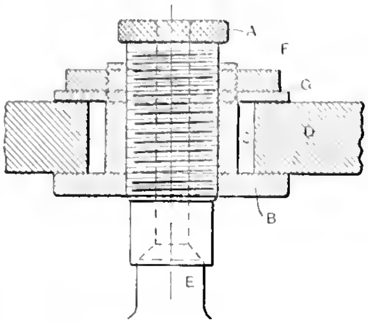


Fig. 28. Floating Bushing.

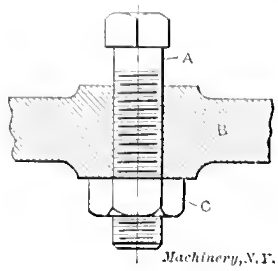


Fig. 29. Simplest Form of Adjustable Locating Point.

The design shown in Fig. 30, where *A* represents the work to be located, *B* the sliding point, itself, and *C* the set-screw, binding it in place when adjusted. The sliding point *B* fits a hole in the jig wall and is provided with a milled flat slightly tapered, as shown, to prevent its sliding back under the pressure of the work or the tool operating upon the work. This design of sliding point is frequently used, but it is not as efficient as the one illustrated in Fig. 31. In this design the sliding point *A* consists of a split cylindrical piece, with a hole drilled through it, as illustrated in the engraving, and a wedge or shoe *B* tapered on the end to fit the sides of the groove or split in the sliding point itself. This wedge *B* is forced in by a set-screw *C*, for the purpose of binding the sliding point in place. Evidently, when the screw and wedge are forced in, the sliding point is expanded, and the friction against the jig wall *D* is so great that it can withstand a very heavy pressure without moving. Pin *E* prevents the sliding point from slipping through the hole and into the jig, when loosened, and also makes it more convenient to get hold of. In Figs. 32 and 33 are given the dimensions most commonly used for sliding points and binding shoes and wedges.

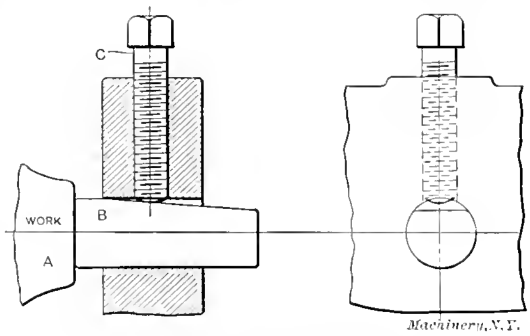


Fig. 30. Adjustable Locating Point consisting of a Flatted Stud held in Place by Set-screws.

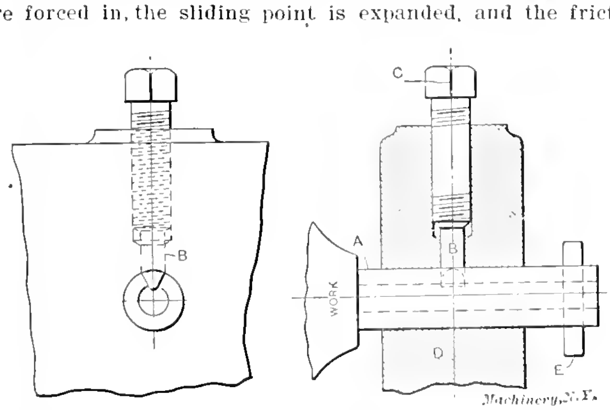
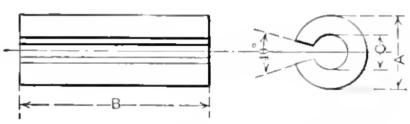


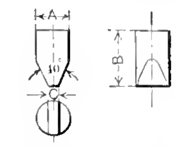
Fig. 31. Sliding Point used for Locating Work

If the work to be finished in the jig has some holes already finished, it is sometimes most satisfactory to locate the work by these holes, which may be done by means of studs or plugs similar to the one shown in Fig. 20, which then enter the holes; preferably, these studs should then be ground and hardened to the standard size of the hole. If the finished hole should be of a character that varies somewhat in size, expansion studs with bushings may be used. These studs may be of a great many different designs and styles, but, as a rule, they always work on the same principle as the one shown in Fig. 34. In this, *A* is the bushing, fitting the finished hole in the work. This bushing is split in several different ways, either by having one slot cut entirely through it, and two more slots cut to within a short distance of the outside periphery, or by having several slots cut from the top and from the bottom, alternating, but not cut entirely through the full length of the bushing. The matter of splitting, however, in every case, accomplishes the same object, that of making the bushing capable of expansion, so that when the stud *B*, which is turned to fit the tapered hole in the bushing, is screwed down, the bushing is expanded.



A	3/8	1/2	5/8	3/4
B	2 1/4 TO 3	2 1/4 TO 3	2 1/4 TO 3	2 1/4 TO 3
C	3/16	1/4	5/16	3/8

Fig. 32. Dimensions of Sliding Points.



SCREWS	5/16	3/8
A	1/4	9/32
B	1/2	5/8
C	1/16	3/32

Machinery,N.Y.

Fig. 33. Dimensions of Shoes or Binders for Sliding Points.

Locating by Keyways in the Work.

Sometimes the work to be finished in the jig is provided with a keyway or a slot, or with some other kind of a seat, by means of which it is located on its component part on the machine for which it is ultimately intended, and it is always essential that the work be located in the same way in the jig as it is to be located on the machine on which it is to go; thus, if the work has a keyway, suitable for locating, a corresponding keyway ought to be put into the jig, and the work located by means of a key, as shown in Figs. 35 and 36. Instead of a loose key, a tongue may be planed or milled solid with the jig, but, as a rule, it is more satisfactory to have the loose key, as, if it should happen to wear, it is possible to replace it; and if the width of the keyway should vary in different lots of the parts made, it is possible, with little expense, to make a new key to fit the variation, whereas, if the key is made solid with the jig, and found to be either too large or too small, the trouble of fixing this would be considerably greater.

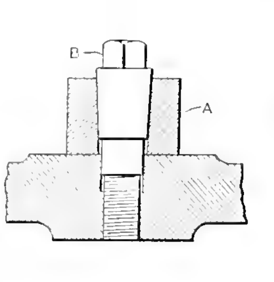
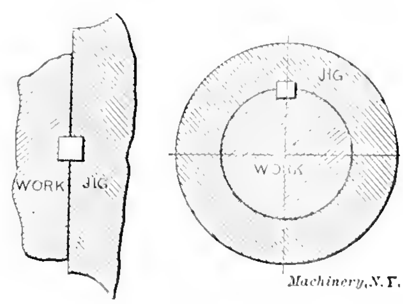


Fig. 34. Expansion Bushing used for Locating and Clamping Work.



Figs. 35 and 36. Locating Work by Keyways

There are, of course, a variety of different methods of locating the work in the jig, depending upon the nature and the shape of the work, but those mentioned above are the most common, the cheapest, and those that, as a rule, give sufficiently good results for ordinary work. The principles involved in the design of the means of locating the work described above, would all be the same in any kind of locating devices, so that it would simply be a difference in application of the principles, rather than a difference in the principles themselves.

SHOP ORDER TRACING SYSTEM.

CHARLES M. POND.*

In suggesting any new system, one must first of all fully realize that the same conditions do not exist in two shops or factories. Hence, the system suggested must be broad and flexible enough to permit of being adapted to the various conditions already in existence. Moreover, the conditions permitting the use and adoption of the system should be carefully analyzed in order that the individual or corporation which is inclined to try the system, may first investigate and see if it can be maintained successfully.

CUSTOMER:

ADDRESS:

CUSTOMER'S ORDER NUMBER	SHIPPING ORDER NUMBER	MATERIAL	SHIPPED

Machinery, N.Y.

Fig. 1. Card on which is recorded Customer's Name and Address, Order Numbers, and Date of Shipment.

The system which the writer is about to present is of chief interest to the manufacturer of tools, instruments, fixtures, and the like. To all those engaged in this work, the daily mail brings its full quota of "tracers," "ticklers," and inquiries. These, in many cases, constitute fully 10 to 15 per cent of all mail received; and if the correspondence is large, their number will be proportionately great, and will require a separate department to give them proper attention and to answer them intelligently and correctly. The customer receives an answer and promise of shipment, and bases his calculations accordingly. If the promise is not kept, it may mean serious loss to him, and consequent ill feeling, and the curtailment of orders placed with the offending concern. Many times it results in cancellation, and consequent loss, if the goods are in any way special. It is therefore evident that care should be taken in replying to these inquiries. Moreover, a manufacturer who has a reputation for keeping his promises of delivery need have little fear of losing his customers, provided his product is satisfactory. That these "inquiries" or "order tracers" before mentioned are very common is evidenced by the fact that almost every concern which buys at all, has a printed form which is sent to the seller, asking that most important, and often vexing, question: "When can you ship?"

Now, having the conditions existing as outlined, it remains for the manufacturer to give an immediate and satisfactory answer; and this is where the value of a comprehensive and practical system will make itself felt. It is the writer's object to lay out such a system as can be easily adapted, and will not require much outlay to install.

First let us see where and under what conditions this system may be used. It will be of chief value, as has been said before, to the manufacturer of small articles such as drills, tools, fixtures, and the like, where a great variety of stock is kept constantly on hand, and for which there is a steady demand. It will also be of most value to the factory having its machines grouped in departments according to kinds of operation. It can readily be seen that, in the case where the complete tool is made entirely in one department under the direct supervision of one foreman, the time of completion of any article or order is readily determined. But this manner of dividing machinery is gradually being replaced by the modern and vastly more economical method of having machines of one type grouped together in one department. This department is under the supervision of an expert in that line, and but one operation is performed under his jurisdiction. For example, we can assume that a concern makes twist drills of a great variety. It would be entirely possible to have one department make the common drill complete; another department, the high speed drill; still another, the wire drill, etc. But the proper way is to have it so arranged that one department cuts off the stock, another does the milling, another the turning, another the grinding, and so on. It is because of the almost universal adoption of this latter arrangement of machinery that it is often difficult to estimate with accuracy the exact date of completion of any order, especially if it must pass through many departments, and take its turn. Hence a follow-up system is necessary, and every manufacturer will find it to his advantage to have one on which he may rely.

Of course, the financial question comes up: "Can I afford to install and maintain a system?" The writer has considered this phase of the question, and has outlined a method that may be readily handled by two men in a shop employing about four hundred hands. With but two hundred men, only one man will be required, and the same proportion holds where the number of men is larger than four hundred.

The first item which comes up for attention is the customer's order. This, as a rule, has a number by which it is known in all future correspondence between the manufacturer and customer. This number is given to it by the customer, and we shall designate it hereafter by the term "customer's order number." Sometimes the date of the order is its only identification as far as the customer is concerned, but this is generally in the case of small concerns.

This customer's order now becomes a definite factor to the manufacturer, and he must keep a record of it in various ways. For this purpose he gives it another number by which he identifies it for his own records. This number may conveniently be called the "shipping order number." In some concerns the customer's order is taken directly to the storeroom and there filled, if possible. Other manufacturers make it a practice to transcribe the order to a regular shipping order form, which has the advantage of uniformity in size, and can be more easily understood by store-room and shipping clerks. This form will have the same shipping order number as is given to the customer's order. If the order (which we will hereafter call the "shipping order") can be filled from stock on hand, the material is immediately boxed and sent to the customer, and the shipping order is filed away after all necessary records are made. But suppose for some

SHORTAGE OF:

ON WORKING ORDER NUMBER:

SHIPPING ORDER NUMBER	NUMBER OF PIECES	SHIPPING ORDER NUMBER	NUMBER OF PIECES	SHIPPING ORDER NUMBER	NUMBER OF PIECES

Machinery, N.Y.

Fig. 2. Card on which Pieces not in Stock, but which are required to fill Orders, are recorded.

particular reason the stock necessary to fill the order is not in the store-room, but is in the process of manufacture somewhere in the shop. It then becomes necessary to place the shipping order in a temporary file, and wait until the material in the works is completed, before making shipments. Again, let us suppose that the customer requires something out of the ordinary, that has to be made up especially for him. Then a special working order must be issued to the shop, and the shipping order filed away temporarily until these special goods are completed. Hence it is evident that there will be in the factory two general classes of orders, namely, the orders for stock goods, and the orders for special goods.

* Address: 49 Tremont St., Hartford, Conn.

These working orders should all be numbered for reference, and when a special working order is made out for any shipping order, the working order number should be noted on the shipping order, and *vice versa*.

We now have the following papers to deal with:

1. Customer's orders.
2. Shipping orders (which may be the same as No. 1).
3. Special working orders.
4. Stock working orders.

Next let us see what printed forms and card indexes are necessary for the follow-up system.

First we must have a card index consisting of cards, as shown in Fig. 1. After the customer's order has been given

DAILY REPORT.

ON SPECIAL STOCK, AND MISCELLANEOUS ORDERS GONE FORWARD TO DAY FROM THIS DEPT

KEY FOR DEPARTMENT NOS.		SPECIAL WORKING ORDER	SENT TO DEP'T NO	STOCK WORKING ORDER	SENT TO DEP'T NO.	MISCELLANEOUS ORDERS	SENT TO DEP'T NO.
CUTTING OFF DEP'T.	1						
PLANING DEP'T.	2						
TURNING DEP'T.	3						
SCREW MACH. DEP'T	4						
MILLING DEP'T.	5						
THREADING DEP'T.	6						
BORING & DRILLING DEP'T.	7						
HARDENING DEP'T.	8						
GRINDING DEP'T.	9						
ASSEMBLING DEP'T.	10						
INSPECTION DEP'T.	11						
STORE ROOM	12						

FOREMAN.

Machinery,N.Y.

Fig. 3. Foreman's Daily Report Card.

a shipping order number, or transcribed to a shipping order form, a record should be entered on this card. At the top of the card is the customer's name and address, and the cards are filed alphabetically, according to the name of the customer. In the first column is entered the customer's order number, in the second column, the shipping order number, and in the third column may be entered, if desired, a short description of the goods. When complete shipment is made, the date of such shipment should be stamped in the last column.

The next card index required is a "shortage list." This is complied from a shortage sheet of any convenient form, made out by the store-room clerk. The cards may be printed as shown in Fig. 2. When any stock article is required to fill a shipping order, and this article is not in stock, the store-room clerk makes out a slip or list showing what is needed and for what shipping orders. These data are then classified and entered on the cards, so that upon receipt of the stock, the number of pieces required for various shipping orders may be correctly distributed. It is well to place on the card the shop working order number on which the stock is being made, in order to readily locate the goods in the shop.

A daily report sheet is necessary, as shown in Fig. 3. These should be made up in pads, and every department supplied. Each day the foreman or his clerk enters in their proper columns the working order numbers which he sends away, and the number of the department to which he sends them. These reports should be dated and turned in every night to the head of the follow-up system. From them the "follow-up man" enters a report on his tracer cards. (See Fig. 4.)

These cards are filed numerically according to the working order numbers, and may be used either for special or stock orders. Of course, in the case of stock orders the customer is "Stock," and there is no shipping order number. These tracer cards are made out from the working orders before they go out into the shop. If kept up to date, it is possible to tell at a glance where any particular working order is located, and on what date it went to the department where it then is.

We are now in a position to assume a case and see the working of the system in detail.

1. A customer sends in an order, duly numbered, for some stock article. This order is first examined to see if everything is clear, and is then given a shipping order number. If customary, a regular shipping order form is made out. The order should then be entered on the proper card in the customer's card index, Fig. 1. The customer's order number is placed in the first column, and the shipping order number in the second column, as explained before. If a regular shipping order form has been made out, the customer's original order may be filed away, otherwise it must go to the store-room to be filled. We will suppose the goods ordered are on hand and that the shipment occurs immediately. The following day all shipments are stamped on the customer's cards in the last column opposite the proper number. Now, as often happens, the customer sends in his inquiry directly after his order. This inquiry comes to the "follow-up man," and he turns to the correct customer's card and sees that shipment was made on such and such a date.

2. Now let us suppose an order was received for some special goods. The entries are made exactly as before, but shipment cannot, of conrse, be made directly. A working order is now issued for the goods wanted, and its number is noted on the shipping order, and this latter is filed away temporarily according to its number. Now comes the inquiry. The "follow-up man" turns to his customer's card and sees that shipment has not been made. He then notes the shipping order number on the inquiry, and gets this shipping order from its temporary file. Then he can readily see that the goods are special, and are in the process of manufacture. By means of the working order number he can locate the tracer card for that particular order, and this tracer card has a complete record to date of the order in question, and shows in which department it is. It is now necessary for him to make out a card as shown in Fig. 5. In the column headed "last reported" he enters the latest report as shown by his tracer card. The working order number, shipping order number, customer's name, and a short description of the goods are also entered in the spaces provided. This "estimate card" may then be clamped to the order and inquiry, and when the "follow-up man" is ready, he takes these inquiries and looks up the work in the department in which it was last reported. From the foreman of that department he obtains a promise as to when his work on the goods will be done. He must enter the date of this promise on his estimate card in one of the "promised" columns opposite the name of the department making the promise. This promise should also be recorded by the foreman in a book suitably indexed for the purpose of enabling the foreman to lay out his work in such a manner as to be best able to keep or anticipate his promises. When he has obtained all the promises desired, the "follow-up man" may return to his desk and enter in his "estimate" column the dates on which he estimates the work should leave the various departments through which it has yet to go. From the estimated date of delivery of the goods to the store-room he makes a promise which he enters on his estimate card, on the customer's inquiry, and also on the tracer card for that particular order number.

ORDER TRACER

DATE:

CUSTOMER:

WORKING ORDER NO.:

SHIPPING ORDER NO.:

DESCRIPTION:

PROMISED:

DEPARTMENT		DATE
ORDER DEL'D		
CUTTING OFF DEP'T.	1	
PLANING DEP'T.	2	
TURNING DEP'T	3	
SCREW MACH. DEP'T.	4	
MILLING DEP'T.	5	
THREADING DEP'T	6	
BORING & DRILLING DEP'T	7	
HARDENING DEP'T	8	
GRINDING DEP'T	9	
ASSEMBLING DEP'T	10	
INSPECTION DEP'T	11	
STORE ROOM	12	

Machinery,N.Y.

Fig. 4. Tracer Card which gives the Location of any Particular Order.

The "estimate card" is now filed in a specially prepared index as shown in Fig. 6. It is filed under the date promised and under the sub-division of the department making the promise. Each day the cards filed under that date are taken out, and the "follow-up man" goes from department to depart-

ment, ascertaining if promises have been kept, and if so, getting a new promise from the next department. This will prevent an inquiry from ever being forgotten, and it is easy to see whether a promise to the customer will be lived up to or not.

3. Last of all we have the case where the customer orders regular goods, but these are not in stock at present. After the usual preliminaries, the store-room clerk makes out his shortage list, which is afterwards transferred to the shortage card file, the shipping order being placed in the first column, and the number of pieces wanted in the second column. The inquiry now comes in and goes, as usual, to the "follow-up man." As before noted, he obtains the correct shipping order

ESTIMATE CARD

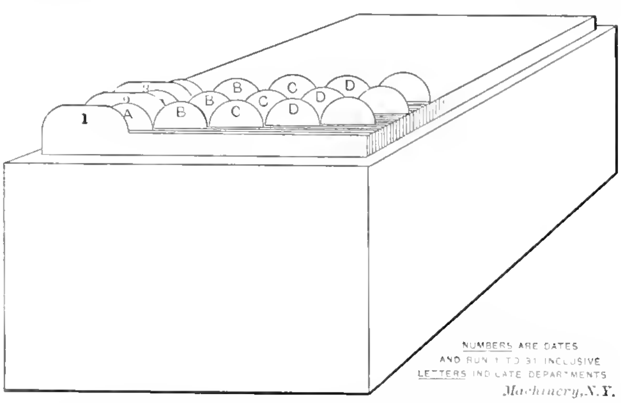
PROMISED:	DEPARTMENT	ESTIMATE	LAST R. P. D.	LOOK UP	PROMISED 1	2	3
WORKING ORDER NO.	CUTTING OFF DEP'T						
SHIPPING ORDER NO.	PLANING DEP'T						
REMARKS:	TURNING DEP'T						
CUSTOMER.	SCREW MACH DEP'T.						
	MILLING DEP'T						
DESCRIPTION.	THREADING DEP'T.						
	BORING & DRILLING DEP'T						
	HARDENING DEP'T						
	GRINDING DEP'T						
	ASSEMBLING DEP'T.						
	INSPECTION DEP'T.						
	DEL. TO STORE ROOM						

Machinery, N.Y.

Fig. 5. Estimate Card which enables an Approximate Date of Shipment to be given.

by means of his customer's cards and then notes what stock is needed to complete the order. Next he looks to his shortage list, where he finds the particular shortage in question duly entered, together with the working order number on which the stock goods are being produced. He will then make out his estimate card and treat this stock order just the same as a special order. A promise once made on a stock order will answer for all inquiries for these particular goods. In other words, there is a record of the probable time of completion of certain stock goods, and these goods are being systematically hurried through the shop by means of the estimate card, which comes up automatically at the time the goods should leave any department.

It has been found that a typewritten list of all stock orders needed to complete shipping orders is a most valuable detail, and should be distributed to the various departments, as it will enable the foremen to direct their work in the proper



Machinery, N.Y.

Fig 6 Estimate Cards filed under promised Date of Shipment, and under Sub-division of Department doing the Work.

channels, and get the goods well under way before an inquiry is received. This list can be made out at regular intervals, say once a week. Another helpful little adjunct will be found in a small paster of any form or wording desired, which should be attached to all orders that are being followed. This paster may simply have the word "Rush" or "Promised" printed upon it in large type. It will facilitate the progress of the work, and give no excuse for its being laid aside because it was not thought to be urgently needed.

Another paster having the word "Shortage" printed upon it can be supplied to the various foremen to paste to any orders in their department which are not being followed, but which, according to the weekly shortage list, are needed to complete shipping orders. Some form of paster is also desirable to attach to the customer's inquiry, on which to enter the shipping order number and the promise. In the accompanying engraving all cards are shown half size.

With these few forms it is easy to answer inquiries in shops receiving fifty to a hundred orders daily. Where fewer orders are received, the number of forms can be cut down slightly. The system is capable of infinite expansion for very large shops.

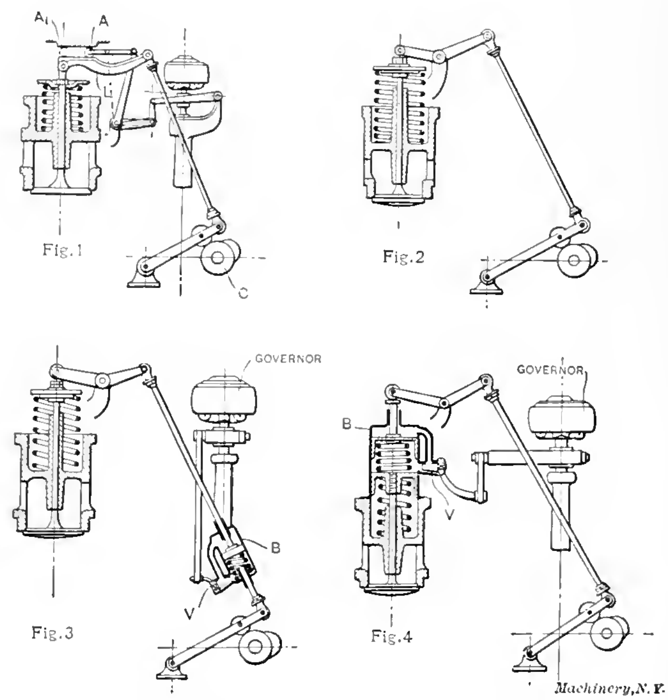
To any manager whose mail contains complaints which are annoying, a remedy such as above suggested will not only give him immediate rest from the annoyance, but tend to increase his business.

* * *

A PRACTICAL PROBLEM FOR ENGINE DESIGNERS.

We take a great interest in your valuable journal, and as we have noted that you encourage your readers to send problems which they want solved, we wish to propose the following for general consideration.

The problem is to design a new method of controlling the movement of poppet valve reciprocating steam engines. Fig. 2 shows the ordinary plain construction of poppet valve, operated by a cam on a longitudinal lay shaft. This valve has a fixed movement, always opening to its maximum extent. Fig.



Machinery, N.Y.

1 illustrates a method for obtaining a variable movement, the variation extending from the maximum to zero, and the operation being controlled by the governor. The construction is quite plain. The little roller *A*, whose position is controlled by the governor through suitable linkage, acts as a pivot on which the lever *L* rocks. When the engine is running slow, the position of the roller *A* is as indicated in the full lines. When the engine is running above full speed, the position of the roller is as indicated at A_1, the result being that the poppet valve is not opened at all by the action of the cam *C*.

In Fig. 3 is shown the "extensible bar" method, the construction being that of a cylinder and piston in the valve connecting-rod with suitable by-pass valve *V* controlled by the governor. The piston is under pressure of a coiled spring and both sides of the cylinder are filled with oil. Fig. 4 shows a variation of the same construction.

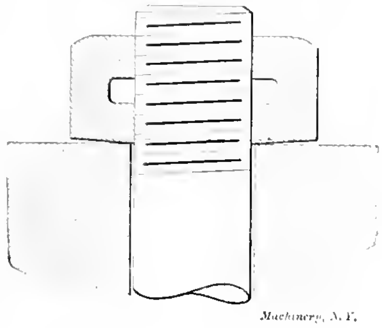
Now, who can get up a different construction which will give variable opening of the valves with delicate governor control?

Societe Anonyme des Moteurs a Gaz A Bollinckx.
Huyssinghen, Belgium.

ITEMS OF MECHANICAL INTEREST.

SIMPLE FORM OF LOCK NUT.

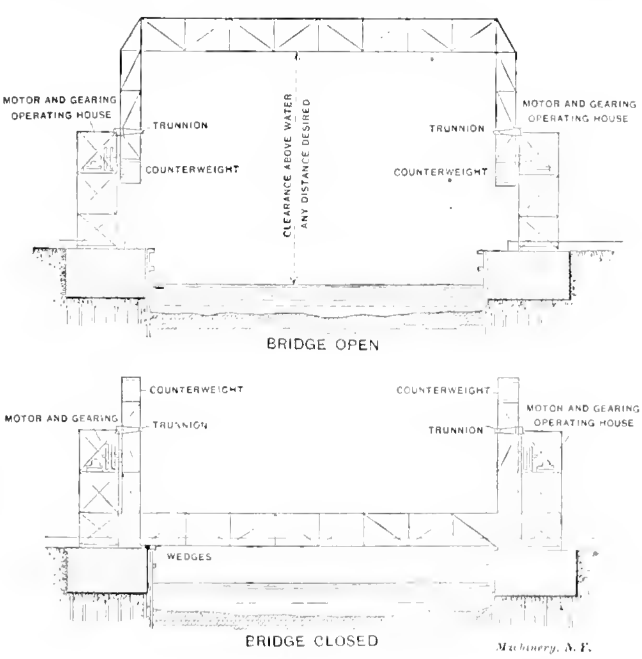
A new form of lock nut, interesting chiefly on account of its simplicity, was illustrated in the February 7 issue of the *Practical Engineer*, and is shown in the accompanying engraving. This construction of lock nut has recently been proposed by some English inventors, Messrs. R. R. Wellbury, T. Harle and G. Mackie. Most of the lock nuts patented from time to time, though fulfilling their purpose successfully, have been expensive to manufacture, and have been accompanied by difficulties in fitting. The nut shown here is free from these objections. The lower face of the nut is faced slightly conical, as shown, and an annular groove is formed inside the threaded hole, allowing a certain amount of elasticity between the upper and lower portions of the nut. When used, the inside area of the lower conical face is the first part to come in contact with the work, and, owing to the elasticity allowed by the annular groove, further tightening forces the lower threads of the nut into close frictional contact with the threads in the bolt, thereby preventing any slackening back or shaking loose of the nut. It is stated that a number of these nuts have been applied to high speed steam engines, traction engines, motor cars, etc., and have proved very satisfactory.



Inexpensive and Simple Form of Lock Nut.

AN INTERESTING DRAW-BRIDGE.

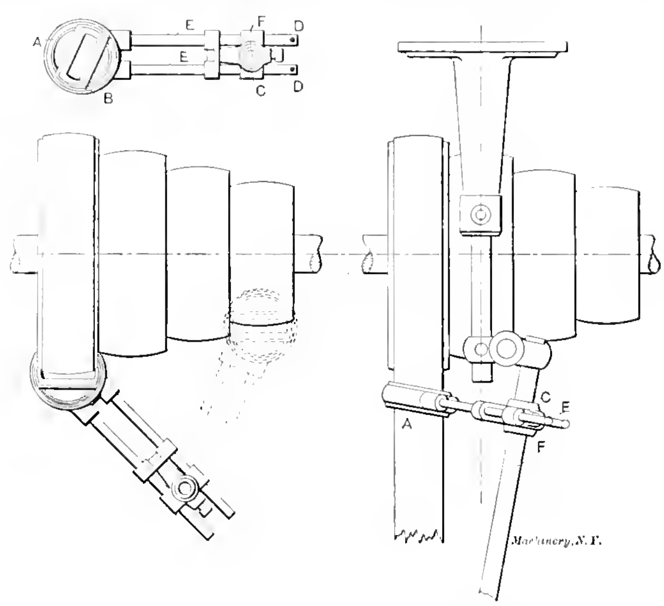
A draw-bridge of novel type has recently been designed by Mr. Eric Swensson, of Minneapolis, Minn., with the intention of applying the design to a bridge across the "Narrows" on Lake Minnetonka. The principle of the construction is shown in the accompanying engraving, taken from the *Engineering News*. The construction is so peculiar that a brief description may be of interest. The bridge consists of a truss or plate girder span, suspended by trussed hangers from trunnions bearing on towers at each abutment. The draw is opened by revolving the truss in an arc around the horizontal longitudial axis through the center of the trunnions, as is clearly indicated in the engraving. The upper portion of the trussed hangers carries counterweights equal in weight to the suspended structure, so that the friction and the wind pressure are the only forces which the machinery has to overcome in opening the bridge. When the bridge is in its normal condition wedges are placed under the extreme ends, so that the weight is carried directly by the abutments, and not by the trunnions.



A Draw-bridge of Unique Design.

GERMAN TYPE OF BELT SHIFTER.

An interesting, and for its purpose, well adapted belt shifter, which has been in use in Germany for some time past, is shown in the accompanying engraving. This belt shifter is made by the Berlin-Anhaltische Maschinenbau-A.-G., Berlin, and is known by the trade name "Bamag." As shown in Fig. 1 this belt shifter consists of a casting *A*, into which the belt guide *B* is fitted so that it can turn freely in the hole in *A*, in order to adapt itself to the belt in the various positions of the shifter. Into the casting *A* are inserted two rods or shafts *E* of such a length as to accommodate the required motion of the belt guide *B*, in relation to the holder *C*, in which the two rods *E* have a sliding fit. The small stop pins *D* prevent the shafts *E* from entirely sliding out of the holder *C* when the device is in operation. Through the hole *F* in the holder *C* the shifting rod, which is made of cold rolled stock, is passed, and the shifting is accomplished by turning this rod, a pin or handle being attached to it at the lower end for this purpose. When the shifter is applied to cone



Figs. 1, 2 and 3. German Type of Belt Shifter.

pulleys, the belt guide *B*, containing the belt within it, will adapt itself to such a position that the belt will run freely, the adjustment of the part *A* containing *B* being accomplished by the sliding action of the studs *E* in the body *C*.

The engraving, Fig. 2, shows a plan view of a case where the belt shifter is applied to a cone pulley. Fig. 3 shows the connection of the belt shifter with a bracket on the ceiling and shows the general arrangement of the device. The connection with the ceiling bracket support is a universal joint, permitting perfect freedom to the motion of the shifter rod and shifter. It is difficult to judge from the engravings to what extent this shifter is practical, but we understand that as many as 14,000 are in use on the European continent, and the Krupp works alone use over 600. This would indicate that the device has proved to be thoroughly practical. The Brown & Sharpe Co. employs in its shops a belt shifter working on a similar principle, although even somewhat simpler; this shifter gives entire satisfaction.

* * *

In the construction of a battleship, the exact weight of every part, and of every accessory, from a doily on the captain's table to the heaviest piece of armament or mechanism, is ascertained and recorded, thus making it possible to determine the weight of the ship at any stage of the construction. The importance of weighing everything will be appreciated the more when it is known that the weight of the paint alone, used on the battleship *Connecticut*, amounted to 210 tons.

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MACHINERY

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DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JUNE, 1908.

PAID CIRCULATION FOR MAY, 1908, 22,426 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

HUNTING FOR WORK.

During the present depression thousands of men, skilled and unskilled, are engaged in the almost hopeless task of looking for work. They spend money and energy in about the most discouraging task a human being can engage in. Rebuffed at every turn, there is great danger of a man's moral fiber being so deteriorated that his former good habits are lost. Such periods make tramps and hoboes, and a skilled man should be very careful how he starts out in an aimless search for employment. It is hard, of course, to sit quietly at home when want is staring you in the face, but what is the use of making a bad matter worse? The cheapest and generally the most profitable way for a skilled man to find out where employment is to be had is to write letters to all the concerns within a radius of, say, one hundred or two hundred miles, stating his experience and asking for employment. When no work is to be had, such letters, of course, cannot bring employment, but they will most likely be placed on file and referred to when openings do develop. A personal interview is always preferable, but when "nothing is doing," superintendents will not entertain applicants, or even go to the trouble of taking their names. The letter puts on file the very data that may give you a job long before the other fellow, who depends on a personal canvass, gets one. It is better, nine times out of ten, to stay at home and help the wife clean house, tend the baby and do the cooking. You will have time also to study mechanical drawing and other matters connected with your trade, knowledge of which may advance you rapidly when good times come.

* * *

BUILDING SHOPS FOR GROWTH.

It is a matter of first importance in building a machine shop to arrange for future growth. We recently visited an old shop which had grown to considerable size by repeated addition made in piece-meal fashion, the result being a shop having no system of arrangement, and which is poorly lighted and badly arranged for the manufacture of its product. It was impossible to provide adequate overhead appliances for handling the work, and in consequence this shop, although well located in many respects, cannot compete advantageously with other shops having modern equipment, so that it has become necessary to put up a new structure having cranes and handling appliances. It is, of course, needless to say that the new shop will be constructed with an eye toward possible extension which can be added in harmony with the original plan.

The saw-tooth roof shop is admirable in this respect, it being possible to add to it indefinitely in harmony with the original unit, and still have a shop that is well lighted in all parts. A monitor roof shop with saw-tooth roof wings can be extended indefinitely, also, and the combination is well adapted to both heavy and light constructions. The monitor roof shelters the heavy traveling crane and heavy erection, while the saw-tooth wings shelter the machines and small erection floors, these latter being provided, desirably, with light hand traveling cranes.

* * *

FOREIGN MACHINE TOOL COMPETITION.

With apparent good reason, many of our American machine tool builders have felt that foreign trade was largely a matter of the past. Europe has an army of educated engineers—men who rank higher in technical attainments and training than the same class here. They have highly developed powers of analysis and are quick to grasp the fundamentals of a given proposition. They excel in the metallurgical arts and are most thorough in general application. Europe's manufacturers are long-established, and the inherited skill of many generations of workmen is at command for moderate wages. With all these resources available in a country where trade is keenly sought, it would seem that the machine tool business must go back into the hands of the native builders.

There is another theory, however, that gives us a crumb of comfort, and it is one that is quite important to consider. It means much to all American manufactures, for, if sound, it may result in giving us the markets of the world. Whether it was developed by a high tariff man we know not, but it does have a measure of plausibility.

The theory is that the machine tool builders of England and Germany cannot develop into strong competitors of the United States for the simple reason that *they have a restricted market*. The rampant militarism in Europe and the trade jealousies fostered thereby, discourage Germans from buying English tools, and *vice versa*. The same holds good with the other European countries all along the line. The colonial trade of none of these countries will call for a large number of machine tools for years to come. Without a large market the machine tool builder cannot specialize, and if he cannot do this he cannot compete with us. The majority of the foreign machine tool builders are "engineers"—that is, they build anything under the sun that will make a penny of profit. If this condition must continue because of the reason we have given, we have a hold on foreign business that cannot be shaken off until military domination is done away with.

However, the influence of militarism and political prejudice is waning, and we are inclined to take the view of Winston Churchill, who started in life as a Tory, but who is now the leader of the younger democratic group in the Liberal party of England. He believes that economic and not political policies will dominate in the future. "The world has become acutely conscious of the fact that political freedom, however precious, is utterly incomplete without a measure, at least, of social economic independence. All over the world the lines of cleavage are ceasing to be purely political, and are becoming social and economic." In trade intercourse, political prejudices will be cast aside, more and more, and the progressive German manufacturer will have no more hesitation in buying machines from English or French makers, which will be money-makers for him, than from his own countrymen. Political prejudice is fostered by ignorance, and the spread of intelligence by the telegraph, telephone, the daily newspaper, the trade journal and the commercial traveler is doing much to prevent war, the bitter feelings engendered by war, and the political prejudices that hinder international trade.

SPECIALIZATION.

The tendency toward specialization in practically all branches of manufacturing develops some curious anomalies, or perhaps we should say some apparently curious anomalies. These, in most cases, are largely imaginary because of the feeling still remaining with most of us that a machine manufacturer constructs his product from the raw materials, that is, from the metals as they are received from the rolling mill, the blast furnace and the smelter. There is no good reason for such opinion, in the first place. Even if there were, a sound definition of "raw material" being impossible, it becomes very difficult to say what work a so-called builder should actually perform to have proper credit for actually manufacturing his product.

Take, for example, the manufacture of sewing machines. It is the most highly organized business in existence, yet we understand that very few sewing machine manufacturers make their own bobbins, practically all the bobbins used in the United States being made by one Chicago concern. Needles and shuttles are made by specialists cheaper, it is claimed, than they can be produced by large manufacturers, because of the ability of an individual to concentrate his powers of organization and inventiveness upon a single subject without interference. In large manufacturing plants it has been found that the development of special machinery is not desirable, and many of our best-known concerns contract with the small concerns for the invention and development of certain special machinery. They have found it more satisfactory both in the efficiency of the machines produced and the cost. This fact betrays a weakness in the organization of large concerns which perhaps means that the small concern will always enjoy certain advantages over powerful corporations.

* * *

WAGES AND THE TARIFF.

It has been often pointed out, although not quite as often, perhaps, as it should have been, that while wages in America are *absolutely* higher than in Europe, they are *relatively* lower in this country, if the amount of product turned out per capita is taken as the basis of comparison. In itself this may be considered as of small consequence; but it is highly significant and of interest to note in connection with the claims made by the defenders of our protective tariff, that it would be difficult, if not impossible, for our manufacturers to compete with European labor if this were a free market, because the wages paid to American labor are higher than those paid in Europe. This argument is fallacious, because for the same amount of product there is less paid in wages in the United States than in Europe. Mr. Clark, in the *Engineering Magazine*, issue of May, 1904, pointed out that while 21.4 per cent of the value of the product went to pay labor and the cost of power in the principal industrial countries in Europe, only 17.4 per cent of the value of the product was used for these purposes in the United States. Power, he says, can be considered as being of the same cost on both continents; consequently, the wages, in proportion to the product turned out, are lower in the United States.

Another indication of the truth of this statement is given by the returns on the coal trade given out by the British Board of Trade. It is shown that the output per person employed in the coal mining industry of the United States, is 560 tons, while in the United Kingdom, the output per person employed is only 280 tons; in Germany, the output is 242 tons; in France, 202 tons, and in Belgium, 159 tons. Now, even if the wages of coal miners in the United States were double the wages paid in Europe, it would follow that the wages as compared with the output, would be the same in the United States and in England; that for Germany the wages would be relatively much higher than in the United States; and in Belgium, in fact, 1.75 times as high. Of course, it is admitted that the coal mining industry presents a case where the difference is greater than in many other industries, but the general tendency is the same in all trades.

The American ability of systematizing and of cutting out useless expense, and the existence of a more contented and intelligent class of workers, has made it possible to produce more per person employed; but it should be distinctly understood that the wages in proportion to the product are lower, and that, therefore, there can be no reasonable fear whatever, that, even with a reduction in the tariff, the lower per capita wages of Europe would be able to force an unprofitable competition on American manufacturers.

* * *

MATHEMATICS AND PRACTICAL EXPERIENCE.

An Eastern machine tool builder, who is a broad-minded and competent mechanical engineer as well, (by no means an unusual combination) remarked the other day that it was the regret of his life that he had graduated as a young man from the technical school which was his *alma mater*, instead of from another whose name he gave, and concerning whose work he was well informed and enthusiastic. In the school he attended, the first importance was, and still is, given to mathematical analysis, the faculty believing that a thorough knowledge of this is the prime requirement for a successful engineering career. As an instance of the kind of instruction given, he mentioned the fact that his text-book on the steam engine was written by a chaplain to Queen Victoria, an estimable clergyman of great mathematical ability, who had analyzed the steam engine problem mathematically, and been rewarded for his labors by the honorary appointment mentioned. He covered the ground of steam engine design quite thoroughly for the time in which he lived, producing what is, perhaps, the most formidable array of formulas on the subject that has ever been assembled. These formulas include an appropriate supply of constants, whose values are not given, as those values can be derived only from experiment and practical experience. The necessity for saying anything about the values of these constants apparently did not enter into the head of the reverend engineer, as he probably believed that the task of instructing students was completed when the analysis and its resulting formulas had been followed and understood.

In contrast with this pedagogical idea, the second school which our acquaintance mentioned so appreciatively, lays special stress on the necessity for bringing analysis and practice into intimate relation with each other. A large share of its laboratory work consists in the commercial testing of various apparatus within its field. Its professors are largely engaged in consulting work, and its president is the head of a famous firm of engineers, and only gives half of his time to the school. Under such conditions as these, the student learns that mathematical analysis is of the greatest importance, but that its importance is the importance of a tool, useful in applying results of past experience and experiment to future design, and in suggesting methods and lines of experimental research into new fields of practice. From a standpoint like this, it will be seen that the chaplain-engineer's neglected constants assume an importance which he did not realize, and his fine spun analysis is left hanging in mid-air, as it were, without any point of contact with the solid ground of practical work.

It was probably due, in part at least, to such an implicit reliance on analysis as would be fostered by prolonged study of the chaplain's text-book, that the engineers responsible for the design of the Quebec bridge disregarded the repeated assertions of the untrained "practical" men in charge of the erection, that the great bridge was unsafe. So confident were they in their knowledge of mechanics and mathematics, that they failed to realize that the signals of distress displayed in the structure had an importance far overshadowing the results of their theoretical conclusions. The *Engineering News* has rightly remarked that perhaps the most profound lesson to be drawn from the Quebec disaster is the lesson of humility for the technically trained engineer. Not humility in the sense that he should think less of his technical training, but that he should think more of the importance of the practical behavior of the materials, structures and mechanisms with which he has to deal.

* * *

The man in charge who is missed when temporarily absent is a bad organizer.—*D. T. Taylor.*

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

In the May issue of MACHINERY we stated that helium had been solidified by a Dutch scientist, Professor Onnes. It seems, however, that Prof. Onnes had made a mistake in stating that he had succeeded in solidifying helium. He has now given out a statement to the effect that his helium contained a slight amount of hydrogen, and that this accounted for the solidification.

The Schlick gyroscope for preventing the rolling of ships at sea has been applied to a small steamer *Silvania* of the Hamburg-American line. The displacement of this vessel is 900 tons. The fly-wheel of the gyroscope is 65 inches in diameter, and will run at a rate of 1,800 revolutions per minute. The results will be watched with considerable interest by marine engineers as well as by mechanical engineers in general.

The tower of the Metropolitan Life Insurance Co.'s building, which is now in the process of construction at Madison Square, New York City, and which is to be the highest structure in the world outside of the Eiffel tower in Paris, is to have another 37 feet added to its original height, bringing the extreme top 693 feet above the sidewalk level. The new design provides for an observation balcony 662 feet above the sidewalk, and including two stories in the basement, the total number of stories will now number 50.

The horse-drawn vehicle is, says the *Horseless Age*, slowly but surely being displaced by the motor car for public transportation in all large cities. In London there were on January 1, 1907, 783 motor omnibuses and 2,964 horse omnibuses, while on January 1, 1908, the number of motor omnibuses had risen to 1,205, and the number of horse omnibuses had decreased to 2,557. The number of motor cabs had increased during the same period from 96 to 723, while the number of horse cabs had decreased from 10,492 to 9,818. There are, at the present time, 1,700 motor trucks in use in London.

An English inventor, Mr. Chas. J. Grist, London, has, according to the *Iron Age*, patented a method of hardening steel or steel alloys. By this process the steel to be treated is heated in a vessel containing mercury heated to a temperature varying for different steels from about 400 to 840 degrees F., and then an electric current is applied at from 200 to 500 volts and 25 amperes. Carbon steel twist drills treated in this manner perform nearly double the amount of work done by drills hardened in the ordinary manner. Inasmuch as mercury vaporizes at 675 degrees F., a temperature of 840 degrees would, however, not be attainable.

According to the *Berliner Lokal Anzeiger*, a course in automobile engineering will be instituted at the technical institute at Berlin. It has been decided to extend the instructions concerning automobile engineering to all its branches, and to render it practical by increasing the laboratory equipment. The cost of machines and testing equipment necessary is estimated at about $60,000, and many expensive machines will be loaned by private firms who will also bear the expense of a great portion of the experimental equipment. The department will be conducted by a professor having a staff of two assistants, two mechanics and a chauffeur.

The best record in high-speed drilling that we know of is that made lately by Baker Bros., Toledo, Ohio, on a special drill press, using a Novo twist drill 1¼ inch diameter. Holes were drilled through cast iron blocks 4¼ inches thick in 8 2/5 seconds, or at the rate of about 29 inches per minute. The drill ran at 450 revolutions per minute with a feed of 1/15 inch per revolution. A peculiarity of this rapid drilling is that the drill is not as hot when it has passed through the block with a feed of 1/15 inch per revolution as when it is run with a finer feed. Allowing that steel plate could be drilled at only one-half this rate, it is of interest to note that even then drilling would be faster than punching 7/16-inch plate on a punching machine running at the rate of 30 strokes per minute!

The highest efficiency as regards steam consumption that has as yet been obtained in any steam engine, has, according to *Industritidningen Norden*, been attained in an engine built by the J. & C. G. Bolinder's Works, of Stockholm, Sweden. This engine is of 1,000 H.P., and at official tests the steam consumption per indicated H.P. hour was only 8.58 pounds. Another remarkable feat in the design of steam engines has been attained with a 100-horse-power superheating portable engine built by R. Wolf, of Magdeburg-Buckau, Germany, which during a 7 hours official trial showed a steam consumption of 8.66 pounds per horse-power-hour, and a coal consumption of only 1.04 pound per horse-power-hour. The lowest steam consumption previously attained with any steam engine is, as far as known, 8.89 pounds, which was attained some years ago by an engine built by a Belgian firm.

In our September, 1907, issue, engineering edition, we mentioned the favorable results obtained with motor-driven fire engines in Hanover, Germany. The city of Berlin also, about two years ago, appropriated $12,000 for the purpose of carrying on experiments to determine the most suitable motive power for fire-fighting apparatus in that city, and the results obtained from these experiments indicate that a great saving can be accomplished by the use of steam and electric automobile fire engines. Gasoline engines are not recommended on account of not being considered absolutely reliable, and also because the danger of gasoline was considered objectionable. In consequence of the favorable results obtained, the Berlin city council has made an appropriation of $32,000 for the acquisition of a complete motor fire engine outfit, consisting of a chemical extinguisher, a tender, a hook and ladder, and a steam fire engine.

A circular from the United States Department of Agriculture calls attention to the significant signs of the awakening of the American people to the dangerous destruction of the forest wealth, and the necessity of a wise use of what remains of it. The question of the limitation of our supply of woods is one that is of great importance to all industries, inasmuch as this material is used in a greater or less degree in all our industrial activities. The circular calls attention to the fact that information on the subject of preserving timber from decay will be furnished to all who make request of the Forester Service of the Department of Agriculture, Washington. The fact is pointed out that it is not only possible to utilize the forests without waste, but also to prolong the service of the wood used so as to thereby decrease the consumption. The life of the wood can be considerably lengthened by the use of certain preserving methods which the department has been investigating.

The saw-tooth roof shop is a very satisfactory construction for the small manufacturer who must "pay as he goes." It is so readily enlarged in harmony with the original lay-out and so cheap in first cost that it is likely to become a very common type of machine shop architecture. The feature of uniform lighting, there being no glare or dark shadows anywhere, is in itself enough to commend it above most other types. Of course, where land is very costly the saw-tooth roof shop must give place to the factory type, having several floors superimposed. A fault of the saw-tooth roof is the difficulty of making the gutters proof against leaking. Hard rainstorms, especially when driving from the north, have caused much trouble with certain concerns, especially if the north saw-tooth windows were glazed with small panes set in the sash with ordinary putty. The remedy is to use large panes of ribbed glass without sash, the glass being set in the frame-

work of the shop, thus avoiding joints other than between the glass and the wood. The Kearney & Trecker shop in Milwaukee is built on this plan, the glass being placed in the openings without sash and set with good white lead putty.

INDICATOR FOR ASCERTAINING HARDENING TEMPERATURE.

An indicator for ascertaining the temperature of steel to be hardened has, according to *Page's Weekly*, recently come into use in Great Britain. This instrument depends on the fact that at the recalescence temperature at which carbon steel should be hardened, it becomes non-magnetic. With the aid of this indicator any kind of carbon steel, but not high speed or alloy steels, may be hardened at much lower temperatures than is commonly done when the temperature is gaged by the eye alone. The gage consists of a permanent magnet held in the hand, the poles of the magnet being prolonged by rods of special metal which remains magnetic at temperatures higher than the hardening temperature of carbon steel. If the pieces of work to be hardened are small, they are held by the magnet itself in the flame for heating the work. They will be attracted and held by the gage until they reach the hardening temperature, and at that time they are promptly quenched. This gage is said to be very accurate, so accurate in fact, that unless the steel is instantly transferred to the quenching bath when heated to the point where it loses its magnetic qualities, the loss of heat during the interval will prevent the piece of work from being fully hardened. It is also stated that it would not be difficult, when using this gage, to harden even the most intricate shapes in ordinary brine. The combined hardness and toughness secured by hardening in this manner is such that many cutting tools—in particular milling cutters—may advantageously be used without subsequent tempering. These gages are manufactured by Messrs. Taylor, Taylor & Hobson, Leicester, England, and they have used them in their tool-room for about two years, and have established a remarkable record. In all of the miscellaneous jobs that have been completed in the tool-room, not a piece has been spoiled by poor hardening, or by the very common troubles of warping and cracking.

MANUFACTURE OF SAND-LIME BRICK.

Many travelers on the New York Central lines between Buffalo and Chicago have noticed the immense sand-hills in northern Indiana, especially near Michigan City. These great moving masses, resembling the waves of the sea and typical of the great elementary force of nature, are almost irresistible in their destructive power. The engineering powers of man can not cope with the march of the drifting sand except as they are directed toward the growing vegetation. The birth of the desert can be directly attributed to the destruction of forests on a sandy tract, and one shudders to think of what the fate of large areas of the United States will be if the destruction of forests now going on is not checked. But this is not what we started to say. The moving sand has been made useful in the manufacture of brick, and brick-yards are so located in certain favored localities that the sand is blown up to them as fast as it is wanted. The transportation of this part of the raw material to the works is done by the wind without cost or effort on the part of the brick maker!

The manufacture of sandstone brick or lime brick is a German industry that has reached great commercial importance in Europe and is one that is rapidly growing in this country, there being two hundred plants that have sprung up in the past five years. A few words on the process may be of interest in this connection. The sand is ground in tube mills and is mixed with crushed lime. This mixture is moistened, pressed into bricks, and dried in large steam cylinder driers of 125 to 160 pounds per square inch, the temperature being that of saturated steam at those pressures, of course. The process is essentially the same as the natural process of forming sandstone, except that the time required is only a day or so against thousands of years by nature's method. The sand-lime bricks are made in a variety of colors, and being very strong and uniform in structure are regarded as a most desirable building material.

NEW DEPARTURE IN THE DESIGN OF HYDRAULIC PRESS CYLINDERS.

Teknisk Tidskrift, April 11, 1908.

A Russian engineer, V. Tatarinov, has designed an entirely new and interesting type of hydraulic press, as shown in the accompanying line engraving, Fig. 1. A detailed section of part of the construction is shown in Fig. 2. The fundamental principle on which the new press is designed depends on the fact that when the diameter of the cylinder is increased, the cross-sectional area increases as the square of the diameter, while the area of the cylindrical walls only increases in the

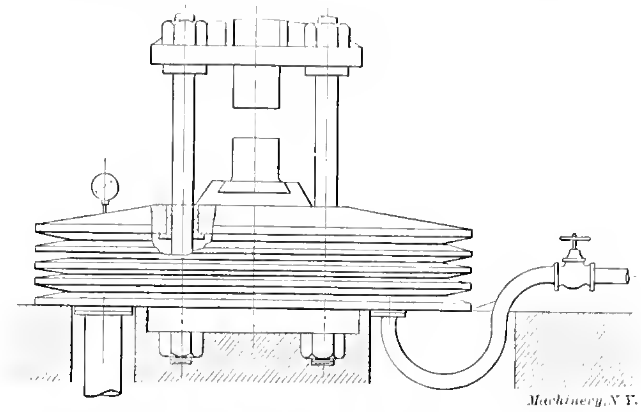

Fig. 1. General Appearance of Hydraulic Press of Novel Design.

same proportion as the diameter. Thus, for instance, if the diameter is denoted $2r$, and the height of the cylinder is supposed to be the unit of length, and the pressure assumed to be the unit of pressure, then the cross-sectional area A of the cylinder equals πr^2 and the area of the cylinder walls Y equals $2\pi r$. Tabulating the results for a few numerical values will best show the variation between the increase of the cross-section area and the area of the cylinder walls for increasing diameters.

r	$2\pi r = Y$	$\pi r^2 = A$
10	63	314
50	314	7,854
100	628	31,416

This table indicates plainly that if the diameter is made large enough, high total pressure can be attained, although the unit pressure on the cylindrical walls will be comparatively low, so that it is possible to use fairly thin walls for the hydraulic cylinders. When the ordinary hydraulic cylinder, however, is made of large diameter, the difficulty of mak-

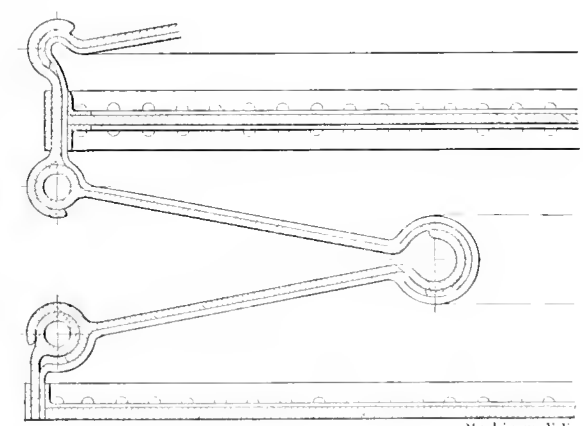

Fig. 2. Detail showing the Design of Elastic Walls in the Hydraulic Cylinder.

ing the pistons becomes very great, and it is practically impossible to make pistons that will work well, with diameters of so large a size as would be required to attain very high total pressures on the pistons without getting any considerable unit pressure on the cylindrical walls.

The next step in the mind of the inventor was therefore to find a cylinder that was so designed that it could work without pistons, the cylinder itself giving the required motions. To accomplish this the walls of the cylinder had to be made elastic in a longitudinal direction. The design of cylinders filling these requirements at first seems to be a more or less

difficult task, but the accompanying line engravings plainly indicate how the problem has been solved. The cylinder, in fact, consists of a large number of shorter cylinders, the cylindrical walls of each one of these simply consisting of plates of metal, joined together, as shown in Fig. 2. This construction permits the lengthening and shortening of the cylinder in a longitudinal direction. It is also evident from Fig. 1 that a comparatively small unit pressure in the cylinder will effect a very high total pressure at the point of action of the press, due to the large diameter of the cylinder on which the pressure acts.

In Fig. 1 the guides or supports, which hold the flexible cylinder in alignment, pass directly through the cylinder, because this permits of a less heavy construction. In a hydraulic press designed as described, it is evident that the circular form of cylinder is not as imperative as in the case of ordinary hydraulic presses, and therefore the section of the cylinder may be either circular or square.

While the present design is rather ingenious and constitutes an entirely new departure in hydraulic cylinder design, it seems that the new construction is not of very great importance, and the making of hydraulic cylinders of this type would be most likely fully as expensive, if not more so, than the making of ordinary hydraulic cylinders and pistons. Besides, the press would work rather slowly, owing to the fact that only low pressures would be used and a large volume would have to be filled with the fluid before action would take place.

FRENCH SELF-TIGHTENING AND QUICK-RELEASING DRILL CHUCK.

La Machine Moderne, February, 1908.

We show in Fig. 2 a section, and in Fig. 1 details, of an ingenious automatic chuck for drills, invented by M. Heynan. This chuck permits the insertion and removal of straight shanked drills without stopping the machine, and without the use of a key or wrench of any kind. Referring to the assembled view and the details, the gripping surfaces are a series of rollers, *A*. These rollers are each composed of three disks, formed integrally with the spindles of which

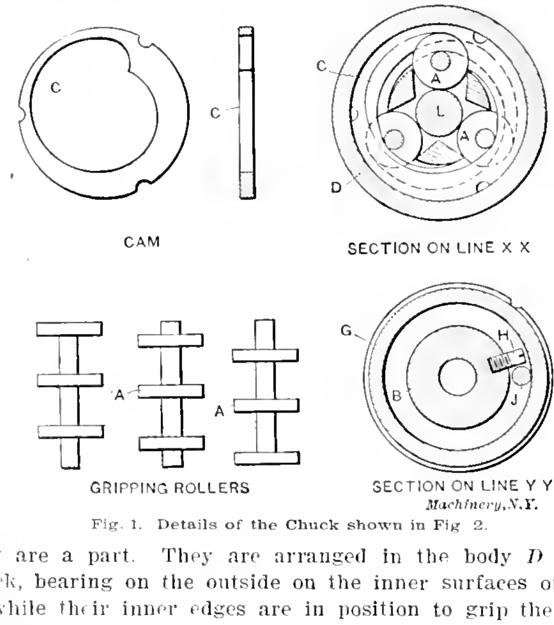

Fig. 1. Details of the Chuck shown in Fig. 2.

they are a part. They are arranged in the body *D* of the chuck, bearing on the outside on the inner surfaces of cams *C*, while their inner edges are in position to grip the work. There are nine cams in all, one in position to engage each of the three rolls of each of the three spindles. These cams *C* are keyed to a sleeve *D*, which is in turn screwed and doweled to a collar *B* on the shank *G* of the chuck. By means of the shoulders shown, parts *D* and *B* may be revolved freely on *G*. Screws *J* in *B*, and *H* in *G*, however, limit this movement. A coiled spring *F*, in the recess shown, tends to revolve *D* in a clock-wise direction. The nine cams *C* (see the upper right-hand view in Fig. 1) are keyed to *D*, so the spring tends by the action of the cam surfaces, to force rolls *A* inward. Cams *C* and rolls *A* are simply slipped into place from the bottom of the chuck, and are retained by cap *K*, which screws over the nose of sleeve *D*.

The operation of the chuck will at once be evident. As it is revolving in the direction required for right-hand drills, sleeve *D* is grasped by the hand, thus stopping its rotation until screws *J* and *H* have been brought up against each other. When this happens, the parts are in the position shown in the section on line *X X*. Centrifugal force throws the rolls *A* outward, leaving the full diameter of the chuck for the insertion of the drill. Drill *L* is then inserted and sleeve *D* released. Spring *F* revolves it in a clockwise direction, forcing rolls *A* into contact with the drill, thus holding it tightly. If the drill should slip under the pressure of the work, it will only cause rolls *A* to revolve, turning cam *C* further in the direction in which it is urged by the spring, thus holding the drill all the more tightly. Since, however, only a very slight turning moment is required to hold the drill firmly, it is easily released, even when the chuck is revolving, by simply grasping the sleeve as before, until the rolls have been loosened and screws *H* and *J* have been brought up against each other so that the parts are expanded to their fullest extent.

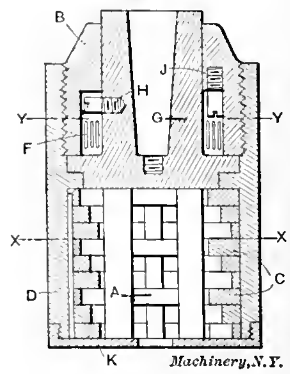

Fig. 2. A Chuck which automatically grips the Drill and automatically tightens if Slippage occurs.

ECONOMY OF HIGH SPEED PLANERS.

Times Engineering Supplement, March 18, 1908.

The first makers of planers contented themselves with giving the idle stroke a speed double that of the cutting stroke, so that, instead of 50 per cent of the time being expended in the idle stroke, as would have been the case were it speeded at the same rate as the cutting stroke, only 33 per cent of the time was so expended. In these early planers no serious amount of energy was dissipated at the time of reversing, because the rate at which the planing was done rarely exceeded 20 feet per minute for cutting and 40 feet per minute for returning. High speed steels, however, have rendered it practicable to cut at a speed of 60 feet per minute, and even if the old ratio of return to cutting speed were not exceeded, the idle stroke would be at the rate of 120 feet per minute.

The energy of a moving mass, however, increases as the square of its velocity, so that whatever dissipation of power there was in the old-time planer, having a cutting speed of 20 feet, the amount dissipated at a speed of 60 feet per minute will not be three times as much, but nine times. It is this circumstance that has made the planer a more difficult subject than the lathe to properly adapt to high speed steels. If the lathe is speeded up threefold, it takes three times as much power to drive it, and it turns out three times as much work, but the power consumed per unit of work remains the same as before. The planer, however, speeded up in the same ratio, dissipates energy at each reversal nine times as great as before, and becomes consequently seriously extravagant with power. It is interesting to note what this waste amounts to. It depends, of course, upon the number of reversals made per minute, and the masses which have to be reversed. A medium-sized planer, with table and work weighing 10 tons, consumes each time the table is stopped or started at the 60 feet per minute cutting speed, power equal to 0.3 foot-ton, and each time the table is stopped or started at 120 feet return speed, power equal to 1.2 foot-ton. This, however, does not include all the energy lost, if the table is driven by gearing revolving at high speed, which also has to be reversed. While these parts may be comparatively light, many of them run at a far higher speed, and as the energy is proportional to the square of the velocity, the power consumed in stopping, starting and reversing these parts is often twice as much as that required for reversing the table itself. If this loss is reduced by the slipping of belts or friction clutches, it is reduced at the expense of time, but if the belts are sufficiently powerful and driven by an electric motor, the

violent fluctuation in the demand made on the motor is plainly visible by the use of a suitable recording wattmeter.

Several schemes have been proposed to save this waste of power. One scheme is to use regenerative springs, which are analogous in their action to the recoil springs on a disappearing gun mounting, and these springs receive the energy of the moving parts in retarding, and restore whatever energy they receive in accelerating these parts in the reverse direction. Other schemes for solving this problem have been the use of hydraulic pressure, which stores the energy in the accumulator at the end of one stroke, where it becomes available without loss of power for imparting energy to the return stroke. Electricians have also arranged to drive planers with reversing motors, on the theory that when the currents are reversed at the reversal of the table, the motor becomes a dynamo, and aids the prime mover in mitigation of the excess of demand upon it for accelerating the motor in the reverse direction. Neither of these two last systems, however, has been carried out over as great a range of speed as the system of spring balancing. There are now a considerable number of spring balanced machines at work in Great Britain, which have return speeds as high as 180 feet, and forward speeds as low as 20 feet, or a ratio between the forward and return speed of 9 to 1. In such a case the idle time is reduced to about 10 per cent of the total time, and, if one may assume that the planing machine while cutting is 10 per cent more efficient than other machines on which the same class of work can be done, there could be no economical reason against its extended use.

It is conceded that the straight-line motion of the planer produces a truer surface than the angular motion of revolving tools, and by the use of high speed planers, there seems to be little doubt that more stock can be removed per unit of power by planing with strongly held, stationary cutting tools than with tools revolving on spindles with running fits.

HISTORY OF CRANE DESIGN.

Alton L. Smith, in the *Journal Worcester Polytechnic Institute*, January, 1903.

The lifting and transporting of great weights has from the beginning of history taxed the ingenuity of mankind. The achievements of the engineers of ancient Egypt, in moving and erecting the enormous masses of stone embodied in their colossi, obelisks, temples and pyramids, for a score of centuries, has provoked the admiration and wonder of travelers. While the methods they employed for transport may be understood from the numerous extant tomb paintings, the apparently more difficult operation of erection has never been explained. The fact that no picture of such an undertaking has been found would seem to indicate that the ancient engineers did not regard such feats as of sufficient importance for record. Plausible suggestions are that the elevation of these massive stones was effected either by the use of an inclined plane of banked earth, or by means of levers and some system of blocking.

Vitruvius, writing just before the beginning of the Christian era, describes a lifting device used by his contemporaries which is easily recognized as our sheer-legs with a primitive windlass and pulley block tackle. He also describes another device similar to our guyed derrick but without a boom. This was for lifting very heavy weights and the motive power was supplied by men walking inside a large drum or treadmill which, as it revolved, wound the rope on the windlass. An antique relief preserved in the Lateran Museum at Rome shows such a machine with an inclined guyed mast. The upper block is attached to the head of the mast and the treadmill is filled with young boys. A civil engineer, writing eighty years ago, mentions this form of motor as being recently in use and speaks of the terrible accidents which sometimes occurred when control of the load was lost. The load, descending, would cause the drum with its occupants to revolve at frightful speed.

Little is known of the details of lifting machines employed during the middle ages, but from the scanty records available it appears that the builders of this period made use of a variety of lifting jacks, sheer-legs, the derrick with swinging boom and the under-braced swing crane. The multiplication of power seems to have been obtained generally by pulley blocks rather than by gear trains.

Up to the time of the introduction of the steam engine, the principal uses of hoisting machinery were for building construction, mining, quarrying, shipbuilding, dock and warehouse purposes, naval and military engineering. The moving and mounting of heavy cannon, particularly, seems to have brought out a large number of lifting devices.

The first part of the nineteenth century teemed with industrial possibilities. During this time steam power had been applied for hoisting purposes and found to be more economical than hand power, but not until about 1850 does there appear a traveling crane actuated by steam power. This was a typical overhead traveler of 10 tons capacity with a steam engine and boiler on one end of the bridge. The various movements of lifting, traversing and traveling were accomplished by means of gearing and clutches. About this time also, Fairbairn's design of a tubular revolving dock-crane was accepted by the British Admiralty. It proved so satisfactory in service that it has persisted as a type until recent years.

While the engine-driven traveler was satisfactory for use out-of-doors and in foundries and forges, the smoke and stifling fumes from the soft coal made it unsatisfactory for other industrial works. The cost of labor, however, did not exert sufficient influence to produce a better machine until about 1861 when Ramsbottom perfected his "flying rope" system for shop cranes and applied it successfully to a traveling jib crane at the Crewe (England) Locomotive Works. In 1864 this type of drive was successfully extended to several 25-ton overhead travelers at the same works and effected an important saving.

From this date forward, power cranes began to appear with increasing frequency until twenty-five years ago they were found in great variety both as to form and motive power. Fixed cranes were operated by compressed air, steam or water pressure, while travelers were driven by high- or low-speed ropes of cotton, hemp or wire, by square shafts or by engines located on the crane itself. Capacities had also greatly increased, going as high as 30 tons for floating cranes, 50 tons for overhead travelers, 60 tons for steam jib-cranes and 70 tons for steam dock-cranes. Many of these types had reached the general form which they present to-day, changes since then having been largely due to the substitution of steel for the wood, cast iron, iron forgings and structural iron then employed. A 2½-ton wrecking crane, described by a writer in 1874 as "very powerful," throws an interesting side light on the rolling stock of that time.

The date of the advent of the first commercial electric overhead traveler is uncertain, but the first of which published record is found was in operation in a foundry at Bourges, France, about 1883. It had a capacity of 20 tons and a span of 50 feet, the power being furnished by a single motor. The various movements on these early single motor cranes were obtained by means of clutches and gearing. At the Paris Exposition of 1889 two 10-ton single-motor travelers were installed by the management, chiefly, it would seem, as objects of curiosity. There was also exhibited at this time a traveling hoist of small capacity equipped with two motors, one for lifting and the other for traveling.

Many single motor travelers were brought out in the next two or three years, but the hesitation with which they were accepted is indicated by the fact that of four 150-ton travelers put in operation at about this time in England and the United States, one was driven by an engine and boiler placed on the crab or trolley, while the other three were square-shaft driven. A three-motor electric traveling crane built at the shops of the Edward P. Allis Co., of Milwaukee, Wis., after a design by Mr. A. J. Shaw, one of their engineers, was probably the first commercial machine of this type installed in America, if not in the world. This was in 1889.

The perfecting of the series motor and its controller for street railway service soon put an end to general demand for the single-motor, square-shaft and flying-rope systems of driving. One manufacturer of electric travelers states that "within six months of the completion of our first successful crane,

inquiries for other styles of construction had practically ceased." In the square-shaft system the unavoidable use of tumbler bearings and the dependence on gravity to hold the shaft in place, did not permit a very high speed of rotation. If the capacity of the crane was large, then the driving gear had to be heavy and clumsy or else the speed for the various operations had to be slow. This method of driving has apparently become obsolete.

In the flying-rope system the troubles and expense incident to the frequent repair and replacing of the rope prevented its general adoption outside of Great Britain where conditions were more favorable to its use. While our conservative cousins buy the single-motor and flying-rope travelers to some extent, they have practically gone out of use in this country. It is recalled, however, that there is at least one manufacturer of each type here in the United States to-day.

For more than ten years the traveler employing a separate motor for each movement has demonstrated its superiority over the older types. The motor in most common use is the enclosed type direct-current series motor. The induction motor has been successfully used by German crane builders for a number of years, but while its adoption has been urged by some American engineers, it has not displaced the direct-current series motor to any extent. The latter has proved very satisfactory for crane service, and in some new installations where alternating current is employed the expense of rotary converters has been added to avoid induction motors for the cranes. If the altenating-current series motor recently introduced for railway service proves as reliable as present experience indicates, it should displace the induction motor entirely for crane work and make an alternating system just as satisfactory for crane service as is the direct current.

The maximum load capacities of power cranes have been gradually increased until at present the limits are about as follows:

	Tons.
Dock Cranes	150
Floating Cranes	150
Foundry Jib Cranes	50
Locomotive Cranes	50
Overhead Travelers	150
Wrecking Cranes	100

It is a significant fact that most of the very large cranes produced at any one period during our industrial development have been made necessary by the requirements of naval armament. Twelve-inch rifles weigh about 58 tons, while the turn-table and gear for the barbette in which they are placed will weigh about 125 tons. So, too, the machines used in the production of modern armor plate must be served by cranes which can handle ingots of 125 tons or more. But large cranes are also needed to handle what may be called peaceable material such as locomotives and parts of large stationary engines and electric generators. The boilers of the *Mauretania* weigh about 110 tons each and the weight of her low-pressure turbine rotor is 126 tons. If the competition continues between Great Britain and Germany for the domination of the Atlantic ferry, we may look for still larger cranes in the near future.

The first of the very large dock cranes was installed at Bremerhaven in 1899 Since then they have sprung up like toadstools in the shipyards of Germany and Great Britain, being mostly of German manufacture. Great Britain seems now to have waked up to the situation and during the first six months of 1907, six cranes of 150-tons capacity each have been installed at various British works. Three of the six were made necessary by the two new Cunarders.

The economy of a crane for handling material has long been recognized in Germany and France. In this respect Great Britain and the United States have been more backward. About fifteen years ago the great German industrial movement began, and their crane industry shared the general stimulus with the result that Germany probably leads all countries to-day in the diversity and capacity of her output. In 1905 the factory department alone of the Krupp Works employed 591 cranes. In the United States the principal production has been overhead travelers and in this type our manufacturers are leaders. Cantilever and Gantry cranes for handling medium and light loads over large areas has also been an important product of American genius. The powerful machines for rapid handling of coal and ore at the ports on the Great Lakes are distinctively American ideas and they have had a most important bearing on our recent industrial activity. The heavy rolling stock and frequent accidents on American railroads have operated to bring out a powerful and efficient 100-ton wrecking crane.

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PIPE BENDS.

WM. F. FISCHER.*

In the modern power house steel pipe bends of large radius are nearly always used in preference to steel or cast iron fittings. There are several very good reasons for this. In the first place, using bends in preference to fittings does away with many extra joints which are liable to cause leakage, and which are, in many cases, a constant source of trouble, requiring the renewing of gaskets, etc. In the second place, in steam lines or water lines of high temperature, the steel pipe bends provide a ready means of taking up expansion and contraction, and it is customary to use special bends for this purpose, known as expansion bends. In the third place, steel pipe bends permit the elimination of many steel castings. The cost of bends is less, and they can be delivered quicker. They also give a neater appearance to the engine-room, in general, than it has when covered with fittings. The weight is also less, and owing to the large radii to which the pipes can be bent, they reduce the friction of the fluids conducted inside of them to a minimum.

The process of bending is as follows: One end of the pipe to be bent is first plugged. The pipe is then filled with sand, which is packed tightly, and the other end of the pipe is capped. The pipe is then placed in an oil-heated furnace, and the portion to be bent is heated to a red heat. It is then taken out and placed on the so-called bending table, which is made of cast iron and securely bolted to a heavy foundation. This table is flat, and is cored all over with holes, spaced about six inches apart. Circular steel pins are inserted into these holes. The pipe is clamped between two or three pins, and bent around other pins set so as to give the required radius. A rope is attached to the end of the pipe, and the bending is accomplished by pulling this rope with a winch or other suitable means.

After the pipe is bent to the required shape, it is cooled by running water with a hose over the heated portion. The purpose of the sand filling is to prevent the pipe from flattening when bending, which would necessarily occur in large pipes if they were not filled and well rammed down before bending. Should it happen that after the pipe has cooled off, it is found that it does not agree with the required measurements, it can be reheated and again pulled into shape. A man well experienced with pipe bending can, in most cases, bend a pipe to within ¼ inch, or even ⅛ inch, of the required dimensions. If the bends are made even as much as ½ inch or ¾ inch off the correct dimensions, they are quite easily drawn into position when erecting, at least if the line is of ordinary length, say 40 feet or more.

Large sizes of pipes, say up to 6 inches diameter, are very often bent by machine. A templet should first be provided by bending a round iron rod and carefully measuring it, until the right radius and dimensions are obtained. This templet is then placed over the center line of the pipe, as a guide in bending to shape.

As regards the kind of pipe to use, it should be of good quality standard steel or wrought iron pipe, full weight or extra heavy. Lap welded pipe should be used in preference to butt welded, as butt welded seam is liable to open up under the stress of bending. The welded joint should be placed directly over the center line of the pipe, along what might be called a neutral section, so that the joint will be neither in tension nor compression. This prevents the seam from being strained to any extent when bending.

Large pipe from 12 to 20 inches in diameter is liable to buckle on the compression side, especially if bent to a short radius. To prevent this, the radius when bending large sizes

* Address: 392 Second Ave., New York City.

should be made as long as possible. A suitable radius for bending all sizes of pipe from 4 inches to 20 inches diameter, inclusive, is 6 times the diameter of the pipe, and this is known as "standard radius." Bends made with a radius having this proportion to the diameter of the pipe are very satisfactory. Pipe from 4 to 12 inches, however, can be bent, if necessary, to a radius equal to three times the diameter of the pipe, and sizes above 12 inches may be bent to a radius of four times the diameter of the pipe, if required. Even smaller radii than those last mentioned may be employed, but it is not advisable to do so, as it puts heavy strains on the pipe, and is likely to cause buckling on the compression side, even in the smaller sizes.

The length of the straight portion at either end of the bend should be at least equal to the diameter of the pipe, and in pipes 10 inches diameter and upward, it is advisable to make the smallest length of the straight portion equal to 1½ times the diameter of the pipe. If the length of the straight portion is made less than one times the diameter, the pipe is liable to flatten on the ends, which will prevent the flange from fitting tightly, and is apt to cause leakage.

All threads should be cut and flanges put on and made steam tight before bending. On rolled, or Van Stone joints, the rolling, "Van Stoning," and finishing the face must all be done while the pipe is straight, as it would be a difficult task to do after the bend is made.

The Data Sheet Supplement for the present month gives formulas for four different classes of bends. The length of the pipe in the finished bend must be calculated to find out the length of straight pipe necessary. This length, of course, equals the length of the straight portions of the pipe added to the length of each of the arcs. The length of the arc is easily found from the formula:

$$\text{Length of arc} = \frac{3.1416}{180} \times \text{radius} \times \text{number of degrees.}$$

This formula, of course, will be found in this or similar form in all hand-books, and can be easily deducted by simple mathematics. In the form as here given (with the exception of that more decimals are stated for π) it will be found in Kent's Pocket-book.

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CALCULATION OF FANS AND HEATERS.

CHARLES L. HUBBARD.*

The tables and formulas presented in the following, together with the tables which will be found in the Supplement, have been compiled in as concise a form as possible, and will be found very useful in determining the sizes of fans and heaters necessary for special given conditions. The article is not intended to deal with the design or construction of those apparatus; but the data given embody, of course, the fundamental principles on which the design must rest.

Centrifugal Fans.

When a centrifugal fan is in motion, the air in contact with the blades is thrown outward by the action of centrifugal force, and delivered at the outer circumference. A partial vacuum is thus produced at the center of the wheel, and air from the outside flows in to take the place of that which has been discharged. This type of fan is enclosed in a steel plate casing having an inlet opening at the center of the wheel and a discharge outlet at the periphery.

The pressure within a fan casing is caused by the air being thrown from the tips of the blades, and varies with the speed of rotation. In Table I are given the velocities of outflow from a fan outlet into the atmosphere for different pressures within the casing.

TABLE I. RELATION BETWEEN PRESSURE AND VELOCITY IN CENTRIFUGAL FANS.

Pressure in ounces per square inch.	Velocity in feet per minute.
¼	2,585
⅜	3,165
½	3,653
⅝	4,084
¾	4,472
⅞	4,829
1	5,161

* Address: 420 Boylston St., Boston, Mass.

When the outlet from a fan casing is small, the air will pass out with a velocity equal to that of the tips of the blades, and the pressure within the casing will be that corresponding to the tip velocity. The limiting area of outlet at which the velocity of outflow begins to drop below the tip velocity, is called the blast area of the fan. This, for the ordinary form of ventilating fan is approximately $0.14\,D^2$, in which D is the diameter of fan wheel.

The effective discharge outlet of a fan, in practice, is always made larger than the blast area. This, for average conditions, taking into account the contraction of vein in passing through the outlet, may be taken as 1.78 times the blast area, or $0.25\,D^2$.

Capacity Speed and Horse-power of Centrifugal Fans.

The capacity of a fan when operating under a given pressure and discharging into free air is equal to the velocity corresponding to the given pressure, multiplied by the effective area of outlet.

Example: A fan 4 feet in diameter has an effective discharge area of $0.25 \times 16 = 4$ square feet, and when operating under a pressure of ¼ ounce will deliver $4 \times 2{,}585 = 10{,}340$ cubic feet of air per minute.

When the discharge outlet of a fan is equal to the blast area, the tip velocity for any given pressure must correspond to that pressure, as given in Table I, and the speed in revolutions per minute will be equal to the required velocity of outflow, divided by the circumference of the fan wheel. When the effective area of discharge is made larger than the blast area, the pressure for a given speed will drop. Hence, when the effective area is taken as 1.78 times the blast area, or $0.25\,D^2$, the speeds as found above must be multiplied by 1.2 to maintain approximately the same pressure.

Example: A fan 4 feet in diameter has a circumference of 12.5 feet, hence to maintain a pressure of ¼ ounce under actual conditions it must run at a speed of

$$\frac{2585}{12.5} \times 1.2 = 248 \text{ R.P.M.}$$

The theoretical horse-power required to move the air which is discharged through each square foot of effective outlet area under different pressures is given in Table II. This table, however, does not take into account the friction of the fan, so that, in practice, the result must be divided by the efficiency, which may be taken as 0.40 under average conditions.

TABLE II. RELATION BETWEEN PRESSURE AND HORSE-POWER IN CENTRIFUGAL FANS

Pressure in ounces per square inch.	Horse-power per square foot of Effective Opening.
¼	0.175
⅜	0.324
½	0.498
⅝	0.695
¾	0.914
⅞	1.15
1	1.40

Example: A fan 4 feet in diameter has an effective outlet area of 4 square feet; hence, the power required when discharging into free air under a pressure of ¼ ounce is

$$\frac{4 \times 0.175}{0.40} = 1.75 \text{ horse-power.}$$

Resistance of Centrifugal Fans.

The Tables in the Supplement for speed, horse-power, and capacity of centrifugal fans have been computed by the methods given above, and apply only to fans discharging into free air. When connected with a series of ventilating ducts the effect is the same as partially closing the fan outlet, and thus reducing the volume and horse-power in practically the same proportion. In the case of schools, churches, etc., where shallow heaters are used, and the flue velocities do not exceed 800 to 1,000 feet per minute, the volume and horse-power as found in the tables for any given speed should be reduced about 20 per cent. In shops and factories where deep heaters are used and flue velocities run up to 1,800 to 2,000 feet per minute, there should be a reduction of about 40 per cent

Disk Fans.

The following data are based on the assumption that the disk fans are connected with shallow heaters or with ventilat-

ing ducts of medium length, through which the air is flowing at a velocity of 800 to 1,000 feet per minute. The tables found in manufacturers' catalogues are usually for fans running in free air without the use of connecting ducts, hence the results are much in excess of those given by the following rules, which are for the average conditions commonly found in ventilating work.

TABLE III. SPEED, HORSE-POWER AND CAPACITY OF DISK FANS.

	Diameter of Fan in inches.								
	12	18	24	30	36	42	48	60	72
R. P. M.	1,300	900	600	500	400	350	300	250	200
H. P.	0.13	0.30	0.48	0.78	1.0	1.5	1.9	3.1	4.3
cu. ft.	650	1,530	2,400	3,900	5,200	7,350	9,600	15,500	21,600
R. P. M.	1,400	950	650	550	450	400	350	300	250
H. P.	0.14	0.32	0.52	0.86	1.2	1.7	2.2	3.7	5.4
cu. ft.	700	1,620	2,600	4,290	5,850	8,400	11,200	18,600	27,000
R. P. M.	1,500	1,000	700	600	500	450	400	350	300
H. P.	0.19	0.42	0.70	1.2	1.6	2.4	3.2	5.4	8.1
cu. ft.	750	1,700	2,800	4,680	6,500	9,450	12,800	21,700	32,400
R. P. M.	1,600	1,100	800	650	550	500	450	400	350
H. P.	0.24	0.56	0.96	1.5	2.1	3.2	4.3	7.4	11.3
cu. ft.	800	1,870	3,200	5,070	7,150	10,500	14,400	24,800	37,800
R. P. M.	1,700	1,200	900	700	600	550	500	450	400
H. P.	0.30	0.71	1.3	1.9	2.7	4.0	5.6	10.3	13.2
cu. ft	850	2,040	3,600	5,460	7,800	11,550	16,000	27,900	43,200
R. P. M.	1,800	1,300	1,000	800	700	600	550	....	....
H. P.	0.36	0.88	1.6	2.5	3.6	5.0	7.0	....	....
cu. ft.	900	2,210	4,000	6,240	9,100	12,600	17,600	....	....

In computing the volume of air moved, it may be assumed that each revolution of the fan moves the air in a direction parallel with the shaft a distance equal to 0.6 of the diameter, over its entire area, or

$C = 0.6\,D \times R \times A$; in which

C = cubic feet of air moved per minute;

D = diameter of fan in feet;

R = revolutions per minute;

A = area of fan in square feet.

The horse-power depends upon the velocity of the air through the fan and the resistance of the ducts. Under average conditions this may be taken as follows:

Velocity through Fan in Feet per minute.	Horse-power Required per 1000 Cubic Feet of Air Moved
800	0.20
1,000	0.30
1,200	0.40

A disk fan operates most economically when the speed is such that the velocity of the air-flow through it is from 800 to 1,200 feet per minute, and Table III is computed upon that basls.

TABLE IV. DEPTH, FINAL TEMPERATURE AND EFFICIENCY OF PIPE HEATERS.

Temperature of entering air, zero.
Velocity of air between the pipes, 800 feet per minute.

Rows of Pipe Deep.	Temperature to which the Air will be raised from Zero.			Efficiency of Heating Surface in B. T. U. per square foot per hour.		
	Steam Pressure in Heater.					
	5 lbs.	20 lbs.	60 lbs.	5 lbs.	20 lbs.	60 lbs.
4	30	35	45	1600	1800	2000
6	50	55	65	1600	1800	2000
8	65	70	85	1500	1650	1850
10	80	90	105	1500	1650	1850
12	95	105	125	1500	1650	1850
14	105	120	140	1400	1500	1700
16	120	130	150	1400	1500	1700
18	130	140	160	1300	1400	1600
20	140	150	170	1300	1400	1600

Heaters for Hot-blast and Ventilation.

The efficiency of a heater is the number of heat units given off per square foot of surface per hour to the air passing over it. This increases with the difference in temperature between the steam and air, and also with the velocity of air flow. The final temperature depends upon the depth of the heater, and increases with the number of rows of pipe, and with the difference in temperature between the steam and air. Increasing the velocity of air flow, reduces the final temperature. Table IV gives the depth, final temperature, and efficiency for pipe heaters under different conditions. In this table it is assumed that the air enters the heater at a temperature of zero, and passes between the pipes at a velocity of 800 feet per minute. The free area through a pipe heater is approximately 0.4 of the gross or over all area.

Efficiency of Cast-iron Heaters.

The efficiency of a pin radiator 8 to 10 inches in depth may be taken as 1,500 heat units per square foot of surface per hour. Deep cast-iron heaters, made up of several rows of sections, may be treated the same as a pipe heater of the same depth.

The heating surface required may be found by the formula

$$S = \frac{T \times C}{55 \times E}, \text{ in which}$$

S = square feet of surface in heater;

T = temperature to which the air is raised from zero, or the number of degrees through which it is raised from any other temperature;

C = cubic feet or air to be heated per hour;

E = efficiency of heater.

Factory Heating.

The heating surface for factory heating is commonly expressed in lineal feet of 1-inch pipe. With all of the air used taken from out-of-doors, allow approximately 100 cubic feet of space for each foot of pipe for exhaust steam, and 150 cubic feet for steam at 80 pounds pressure. If air from the building is rotated through the heater, substitute 140 and 200 for the above figures.

Air Velocities.

The average air velocities given in Table V may be used in the different parts of a heating and ventilating system.

VABLE V. AIR VELOCITIES FOR DIFFERENT PARTS OF HEATING AND VENTILATING SYSTEMS.

Section of System.	Velocity in Feet per minute.
Through inlet windows	800 to 1,000
Between inlet and heater	800 to 1,000
Through heater	800 to 1,000
Schools and churches—	
Main ducts	1,000 to 1,200
Branches, large	800 to 1,000
Branches, small	700 to 800
Uptakes	600 to 700
Shops and factories—	
Main ducts	1,800 to 2,000
Branches	1,500 to 1,800
Uptakes	1,200 to 1,500

Volume of Air Required.

The volume of air supplied to a building is usually based on the number of occupants. Table VI represents good modern practice and may be used with satisfactory results.

TABLE VI.

Air Supply per Occupant.	Cubic Feet per Hour.
Hospitals	4,000 to 6,000
High schools	3,000
Grammar schools	2,400
Theatres and halls	1,500
Churches	1,200

* * *

In the engineering review of the May issue of MACHINERY it was mentioned that the White Star line planned the building of steamships a thousand feet in length. This statement, however, has been corrected, and it is now reported that the new steamships are to be 840 feet long, which is about 50 feet more than the length of the *Mauretania*, hitherto the longest vessel built.

MAKING CROSS-HEAD PINS FROM BAR STOCK IN THE GISHOLT TURRET LATHE.

The requirements of the railroad shop are so different from those of factories engaged in repetition work, that it is not always possible to use in them the highly developed machines that have been devised to meet modern manufacturing requirements. It is seldom that parts have to be made in large quantities, and the work is, in general, heavier than is usually adapted to elaborate methods of machining.

Despite these general conditions, however, the Gisholt Machine Co., Madison, Wis., some time ago decided that there was a field in the railroad repair shop for the particular turret lathe of which they are the builders. Without requiring any further development in the design of the machine or the tools used with it, it was already well adapted to the machining of such work as bushings, brasses, pistons, cylinder heads, bull-rings, eccentrics and other small and medium-sized cast parts used in the locomotive. But there is not always, in the repair shop of ordinary size, enough of even this wide range of work to keep a machine busy all the time; so it became necessary, in developing the lathe to its maximum of usefulness, to design tools and methods of working for producing miscellaneous turned steel parts, such as the cross-head, valve motion and brake hanger pins, etc., which were previously made from forgings. The accompanying illustrations and description show the successful way in which this machine, primarily designed for chucking, has been adapted to the finishing of such parts from the bar.

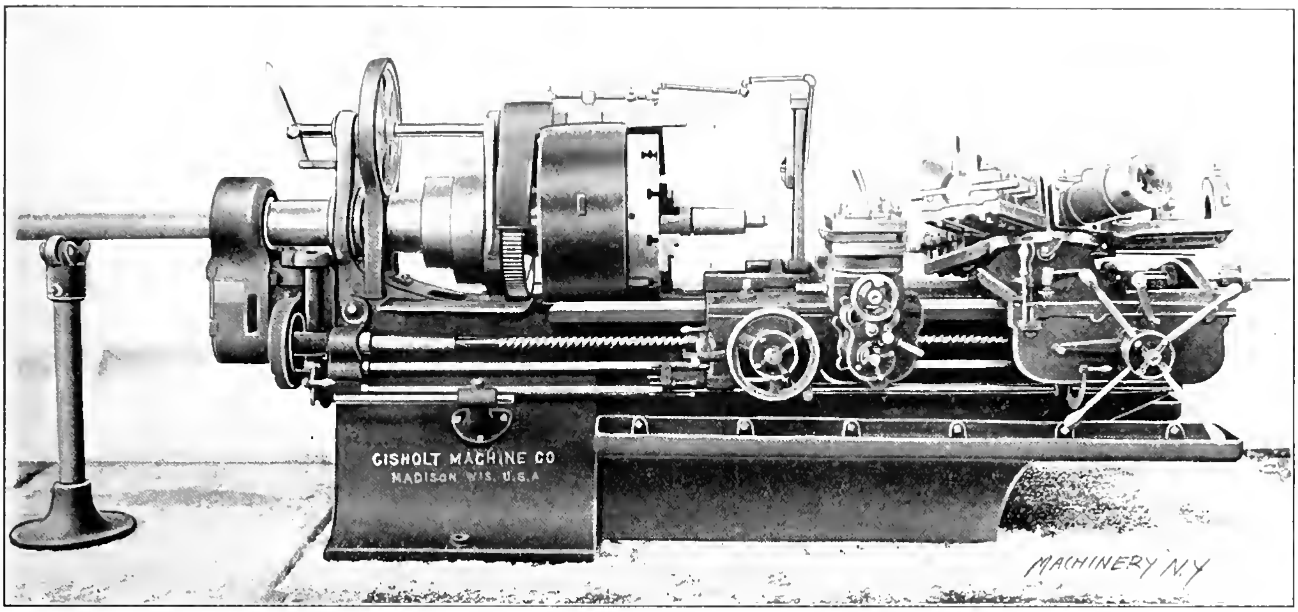


Fig. 1. Gisholt Turret Lathe arranged for Railway Shop Work; shown set up for Finishing Cross-head Pins.

The machine used is of the type called by its builders the "Big Bore" lathe, which is simply the standard machine with an extra large spindle for bar stock, the principal features of special interest in connection with this work being in the tools used rather than in the machine.

In Fig. 1 the machine is shown rigged up for turning a cross-head pin, shown completed in the chuck and ready to be severed from the bar. As is more plainly indicated in the diagram, Fig. 2, which gives the lay-out of operations, this cross-head pin is of the usual type, having a central cylindrical body F which is the journal for the connecting-rod brasses, and two tapered diameters E and G by means of which it is fitted into the sides of the cross-head, being held in place by a nut threaded onto the stem H. It will be noted that all the various portions of the work are lettered, and in following the different operations, the cutting blades in each tool will be lettered to correspond with the parts of the work which they machine, thus making it easy to follow the course of the work.

The stock A is held in a scroll chuck by three hardened jaws B and is further steadied and clamped by the supplementary chucking screws C, threaded into blocks clamped to the face of the chuck alternately with the jaws. The stock being fed to length, as will be described later, the end of the bar is faced with tool N in the cross-slide turret. The first turning operation is performed by box tool No. 1 in the main turret. This tool rough turns all the various diameters and shoulders of the work, the various blades E_1, F_1, G_1, etc., turning the corresponding portions E, F, G, etc., of the work. Two sets of back rests L are provided, the forward one of which bears on shoulder E and the rear one on diameter H. The last tool K_1 finish faces the end K of the work.

The pieces being thus brought approximately to size, the main turret is revolved to bring box tool No. 2 into operation. In this, blades F_2, H_2, and K_2 turn to size shoulders F and J, and face K, the holder being steadied meanwhile by two sets of back rests L_2 bearing on shoulders F and H, as in the first cutting operation. Box tool No. 3, which is next presented to the work, carries taper shaving blades E_3 and G_3 for forming the two taper bearings on the work. These taper bearings fit into corresponding taper seats in the cross-head. The tool is back rested on the work as before while this operation is in progress. The positive stop R determines the length of this taper turning, by stopping against the face K. This arrangement insures duplicate work when cutters E_3 and G_3 are once properly set.

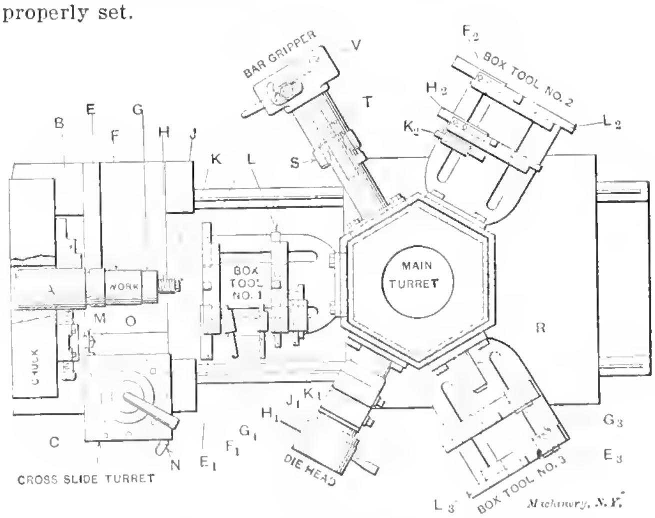


Fig. 2. Tool Equipment used for Making Cross-head Pins.

All the surfaces on the pin having been brought to size, the next operation consists in cutting the thread, which is done by the die-head shown. The part being thus completed, cutting-off tool M in the cross-slide tool-holder is used for severing the work from the bar. Owing to the large diameter of the stock, this slender cutting-off tool is supported by an adjustable threaded post O, more plainly seen in the foreground in Fig. 3.

After the piece has been cut off, jaws *B* and set-screws *C* are loosened to allow the work to be fed out. The feeding is done by the "bar gripper" shown mounted in the turret in Fig. 2. The bar is fed by being pulled through the chuck instead of being pushed from the rear, as commonly done. The procedure is as follows: By the operation of the rapid traversing device for the carriage, the bar gripper is brought rapidly to the piece. The self-acting jaws *V* then grip the stock firmly. The carriage is then returned by power until the bar is drawn out to approximately the proper length after which the gripper is released. The body of the gripper is then swung upward out of the way about pivot *S*, and the turret slide is brought forward to a positive stop, arbor *T*, meanwhile, pushing the work along until it projects just the right amount, *T* being accurately adjusted for this purpose. The operations then proceed as before.

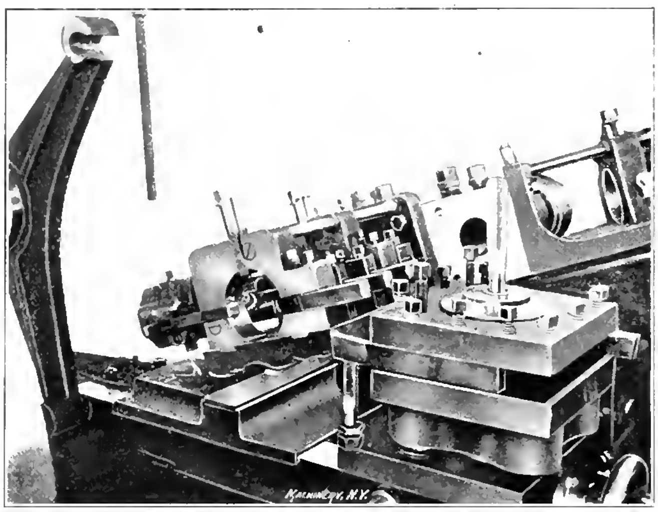


Fig. 3. Box Tool and Cutting-off Blade; note Support for Blade.

Figs. 3 and 4 give a good idea of the tool equipment used. Fig. 3 shows the cross-slide turret or tool-post and one of the box tools in position for operation. In Fig. 4 a front view of the box tool is shown. It will be seen that this outfit of tools is suited for work of a large range of diameters and lengths, although this adjustability is not obtained at the expense of quickness and simplicity in changing from one size to another. The holders for carrying blades and back rest jaws combined, are tied together and with the body of the cutter by threaded tie-rods, which stiffen the whole structure, allowing heavy cuts to be taken.

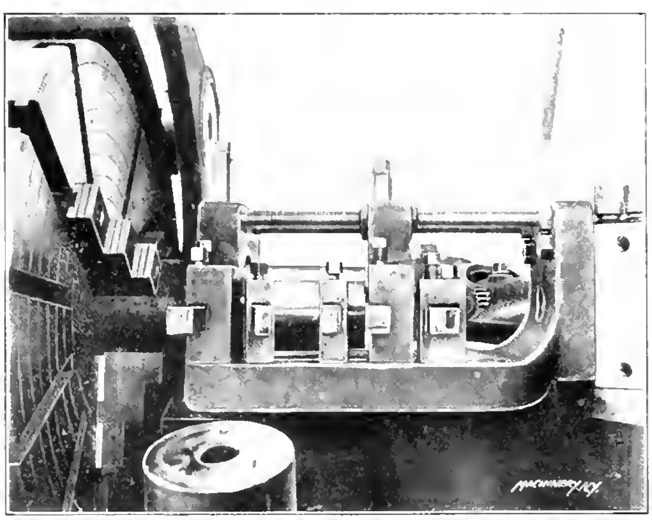


Fig. 4. Front View of Box Tool showing Adjustability of Blades and Back Rests.

The makers state that the convenience of a tool outfit of this kind makes it possible with bar work, as with castings, to finish parts in lots of as few as six or eight of a kind, and still save a large amount of time in the operation. Owing to the fact that the work of this kind may be made from bar stock, the expense of forging the blanks from which these pins were formerly made is done away with. Besides this, owing to the manner in which the work is chucked, there is no time lost in centering as with the older methods. In some shops such parts as knuckle and cross-head pins are made for stock, finished complete except the taper surfaces, which are left large and finished to size and fitted in place as required.

* * *

A MASTERPIECE AMONG PERPETUAL MOTION ADVERTISEMENTS.

The following notice, here reprinted verbatim, appeared in a recent issue of a Hartford paper, sent us by one of our readers:

FOR SALE—A Wonderful Machine. A machine that will overcome Newton's third law and transfer a horseshoe magnet force into a revolution, and will produce more power than what is put into the machine. Because not having the funds to build a machine in a perfect way so I can demonstrate it in practical mechanical working order. It is a perfect success from the mechanical laws of nature which I have tested in their natural working order, and from the small machine which I have in perfect working order to demonstrate from that when the electro or the horseshoe magnet system is connected with the machine it will do the work. Just as I have stated, every professor on the face of the earth will have to give the same statement as I have in regard to this machine in the form it does its work, even in case it should not produce more power than what is put into the machine, it would be one of the most mysterious mechanical laws that the professor ever came across which they pronounce correct to-day, therefore it would be a valuable machine to put on exhibition to demonstrate to the world in a mechanical form that it is impossible to make a machine that will produce more power than what is put into the machine it would show then that it was imperative to get the perpetual motion system in a mechanical form. Therefore by putting this machine on exhibition if it should not work it would bring in a small fortune more than the machine would cost to build, and by publishing a book of the six mechanical laws which I have worked out, what is the foundation of this machine to work from that would bring in a small fortune for itself; therefore it is impossible to lose one cent by investing in this machine. I have studied these laws out to their limits and according to the laws the machine can be made to drive small or big machinery. Now I would like to know if there is a lady or gentleman on the face of this earth who has funds enough that will be so generous and borrow me Five Thousand Dollars so I can build a machine and exhibit it before the public.

This man hopes to "catch 'em coming and going," evidently, for he promises that the investment will be a profitable one, even if his machine proves a failure. This is, we believe, a new wrinkle in perpetual motion promotion.

* * *

A clever wrinkle is used by the Stromberg Electric Mfg. Co., Chicago, Ill., in the construction of the Perry time stamp for securing rubber type bands to hexagonal brass printing wheels. The brass wheels are made from hexagonal stock in a screw machine, and are prepared for the rubber type bands by gripping them closely together on a mandrel and covering the edges with a thick coating of brown shellac. When thoroughly dried, the wheels are separated and the rubber type (which is vulcanized in bands), is slipped onto the periphery of the wheel, and then dipped into alcohol. The alcohol penetrates between the rubber and the wheel, softening the shellac and causing it to adhere to the rubber. Upon removal from the alcohol the shellac quickly dries, leaving the rubber firmly attached to the wheel. The reason for applying the shellac in this manner is to avoid getting it upon the face of the rubber and making the mussy job that would unavoidably result from direct application.

* * *

An engineering firm in Hamburg, Germany, contemplates, according to *Frankfurter Zeitung*, the erection of a power plant at the mouth of the river Elbe, the driving power of which it is proposed to derive from the tidal movement of the sea. It is expected that two neighboring cities of comparatively large size will be supplied with electric light, and that electricity may also be supplied for electric railways. The cost of the electric current is calculated to be extremely low. The statements made by the firm itself, however, are to be accepted with considerable reservation. In new departures of this kind the engineer requires to see results before his enthusiasm can be aroused in any remarkable degree.

LETTERS UPON PRACTICAL SUBJECTS.

ON SENDING ELECTROTYPES ABROAD.

Machinery agents and technical editors over here get a good many electrotypes which are in the condition of the dog that was sent by express and ate his tag. The "stickers" of the post-office, custom house and forwarding agents usually cover the sender's name. Blocks should be marked with the sender's name on the edge, not on the bottom. As "samples without value," they come more cheaply and quickly, and make less bother at both ends of the line, than as postal packages. A card of advise should be mailed the same time as the blocks.

Dresden, Germany. ROBERT GRIMSHAW.

QUICK RUSTING OUT OF SMOKESTACK.

We had a steel smokestack 80 feet high, 42 inches diameter, made of No. 8 steel. This stack, after being in continuous use for only three years, was completely eaten up by rust, and had to be taken down. Some of the sheets were so wasted away as to be thin as paper. We would like to know if any of your readers have had a similar experience. What is the cause of it and how can it be prevented? The fuel used was run-of-mine, Kanawha gas coal such as is used in the Cincinnati district, and the analysis is as follows: Moisture, 0.39 per cent; volatile matter, 38.47 per cent; fixed carbon, 58.01 per cent; ash, 3.13 per cent; sulphur, 0.666 per cent. We are at a loss to understand why the stack should have gone to pieces so quickly. Is the kind of steel used in smoke stacks more readily attacked by rust than ordinary grades of steel used in other constructions? THE J. & H. CLASGENS CO.

New Richmond, Ohio.

AN EXAMPLE OF HIGH-SPEED DRILLING.

The accompanying table gives the results of some trials made with our heavy upright drilling machine, illustrated in the March issue of MACHINERY, using a special brand of twist drills. The trials were made to obtain the maximum capacity

HIGH SPEED DRILLING TESTS ON DROOP & REIN DRILLING MACHINE.

Diam. of Twist Drill	Feed per Revolution.	Number of Revolutions	Depth of Holes.	Time. min.	Time. sec.	Effective Feed per min.	Calculated Feed per min.
2	$\frac{10}{1000}$	145	$2\frac{7}{8}$	2	24	$1\frac{3}{8}$	$1\frac{7}{16}$
2	$\frac{15}{1000}$	145	$2\frac{7}{8}$	1	35	$2\frac{1}{8}$	$2\frac{3}{16}$
2	$\frac{18}{1000}$	150	$2\frac{7}{8}$	1	15	$2\frac{5}{8}$	$2\frac{11}{16}$
2	$\frac{18}{1000}$	150	$3\frac{3}{4}$	1	35	$2\frac{11}{16}$	$2\frac{3}{4}$
2	$\frac{25}{1000}$	160	5	1	25	$3\frac{7}{8}$	$3\frac{15}{16}$
2	$\frac{35}{1000}$	140	$3\frac{3}{4}$	0	56	$4\frac{1}{2}$	$4\frac{13}{16}$
$2\frac{3}{8}$	$\frac{18}{1000}$	120	3	1	45	$2\frac{1}{16}$	$2\frac{3}{16}$
$2\frac{3}{8}$	$\frac{18}{1000}$	130	$3\frac{1}{16}$	1	40	$2\frac{3}{16}$	$2\frac{3}{8}$
$2\frac{3}{8}$	$\frac{18}{1000}$	130	$3\frac{9}{16}$	1	48	$2\frac{5}{16}$	$2\frac{3}{8}$
$2\frac{3}{8}$	$\frac{25}{1000}$	120	3	1	15	$2\frac{7}{8}$	$2\frac{59}{64}$

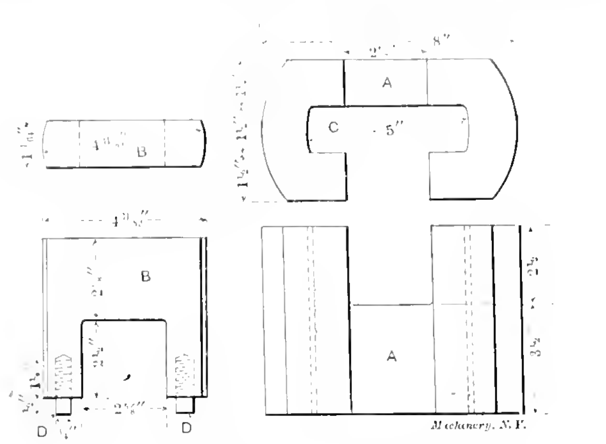
of the drills. The holes were drilled from solid steel of about 55 kilos resistance per square millimeter. Perhaps the table will be of interest to some of your readers. DROOP & REIN.

Bielefeld, Germany.

[The designation "55 kilos resistance per square millimeter" refers to the tensile strength, and gives a comparison for the hardness of the steel. In this case the material had a tensile strength, in English units, of 78,000 pounds per square inch. Inasmuch as the hardness curve of untempered carbon steel is approximately parallel to the curve of tensile strength, it follows that a statement of the tensile strength gives a fair idea of the hardness of the material.—EDITOR.]

CUT-OFF TOOL FOR THE STEAM HAMMER.

A cut-off tool to be used under a steam hammer is shown in the illustration. It is made of tool steel, and can be either forged and used with very little finish, or be made accurately by finishing all over. The one in use at the shops was made rough, and gave very good results, cutting off bar iron as fast as it could be placed in position under the hammer, and only requiring two men to operate, as against three with the old way. The tool shown is intended for cutting either flat or square stock. The rest upon which the steel is placed is shown at *A*. After the bar has been placed upon the rest, the cutter *B* is placed in the slot *C* in the rest *A*, and the hammer brought down. Better results can be obtained by using different cutters for the various sizes of stock. The studs *D* are used to center a pair of springs, which bring the cutter back into position, after a piece has been cut off, ready for another blow. The upper part of the cutter is made 2 5/8



A Tool for Cutting off Stock under the Steam Hammer.

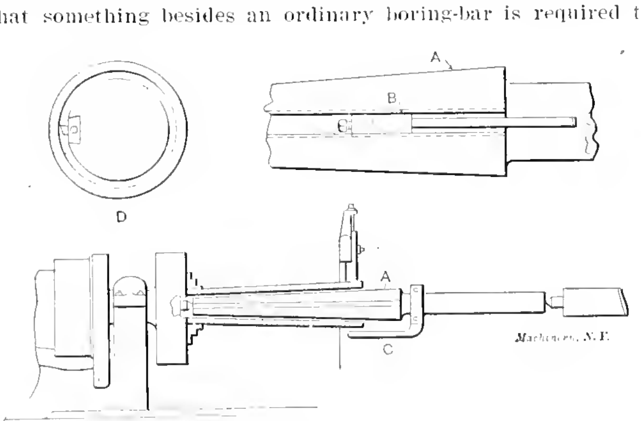
inches, or 1/8 inch longer than the depth of the slot in the rest, so that the piece is cut off before the top of the cutter is flush with the top of the rest.

When it is desired to cut off round bar steel, the same style rest can be used with the exception that instead of the slot a round hole is drilled which is 1/16 inch larger than the bar, and the cutter *B* must have a half circle cutting edge, instead of a flat edge as shown. Very stout springs should be used under the cutter. It is not necessary to have the cutter very hard, as it is liable to crack. For angle irons the same principle can be applied, only the tool must be made stronger in proportion to the size of the stock.

Jackson, Tenn. JOHN BRANDLE.

TOOL FOR TURNING HARD BRONZE CASTINGS.

The specifications for the sleeve bushings which form bearings for the axles of a certain make of gun carriage, call for phosphor bronze as hard as steel can cut. It will be seen that something besides an ordinary boring-bar is required to



A Boring Tool Designed to give Great Rigidity to the Cutter

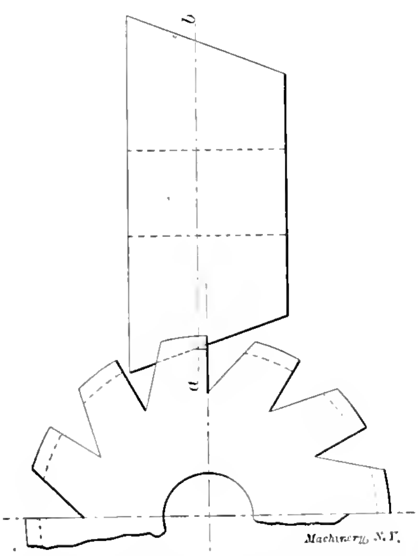
bore these castings, and the bar shown in the engraving is used for this purpose. It consists of a heavy steel bar *A*, turned taper about half its length, the tapered portion being small enough to enter the rough casting without touching any part. The shank portion is smaller than the head of the taper, and a dove-tailed slot is planed parallel with the taper, so that a closely-fitting block carrying a tool, as shown at *B* in the detail, gives a very short and rigid hold for the tool. The block is attached to a rod *C* which is in turn fastened to the tool post on the carriage, by which means the tool is fed to its work. The bar *A* is held on the centers, and is kept

from revolving by a suitable clamp or dog, one form of which is shown at *C*, this being wedged in the lower part of the steady-rest. At *D* is shown a section of the bar and sleeve. The sleeve is turned outside before being bored, and after boring with the tool described, it is reamed.

Ottawa, Ont., Canada. W. L. McLaren.

SELECTING CUTTER FOR CONCAVE MILL.

"M. E. M." offers in the How and Why section of the March issue of Machinery a rather complicated problem in mathematics. As stated by the editor, an exact solution is impossible. Maybe, however, a formula could be worked out that would give the same width of land at three points, *viz.*, the bottom of the segment and the two points on the largest diameter of the cutter blank. It is doubtful, however, if anybody would want to use it, if he had it, as no less than six variables would have to be taken care of, namely, the arc of the circle wanted, its radius, the radius of the cutter blank, the angle included between two teeth, the width of land, and the edge angle of the milling cutter. This rather looks like "more than the job is worth." I can offer no approximation that will fit the case as presented. But if "M. E. M." will go about it a little differently, there is a very simple solution, giving results well within the limit called for on that class of work.



Method of Milling a Concave Mill so that the Width of the Land at the Center and Outside Edges will be Approximately Equal.

First, gash the cutter blank, and then set it with a cutting edge vertical. Then select an angular cutter for the relieving operation of such size that at some plane, as *a b* in the sketch, it will be of the same diameter as the circle on the edge of the blank, and sink it into the blank to this line. In this way a semi-circle can be relieved to a sharp edge with theoretical accuracy. If the land is very wide, there would be an error, most of which could be compensated by a slight rotation of the blank, but this would seldom be necessary, as the land would not generally be over 1/16 inch to 3/32 inch wide, and for all such cases the method is near enough.

Washington, D. C. H. K. Harring.

THE EFFECT OF DISTILLED WATER ON LIFE OF MILLING CUTTERS.

One of the English technical papers incorrectly reported my remark on lubrication on the discussion of Dr. Ashton's paper. [See note on page 454, engineering edition, March issue.] What I really said was that a manager of a motor car works mentioned to a friend of mine that he had increased the life of his milling cutters from two to ten times their original life by using distilled water in making his suds instead of ordinary untreated water. As I had no data to substantiate the statement, I gave it for what it was worth.

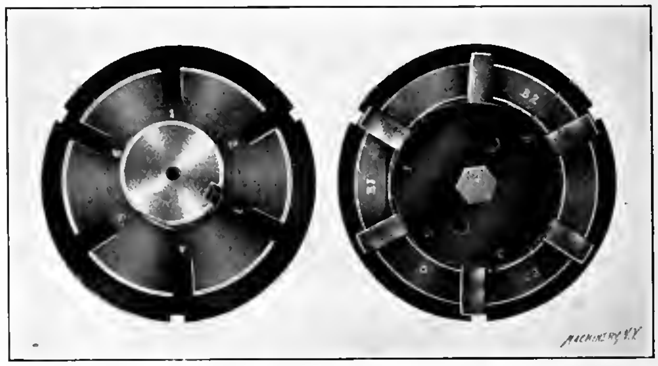
Personally, I am a little incredulous that an improvement to the extent mentioned is possible, yet I am convinced that better results can be gotten by using distilled instead of ordinary water in a lubricant.

The theory upon which I base this statement is that with distilled water the objectionable earthy carbonates and sulphates are removed, and do not, therefore, have a deleterious effect upon the cutting edge of the milling cutter. Also, the magnesium chloride in "hard" water has a slightly corroding action on the tool. The above elements in combination with a lubricant would certainly dull the edge of a tool and consequently reduce its life. The water at the works referred to was particularly "hard." F. Carnegie.

Enfield Lock, England.

LARGE ADJUSTABLE TAP.

The accompanying half-tones illustrate a rather unusual way of constructing an adjustable tap. The tap shown is used for tapping out a large cap, and the diameter of the thread in this cap must be full size all the way to the bottom of the hole. The principle of adjustment in this tap permits it to retain its full diameter on the front end of the inserted chasers. Figs. 2 and 3 show the general construction of the tap. The threaded chasers are held in place by shoes, shown



Figs. 1 and 2. End Views of the Adjustable Tap.

in detail in Fig. 3. These shoes are tightened by the small slotted head screws shown. It will be noticed that there is a shoe between every other pair of blades only, and that the metal of the tap body is left solid between alternate pairs, so that when the blades are tightened in place by means of the shoes, they are held firmly up against the body part of the tap. The means by which the adjustment is accomplished is best shown by the end view in Fig. 2. It will there be seen that the bottom surface of the ends of the chasers rest against the outside edges of a disk or cam, milled with steps so that on being turned, all the blades will move outward an equal amount in a radial direction. This cam is shown in detail in Fig. 3. It is provided with two holes, as shown in

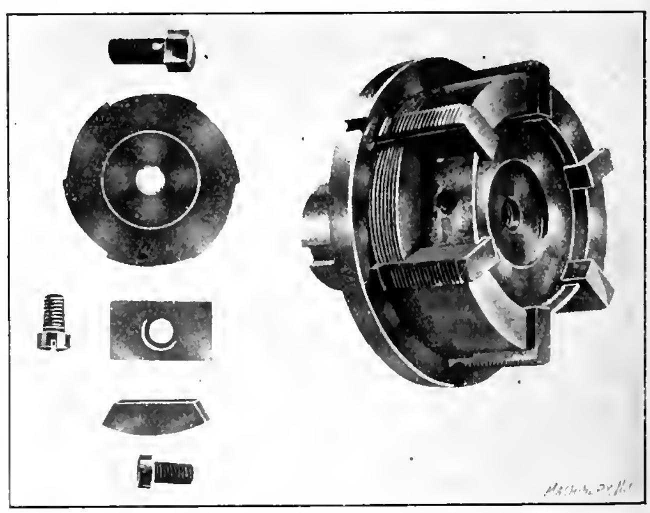


Fig. 3. View showing the Construction of the Tap.

Fig. 2, for a spanner wrench. The chasers can be moved forward in a longitudinal direction, by adjusting the collar shown in Fig. 3, at the upper end of the tap body.

Fig. 1 shows a view of the tap from the shank end. Marks (not shown) on the back of the shank indicate, first, the size of the tap, which is 4.520 inches, then the drawing number, and, finally, the number of the bin in the tool-room where this tap is kept when not in use. The upper ends of the chasers or blades simply bear against the face of the threaded collar.

When having adjusted the tap, it is evident that the front end of the chasers will have all the cutting to do, and for this reason it is likely that many will criticise the construction.

However, this tap was made nearly four years ago, and has given satisfactory service for the purposes for which it was intended, and this is, of course, the main consideration.

Decatur, Ill. ETHAN VIALL.

REASONS WHY SO LITTLE IS HEARD FROM FORGE SHOPS.

In the January issue of MACHINERY the editor remarks that it is strange that there is so little literature on drop forging and machine blacksmithing, considering the importance of the art. It would not seem so strange were the conditions under which the men actively employed at such work were better known. Manufacturers are principally responsible for existing conditions. Quite often we find a thoroughly up-to-date manufacturing plant with the forge shop in the most obscure corner, practically the place the farmer would use for a hog-pen; and the blacksmith is looked upon as a disagreeable necessity or an expensive luxury. Very little has been done to make the art of blacksmithing attractive to the young American, with the result that we depend almost entirely upon the imported article to do our iron and steel working.

Usually the inside of the forge shop compares well with its location: a great and fearful combination of scrap, discarded tools, and smoke, slightly mixed with modern machinery such as an occasional steam- or trip-hammer, usually of a design out of proportion with the work for which it is intended. System is conspicuous by its absence, and as a rule men employed in such shops have adapted themselves to their surroundings. The writer has been employed in shops of from four to ten forges, with scarcely enough tools to equip one fire. The result is that the "borrow-and-lend" or "first-come-best-served" principle had to be adopted. Much time was lost in hunting up tools, and quite often when they were located, some one else was using them.

Too much seems to be taken for granted both by the management and by the blacksmith himself. The manufacturer seems to take for granted that the equipment of our grandfathers is good enough for the blacksmith of the present day; and it takes a great deal of argument to convince him that a fixture for a steam hammer, a set of dies, a former, or a modern furnace, would reduce the cost of production. The same man, however, is willing to get any kind of machine or appliance to keep his machine shop or tool-room up to date. On the other hand, a great many blacksmiths take it for granted that because some one who had a reputation made a piece of work in a certain way, there is only that one way of doing it. They do not seem to trouble about thinking for themselves, and will find all kinds of objections to up-to-date appliances: A furnace will heat too many pieces at one time, the noise deafens them, the trip-hammer sounds like a boiler-shop, and so forth; but they never mention the increase of production or reduced cost. And, too often, when they find a thinker who gets ahead of them, they will brand him the fellow who is trying to get a mortgage on his job.

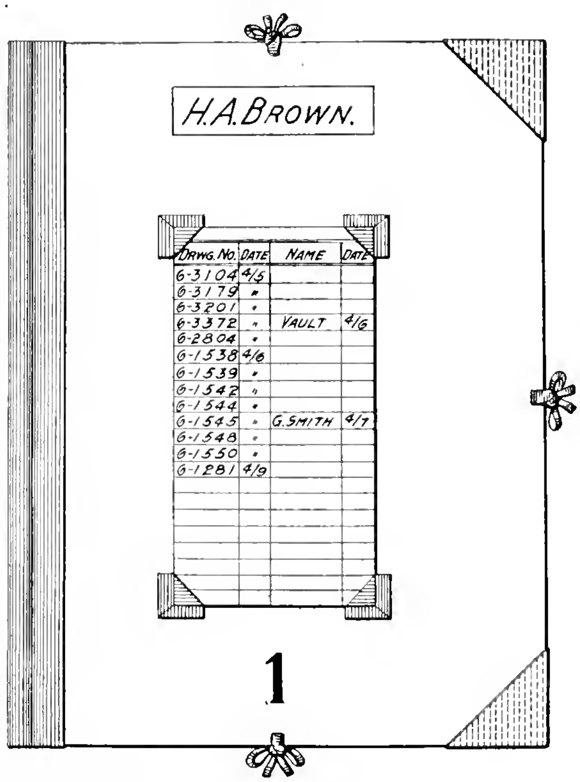
It is very rare that we find a well-educated man in the forge shop. The majority of American blacksmiths are recruited from boys who have had to earn a living at the first thing which would bring in the most money—usually doing odd jobs around the forge shop, or operating a steam hammer, as a start. After a time they may be put to help a blacksmith, and if they are bright and have a foreman who recognizes merit, they may get a forge, doing small work. Once at the forge, they are usually there for life. There are very few who are blacksmiths from choice, and so few of them have a fair education, that it is not surprising that so little has been written on the art of blacksmithing.

If manufacturers would do something to bring the forge shop up to the standard of the average machine shop in the way of equipment, ventilating, heating, provision for wash-rooms, etc., and besides take an interest in the boys who are learning the trade, encourage them to study mechanical drawing, arithmetic and such things as would help them to do work according to mechanical principles, we would in a short time have our forge shops filled with men who would bring the art of blacksmithing to the front. But few people seem to realize the importance of blacksmithing, although there is not a machine-building concern, nor an individual, who does not depend upon it more or less. What would happen to our industries if it was not for the men who earn their living behind the anvil? JAMES CRAN.

Plainfield, N. J.

DRAFTSMAN'S PORTFOLIO.

Difficulty is often experienced, and time is wasted, in "hunting up" tracings. Every large firm has a boy or two to take care of the tracings in the files or the vault, and who are required to see that every drawing is properly charged to the draftsman requesting to borrow it. It is a fact, however, that tracings often disappear among the piles the draftsmen have on their tables. If, for instance, a certain tracing is wanted by the superintendent, the way to get it is usually as follows: After looking up the number, the boy in charge of the vault finds out that the drawing in question was charged to Brown on a certain date. He goes to Brown, looks through the tracings, and after a while, to make sure that the one he wants is not there, upon asking for it, he gets the following answer, "Somebody took it," and the boy is just as wise as before. He will have to look through all the piles of tracings, the number of which may reach to hundreds.



A Draftsman's Portfolio in which the Tracings in Use are kept.

If the boy has good luck, he will find what he is looking for, but he as likely may have to report that the tracing cannot be found, which, of course, will not satisfy the superintendent. This is an every-day occurrence, but the following device or system will do away with this trouble:

Let every draftsman have a portfolio large enough to hold the largest standard size of tracings. This portfolio should be of heavy cardboard, with the back and corners leather-covered. The front should have a number corresponding to the number of the table where it is used. The portfolios being kept in the vault over night, will assure quick distribution when they are taken out of the vault in the morning. A small block of loose leaves divided into four columns should also be attached to the front. The first column is to be used for the drawing number, the second and fourth for dates, and the third for the name of the draftsman to whom the tracing has been given. The portfolio should also have three or more partitions of cardboard to separate the drawings of different sizes or types of machines, thus facilitating the finding of any particular tracing. The drawings should be handled in the following manner: Each person taking a tracing out of the

vault, should register his name and the date on a card for that purpose, to be left in place of the tracing. After returning to his own table, the draftsman should at once put the number and the date in their proper columns. Now, if Smith asks for the same tracing later on, his name and the date should be put down by him in the proper column. When the boy looks for a tracing, all he has to do is to glance at the cover to know at once whether the tracing is in the portfolio or has been given to Smith. In this way he will find the tracing very quickly. If the tracing is returned to the vault or to Brown, the corresponding charge should be cancelled. By this method, the tracings will be kept clean and in good shape. GEO. WILLIAM BOHLER.

Milwaukee, Wis.

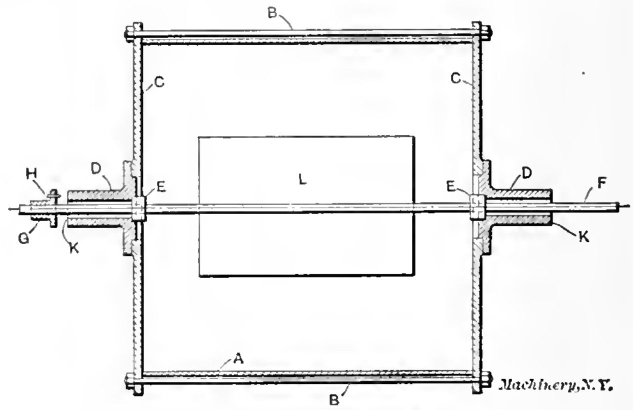
[While the system proposed by our correspondent has many good features, it is likely that the draftsmen would find it troublesome to open up the big portfolio every time they wanted to get or put back a tracing, and after a while it is to be feared that most of the tracings would be found on top of the portfolio, and not inside. That, however, may be a minor matter. A more important point to call attention to in this connection is that *tracings should not be used for reference*. Tracings are made to take blue-prints from, and for no other purpose. The only thing given to the draftsman for reference should be a blue-print; then there is no danger of soiling or spoiling the tracings by constant handling, nor of losing them; and a blue-print is fully as satisfactory as a tracing for reference.—EDITOR.]

FITTING TRUNNIONS TO A LARGE DRUM.

The sectional view shown herewith represents a steel drum held between two cast iron heads by rods with nuts on each end. To each head is bolted a flanged, hollow cast iron trunnion on which the drum is to revolve. In a shop where there is no lathe large enough to swing the drum, the problem is how to get the trunnions turned and bolted on so that they will be in line and true with each other.

Referring to the illustration, *A* is the steel drum, *B*, the rods for holding the drum and heads in place, *C*, the cast iron heads, *D*, the trunnions, *E*, two cast iron collars, *F*, a piece of cold rolled shafting, *G*, a flanged sleeve with a brass thumb-screw to hold it at any desired place along the shaft, *H*, a piece of drill rod sharpened for a scriber and held in the flange of the sleeve *G* by a small set-screw. After removing all rough spots on the bosses against which the trunnions *D* are to be bolted, holes are drilled through the heads *C* for the bolts which are to hold the trunnions. The steel drum is then placed between the heads and fastened by the rods *B* which pass through holes cast in the heads. The drum is now ready for putting the trunnions on. The trunnions are taken to the lathe and caught in the chuck by the flange, and the ends *K* faced. Then catching the end *K* in the chuck, the cored hole which passes through the center of the trunnion is counterbored a short distance at the flange end to fit the outside of the collars *E*, these collars having previously been bored a close running fit for the shaft *F*, and turned true on the outside. After chamfering the corner of the counterbore, the trunnion may be steadied by means of a pipe center while the outside diameter of the flange is turned true with the counterbore. The flange is then faced and fitted to the smallest diameter of the opening in the drum head, assuming that the opening will be somewhat out of round. The trunnions are now put in their places on the drum heads, and fastened by means of a strap across the opening in the head, and a bolt long enough to reach through the center of the trunnion and a washer against end *K*. By reaching in at the opening *L* in the drum, the bolt holes are marked on the trunnion flanges. After marking the trunnion flanges and drum heads so that each trunnion can be put back in the same place and position, the trunnions are removed and the bolt holes drilled after which the trunnions are put back in their places on the drum heads and all the bolts put in and tightened. Ordinarily on a rough job of this kind the flange seats on the drum heads will be true enough so that the trunnion flanges under the pressure of the bolts will come down tight all round, if not, the seat must be chipped or planed to give a fair bearing.

Now, with the trunnions on the drum heads, and bolts all tight, the cold rolled shaft is put in place as shown in the drawing with the two collars *E* in the counterbores of the trunnions. It is evident that the shaft is true with the outside diameter of the flanges at both ends of the drum. After coating the ends *K* with any good marking material, the sleeve *G* is placed on the outer end of the shaft and moved along until the scriber *H* is very close to the end *K* of the trunnion, where it is made fast by means of the brass thumb-screw, not shown. The shaft is now revolved, by taking hold of the sleeve *G*, and at the same time pushed gently until the scriber comes in contact with the end of the trunnion and scribes a circle thereon. It is obvious that the circle so scribed is true with the shaft bearings in the collars *E*, and also true with the outside diameter of the trunnion flanges. The sleeve is now removed, and placed on the other end of the shaft and the other trunnion scribed in the same manner. The trunnions are now removed and taken to the lathe, and



Section showing the Drum and its Trunnions which were turned in a Small Lathe, and then set in Alignment with each other.

caught by the flange end in the chuck and set so that the outside diameter of the flange and the circle on the end *K* both run true at the same time. The cored hole, which passes through the center of the trunnion may now be bored a short distance in at the end *K*, and chamfered to fit a pipe center which may be used to steady the work while roughing, after which the center should be withdrawn to see if the circle is still running true; if not, it must be made to run true with the outside diameter of the flange after which the finishing cut is taken. After finishing to size, the trunnions are put in their places on the drum heads, and bolted up in the exact positions which they were in when the circles were scribed on their ends at *K*, and they will be in line and true with each other as desired. J. T. GRIMSHAW.

Detroit, Mich.

AN ALTERNATIVE PLANER TYPE SUGGESTED.

We have read with much interest your description of the huge Bement (Niles-Bement-Pond Co.) planer, published in your January issue. It seems to us that if we take into account the depreciation, interest on money invested, the large space taken up by the machine and the extra power required, a sum of at least 50,000 to 60,000 francs per annum should be charged against it. The first cost, no doubt, was not far from 300,000 francs. It is a pity that we do not know exactly the kind of work this machine has to plane, but it seems that a planer built on the style shown in the accompanying half-tone illustrations, would have served general purposes much more economically and would have been fully as adaptable, especially so if the bottom table could be raised and lowered by hydraulic pistons so as to place the work at the required height.

M. Morane, of Paris, has a planer of this type in a much smaller size with the hydraulic system to adjust the table, and it is giving excellent satisfaction. In our opinion a planer built according to this plan would not require more than 25 horse-power, and it would take up no more room than the machine illustrated in your January issue. There certainly would be much difference in the capital invested.

SOCIETE ANONYME DES MOTEURS A GAZ A. BOLLINCKX.

Huyssinghen, Belgium.

[The type of planer referred to in the above is that built

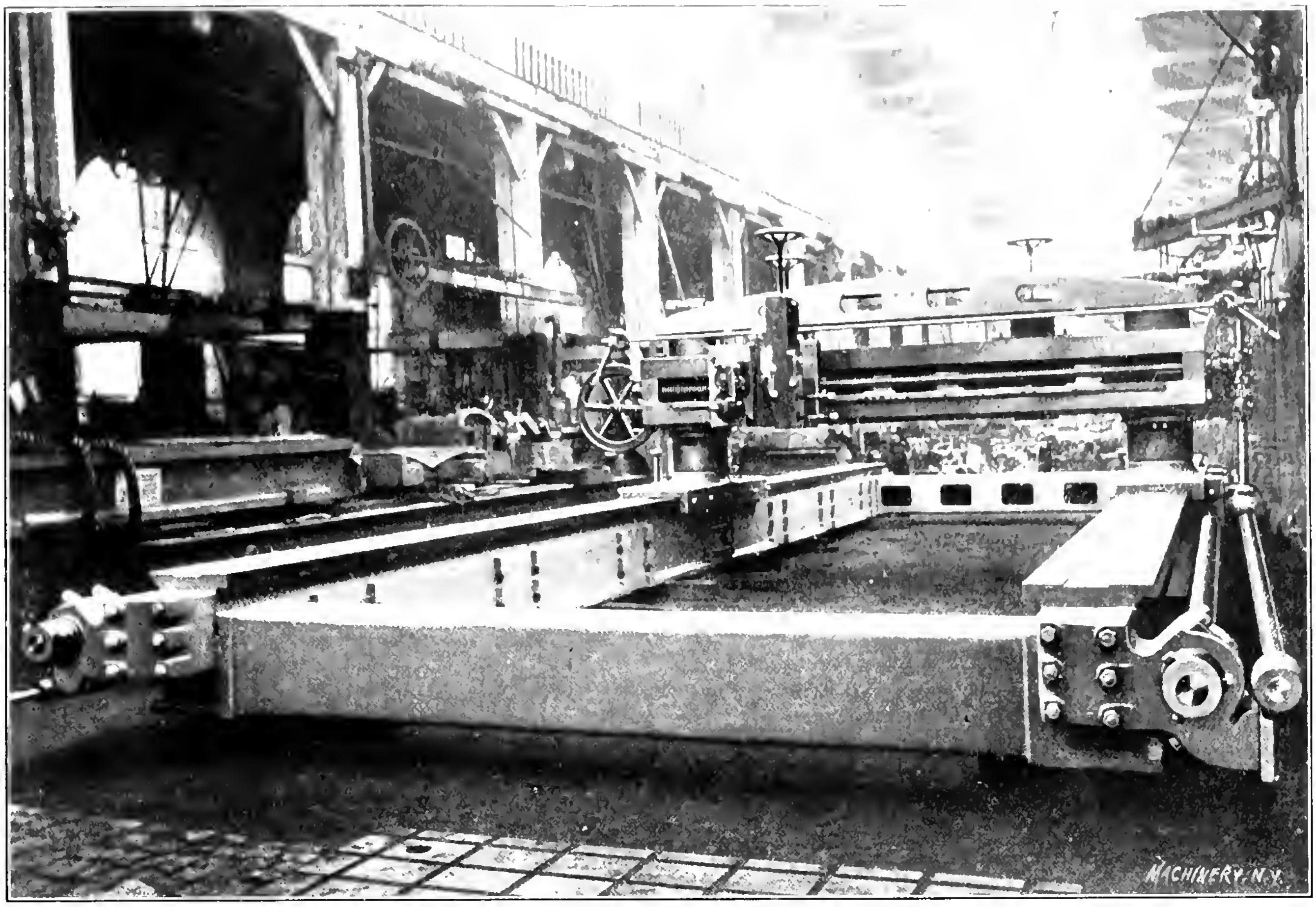


Fig. 1. Pit Planer built by Societe Anonyme des Etablissements Fetu-Defize, Liege, Belgium.

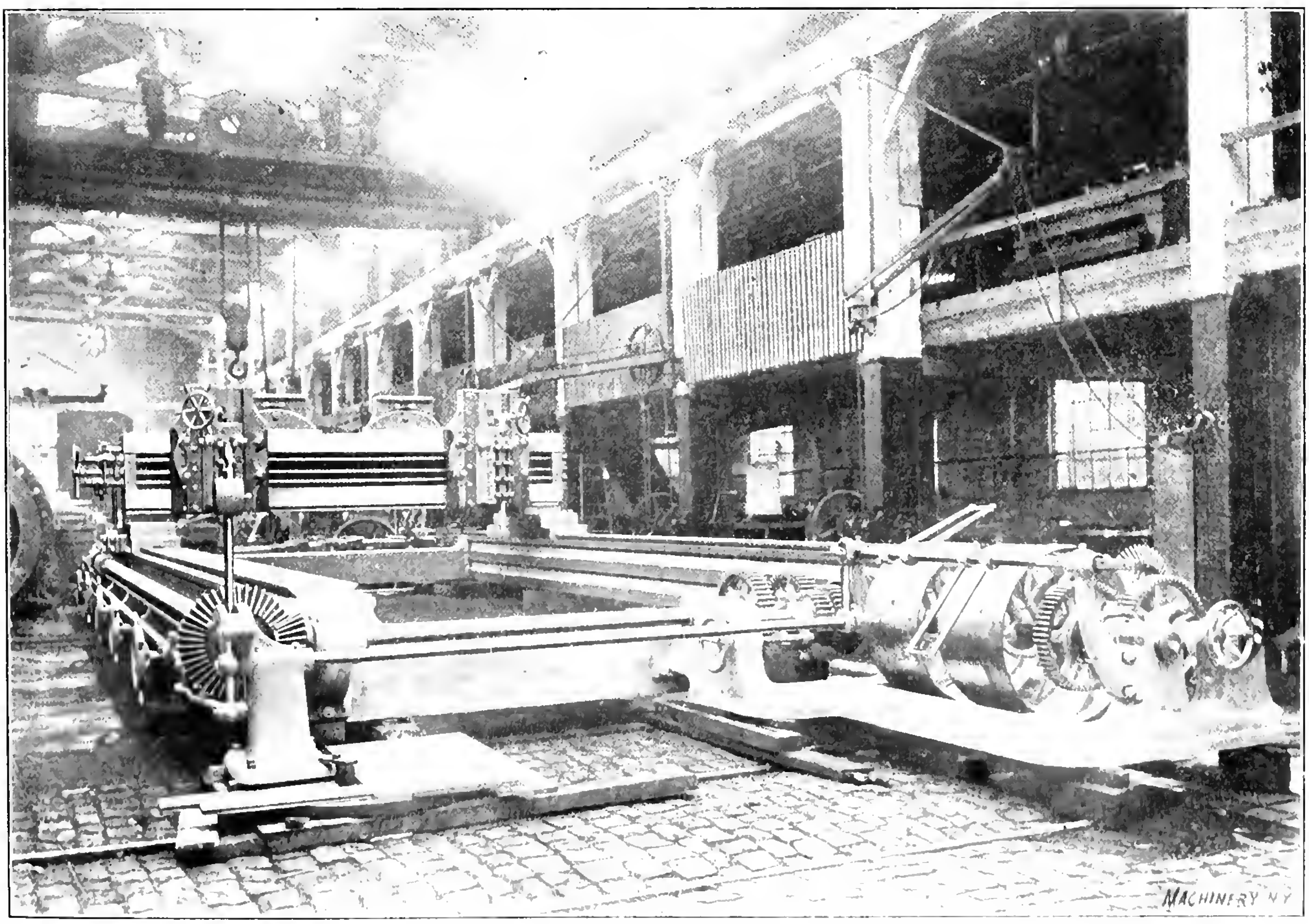


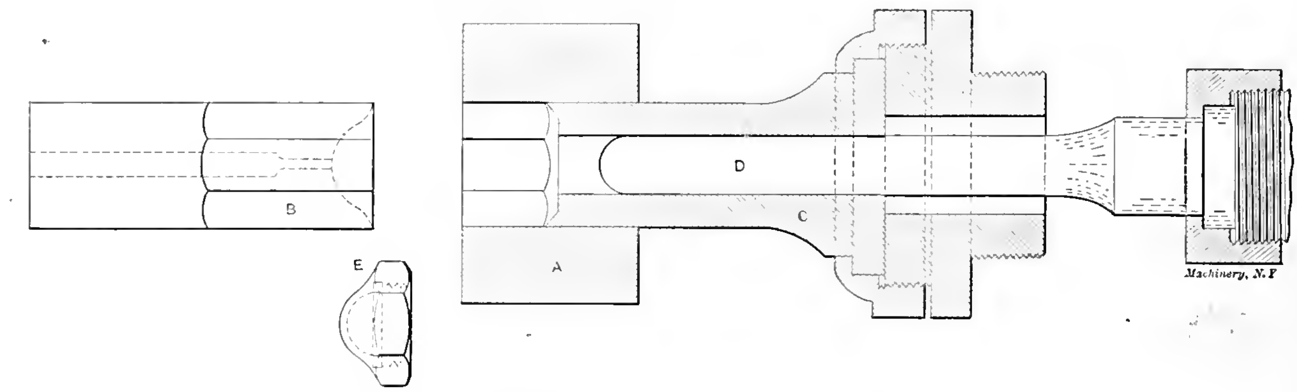
Fig. 2. Another Pattern of Pit Planer built by the Same Concern.

by the Societe Anonyme des Etablissements Fetu-Defize, Liege, Belgium, and is used by such concerns as Fried. Krupp, Essen, Germany; Armstrong Whitworth & Co., London, England; Dillingen Huttenwerke, Dillingen, for planing armor plates, conning towers for forts, and other heavy work having great weight. The same type of planing machine is used in America by the Bethlehem Steel Co.'s and Carnegie Co.'s armor plants.—EDITOR.]

MAKING NUTS FOR FLEXIBLE STAY-BOLTS.

The accompanying engraving shows a method of making nuts for flexible stay-bolts, which may be of interest to some of the readers of MACHINERY. In the shop where this method is employed, a drop forging press is not available. This device was therefore designed to be used on a 1½-inch Ajax nut machine. The nut blank is placed in a holder *A*, and the die *B* holds it in place. The punch *C* then moves forward and crowns the nut, and finally punch *D* is fed forward and makes the recess into the blank for the thread, at the same time that the projection is thrown up on the end of the nut. The finished nut is shown at *E*. This process of making nuts proved a complete success, it being possible to make 1,000 in 10 hours.

W. L.



Device for making Flexible Stay-bolt Nuts on the Ajax Nut Machine.

THE USE AND ABUSE OF THE HACK-SAW.

The most useful tool in the tool-room, and, at the same time, the most abused tool of all, perhaps, is the power hack-saw. Nearly every tool-room has one, and every one, from the new apprentice to the "old man" uses it more or less—but how do they use it? In the average shop this tool is not only neglected in so far as cleaning and proper oiling is concerned, but it is misused in almost every conceivable way, and it has occurred to the writer that a few words in the columns of MACHINERY with reference to the proper use of the hack-saw might be instrumental, to some extent, at least, in calling attention to this matter. The following, therefore, contains a few suggestions which will be helpful for getting the best results out of this machine with a minimum cost for hack-saw blades.

When a piece of steel is nearly sawed off, it is poor practice to try to break it off while the saw is running, by working it up and down, because it is likely to break the saw in every instance. The saw should be stopped, and the saw-frame raised first, before any attempt is made to break off the piece.

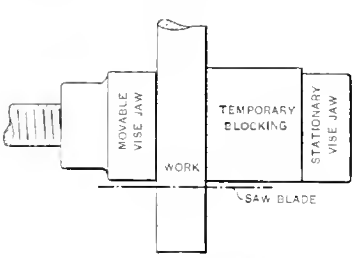


Fig. 1. Temporary Blocking for Using Portion of Saw not yet Dulled

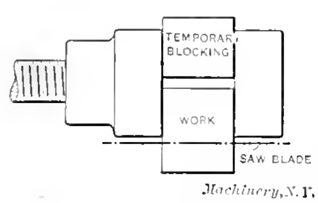


Fig. 2. Blocking for Holding Short Work.

If a piece of steel or iron is sawed through about one-half or three-quarters of its thickness, and the saw blade proves to be too dull to cut through the piece completely, then remove the blade and replace it with a new one, but turn over the piece and start the cut on the opposite side, because a dull saw blade is always worn more or less on the sides, and will always cut a narrower slot than a sharp blade, and if a new blade is forced into the slot already sawed by a dull saw, it will almost always stick, and when started up it is very likely to break.

The duller a saw is, the more pressure or weight should be brought to bear upon it. Whenever the old blade is replaced by a new one, the pressure should be released, to a certain extent, as a sharp blade, with too much pressure back of it, will have a tendency to break. If, by chance, it does not happen to break, it will at least get some of the teeth broken off, which, as far as its usefulness is concerned, to a certain extent, is almost as bad as if the saw itself were broken. This, in fact, is one of the chief causes of the breakage of saws, and it is also a reason why saw blades made by reliable and able makers are pronounced too hard, and discarded, at times, for inferior ones, although the real cause of the breakage ought to be laid to the ignorance and carelessness of the operators.

The writer has often seen saw blades thrown away, that are supposed to be too dull for further use, although they could have been used for a great deal longer time, if the method shown in Fig. 1 had been employed, where that part of the blade is used which has not previously been employed to any great extent. When most of the pieces cut off in the hack-saw are of small diameters, it is often only one small portion of the saw that becomes dull, the remainder being as good as new. The engraving indicates how the piece sawed off is removed from its ordinary position by a temporary blocking between the piece itself and the stationary vise jaw. This, of course, permits the saw to cut with a different portion from that which has previously been employed to do most of the work.

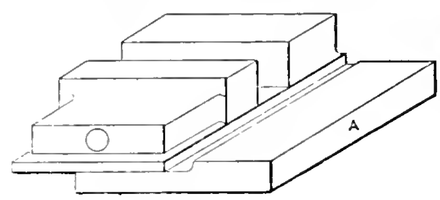


Fig. 3. Shelf for Supporting Portion of Work being Cut Off.

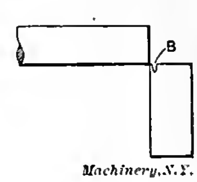


Fig. 4. Effect when End of Work being Cut Off is not Properly Supported.

In starting up a saw, it always pays to slightly lift up the saw frame until the blade has made a few strokes and provided a bearing surface for itself in the piece to be cut off. It is evident that in sawing off a piece of square or flat stock, the blade will first come in contact with the sharp corners of the stock, which, of course, give no bearing surface for the saw at all, and the saw will therefore dig in. If, however, the saw is prevented from coming down upon the work with its full weight until a sufficiently long bearing surface for the teeth has been provided, the life of the saw will be greatly prolonged, and a consequent cutting down of the expense of the operation of the hack-saw will follow.

If a bar is to be cut off, always hold it in the vise in such a manner that the greater portion of the bar is between the vise jaws. This will give a good support to the piece. A piece of work that is insecurely held in the vise will always wobble, and this is a frequent cause of breakage of saws. Should a piece be so short that, when placed in the vise, it will not extend over one-half of the length or width of the vise jaws, then place a piece of blocking of the same diameter at the other end of the vise, as shown in Fig. 2, before tightening it. This will tend to permit the vise to hold the work securely, and also prevent injury to the vise from springing or breakage.

If a hack-saw is of a good design, it usually has a projecting shelf similar to that shown at A, Fig. 3, which provides for support of the piece to be cut off. Otherwise, when nearly sawed off, the piece will bend over, causing the saw to dig into it, as at B, Fig. 4. All hack-saws, however, are not provided with this projecting shelf, and this is rather surprising, as it seems to be a serious defect.

In conclusion, the writer would say that, from personal experience, he believes that the best results are obtained by having all the sawing off, either on the power hack-saw or a cutting machine, done by one man, provided it is seen to that this man knows his business. No one else should be permitted to run the machine. In this way, if anybody is to be blamed for undue carelessness, it is an easy matter to find out who is to blame. Better results are also obtained, from a financial point of view, because a great deal of time is wasted by each man spending a certain time on cutting off his work himself at the hack-saw, when this could as well be done by somebody who is doing this kind of work all the time.

C. F. Emerson.

WHITWORTH OR ENGLISH TAPER PIPE TAPS.

In the article on Screw Thread Systems in the February issue of Machinery, it was mentioned that the manufacturers make the taper on Whitworth or English pipe taps the same as the taper on Briggs standard pipe taps. In the April issue, however, it is also mentioned that in England these taps are made with a 1-inch taper per foot, instead of ¾-inch, and that at least one firm in this country makes these taps with the taper according to this practice. No table, however, is appended, giving any dimensions for English taper pipe taps, when these are made with a 1-inch taper per foot. Mechanical hand-books give nothing on the subject of the taper of Whitworth pipe taps, and for that reason it is highly desirable that the question of correct taper be brought up in the discussion of this subject. The dimensions of these taps should be based upon standard Whitworth pipe tap gages, which are made in England by the Whitworth Company. These gages all taper 1 inch to the foot and are so marked upon the gage.

The accompanying table shows the dimensions of Whitworth pipe taps, as made by the A. J. Smart Mfg. Co. It will be noticed by comparing this table with the one appearing in the March issue of Machinery, for regular Briggs pipe taps, that the diameters at the small end are not the same for the

TABLE OF WHITWORTH PIPE TAPS.
(A. J. Smart Mfg. Co.'s Standard.)
Taper per foot = 1 inch.

Nominal Size.	Diameter at Large End of Thread.	Total Length of Tap.	Length of Thread.	Length of Shank.	Diameter of Shank.	Length of Square.	No. of Threads per inch, Whitworth Form.	Number of Flutes.	Size of Steel.
1/8	0.435	2 1/8	1	1 1/8	0.328	11/32	28	4	15/32
1/4	0.570	2 3/8	1 1/8	1 1/4	0.438	7/16	19	4	19/32
3/8	0.718	2 5/8	1 5/16	1 5/16	0.563	1/2	19	4	3/4
1/2	0.888	3	1 7/16	1 9/16	0.703	9/16	14	4	59/64
5/8	0.964	3 1/4	1 15/32	1 25/32	0.781	5/8	14	4	1
3/4	1.103	3 3/8	1 1/2	1 7/8	0.906	11/16	14	4	1 9/64
1	1.382	3 3/4	1 5/8	2 1/8	1.125	13/16	11	4	1 13/32
1 1/4	1.725	4 1/8	1 3/4	2 3/8	1.453	15/16	11	6	1 3/4
1 1/2	1.958	4 3/8	1 7/8	2 1/2	1.609	1	11	6	1 63/64
1 3/4	2.130	4 1/2	1 15/16	2 9/16	1.766	1 1/16	11	6	2 5/32
2	2.430	4 5/8	2	2 5/8	2.063	1 1/8	11	6	2 15/32

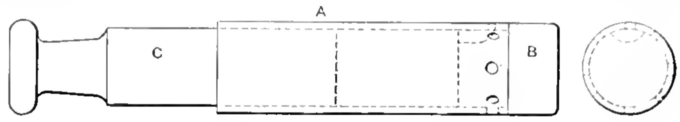
same nominal sizes. This is because English pipe is smaller than American pipe, according to all tables, so that the ends on the Whitworth pipe taps should be made correspondingly smaller. It is believed by the A. J. Smart Mfg. Co. that the proper way to make the taps, therefore, is to make the diameter at the smaller end correspondingly smaller. The lengths of the pipe taps in the table will also be found to be shorter, because it has been found that all users of pipe taps, especially plumbers, prefer the shorter lengths, and many of the tap manufacturers are now making the lengths of the threaded part of pipe taps the same as those given in the table. The A. J. Smart Mfg. Co. also only makes 4 or 6 flutes in its taps. The company has found that customers do not like an odd number of flutes, as the taper with the odd number of flutes can never be measured by micrometers after the flutes have been once milled. This is a great disadvantage (or, to some people, an advantage) in cases of disputes as to the sizes of the taps. In the table given, there will be found a column giving the size of the steel used for the different taps. This information is given for the convenience of the purchasing agent, the superintendent, the foreman, etc., and has often been found exceedingly useful.

Charles E. Smart.

Greenfield, Mass.

DEVICE FOR MAKING WAX FILLETS.

The device for making wax fillets, described by M. R. Kavanagh in the December, 1907, issue of Machinery, is a good thing for a pattern-maker to own, but it may be made as shown by the accompanying illustration with less trouble and expense. The barrel A is a piece of brass tubing. The cap B



A Simple Tool for Making Wax Fillets.

and the plunger C are both made of hard wood. Eight different sized holes are drilled near one end of the tube, all but one being covered by that part of B which extends into the tube, as shown. Any other hole may be uncovered by turning B. To produce a fillet, fill the barrel with wax, warm, and compress in a vise.

W. H. Knowles.

New Britain, Conn.

METHOD OF MAKING SCREW FOR DRILL CHUCK.

Some time ago I had occasion to replace a screw in the Standard Tool Co. drill chuck, and as we did not have any in stock, one had to be made as soon as possible. I gave the job to a tool-maker working under me, and asked him how long it would take to make it, and he said about one hour

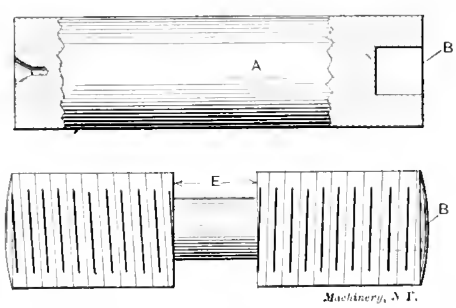


Fig. 1. Two Views of the Partly Finished Chuck Screw.

and a half. I doubted his word, somewhat, on the time, but told him to go ahead, and in less than an hour and a half he handed me the chuck repaired with a good hardened screw, and as true as the day it came from the factory. This is a job that a tool-maker does not have very often, as these screws

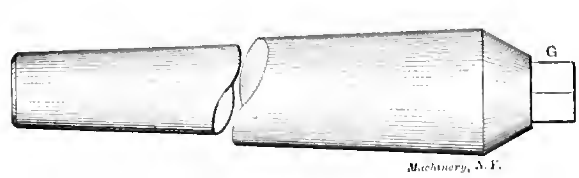


Fig. 2. Lathe Center for Holding and Driving the Work.

are usually replaced by ordering from the factory, but at the same time, when there is one needed and there is none in stock, it is usually a hurry-up job, and it is very important that we should know how to get it out in good time.

Referring to Fig. 1, the first operation is to cut off a piece of stock A long enough to make the screw, allowing a little

stock for finish on both ends; then broach in the square hole *B*, and center the other end. Then it is ready to be turned and threaded as shown. It is also necessary to have a lathe center such as shown in Fig. 2, with a square *G* to fit the hole *B* snugly, the square also acting as driver. Then with a parting tool, cut groove *E* (Fig. 1) about 1/8 inch narrower than it is to be when finished. Then the piece is ready to be threaded. Cut the thread right- and left-hand, using the broken screw for thread dimensions. It is not necessary to take any care in starting threads in the right position, in order to have the jaws come central in the chuck.

After the threads have been finished to size, chuck jaws *D* (Fig. 3) are set in place on the screw and turned around until they come firmly against center pin *H*. The groove *E* can then be made perfectly central with the working faces of the chuck jaws by setting the parting tool with the pin *H*, which is held between the jaws. After the tool has been set in this way, and one side of the groove *E* has been faced, the jaws may be put on the screw again in the same position, and the tool set for facing the opposite side of the groove.

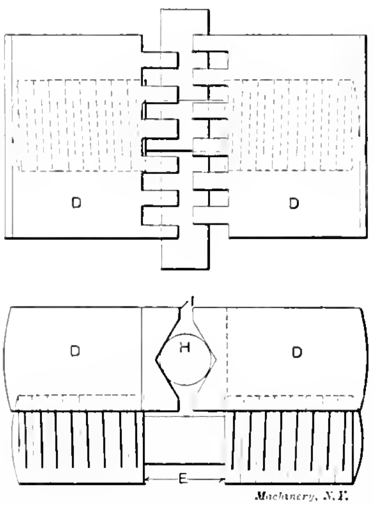


Fig. 3. Method of getting the Groove E and the Working Faces of the Chuck Jaws Central.

It may seem useless to the reader to use the center pin *H*, as it would be just as well to use the chuck jaw at *I* to obtain the center of the groove *E*, but that will not hold good in all cases, as sometimes you will find that the surface *I* is not true with the part of the chuck jaw that holds the drill. In order to be on the safe side, it is wise to take the measurement from the working part of the chuck jaw. It does not matter whether the chuck is old or new, groove *E* is bound to be central with the working face of the jaw. One thing I would like to say in conclusion is that it is wise to have a piece of steel on hand suitable for making screws, as most carbon steel used for reamers, taps, etc., would be too high in carbon to give good results on screws where there is a twisting strain, such as chuck screws. B. M. Weller.

Franklin, Pa.

HARDENING OF HIGH SPEED STEEL VERY IMPORTANT.

Referring to your remarks anent high speed steel for milling cutters (page 453, engineering edition, March issue), users of steel must not confuse "hardness" and "red-hardness." Further, some steel tools last longer than others without re-grinding, on cast iron; while on steel or wrought iron it is the other way about. Too many steel users mix the terms "self-hardening" and "high speed"; also, they consider that all high-speed steel is alike; whereas, there are more sorts thereof (I don't mean brands) than there are of ordinary "binary" or carbon tool steels. The lasting propensity of a tool steel is more dependent on the hardening process than on the manufacturer; and more on the hardener (man) than either. Robert Grimshaw.

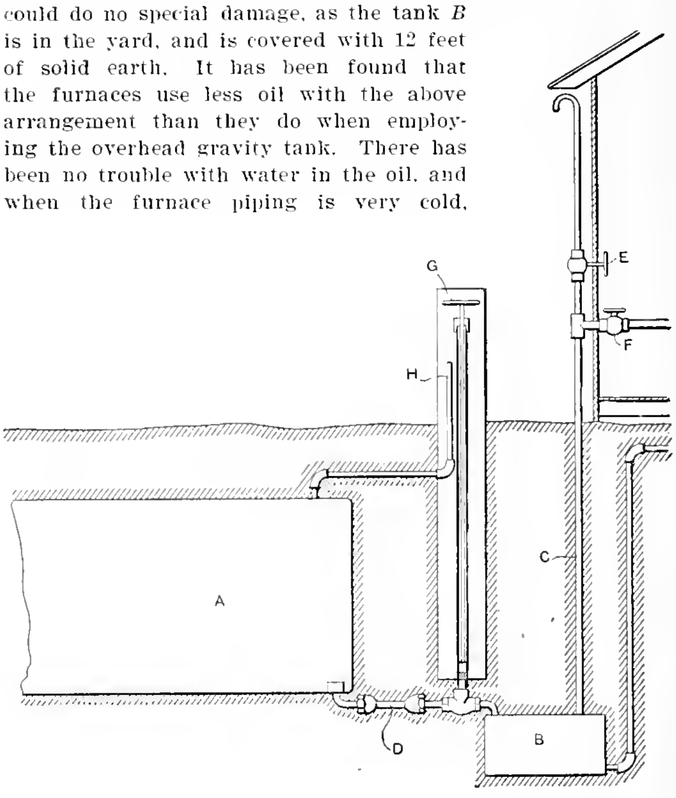
Dresden, Germany.

FUEL OIL STORAGE SYSTEM.

Most oil storage systems are arranged so that the oil will flow by gravity to the places where it is required. This, however, necessitates having the oil tank elevated, and considerable danger is connected with this system. In order to eliminate this danger, the arrangement shown in the accompanying engraving was resorted to by a foundry in the middle West. The object of the arrangement shown is to place all oil below the ground, and to keep it there unless it is forced away from its reservoirs by means of air pressure. As will be seen from the following description, all pumping of oil is eliminated, and at the same time the danger of carrying air pressure on a large storage tank for oil is avoided.

The arrangement consists of a large storage tank *A*, which is 35 feet long and 8 feet in diameter. This storage tank is filled directly from a tank car at that end of the storage tank not shown in the engraving. The small tank *B*, from which the oil is fed to the places where it is used, by means of air pressure, is connected with the storage tank *A* through the piping *D*. This tank is 5 feet long by 2½ feet in diameter. When it is required to fill the tank *B*, the vent valve *E* is opened and the air pressure valve *F* closed. The tank *B* will then be filled, by gravity, in six minutes. The valve *G* and the vent valve *E* are now closed, and the high pressure valve *F* opened, permitting the air pressure to be applied on the oil in tank *B* through pipe *C*. Then, if such furnace valves as required are opened, the oil will flow to the places where wanted, actuated by the air pressure on the oil in tank *B*. It is impossible to get any air pressure on the oil in the large tank on account of this tank having a vent pipe *H* which cannot be closed, and the security is all the greater as the air pressure pipe to tank *B* is smaller in diameter than the vent pipe *H*, so that if valve *G* should be left open, the air will escape directly into the atmosphere through the pipe *H*. When the pressure valve *F* is closed and the vent valve *E* opened, leaving all furnace valves as they are in operation, all oil in the pipes in the shaft will return by gravity at least 36 inches below the floor of the shop.

If, after several years of use, the pressure tank should be weakened through corrosion so that it would rupture, this could do no special damage, as the tank *B* is in the yard, and is covered with 12 feet of solid earth. It has been found that the furnaces use less oil with the above arrangement than they do when employing the overhead gravity tank. There has been no trouble with water in the oil, and when the furnace piping is very cold,



Economical and Safe Storage System for Fuel Oil.

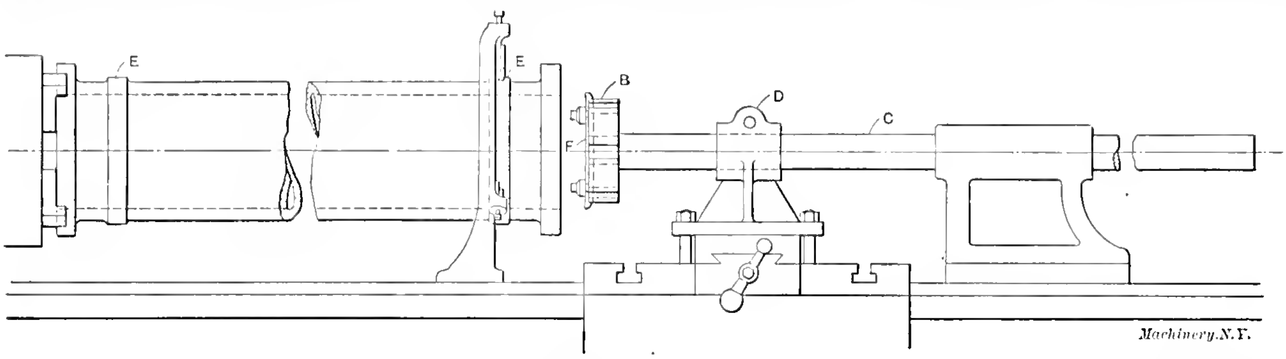
no heating of the same has been required, as was formerly the case, because the oil is comparatively warm in the underground tanks, and, having a pressure of 60 to 80 pounds per square inch, it always finds its way to the furnaces. It should be noted that it is important that a lead pipe be used for connecting the two tanks, permitting each tank to settle independently.

The valve between the two tanks *A* and *B*, which is operated by the hand-wheel *G*, is placed in a box with locked cover. This box enters in the ground so that it comes down close to the valve seat. The vent pipe *H* is also placed inside of this wooden cover, and ten 1½-inch holes bored in the side of the box to permit free circulation of the air.

Racine, Wis. E. Falkenrath.

BORING LONG CAST IRON CYLINDERS.

We had some cast iron cylinders to bore, and as they were ten feet long, and were to be bored twelve inches in diameter, we were obliged to make a special boring tool. The sketch shows this tool, and the way in which it was attached to a lathe. The boring head *B*, which is keyed to the bar *C*, has six dove-tailed slots cut across its periphery. These slots were for holding hard wood blocks which fitted closely into the bore, guiding the bar. A double-ended boring tool was clamped in the groove across the head, as shown at *F*. The split sleeve



The Way in which a Boring-bar was attached to a Lathe when boring Long Cylinders.

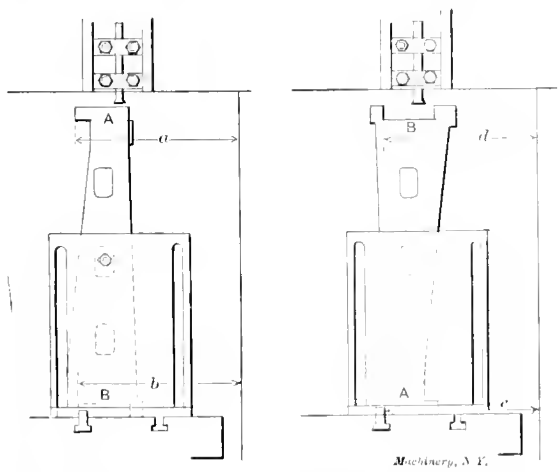
D, which was fastened to the lathe carriage, supported one end of the boring-bar, and the sleeve was clamped to the bar when boring, as the feeding was done by the lathe carriage. The bar was also supported by the tail-stock as shown. Before the boring-bar was placed in position, the enlarged parts *E* of the cylinder were trued up, as the outer end of the cylinder had to be supported by a steady-rest.

In starting the cut, it was necessary to steady the bar by clamping the sleeve nut *D* close to the boring head, but when the head had entered the cylinder, the sleeve was moved out as far as the tail-stock would permit, and again clamped to the bar. In starting this job, the double-ended boring tool and hard wood block referred to, were used. It was found, however, that by using a single tool, and by inserting hardened steel blocks in the two slots opposite the tool, much better work could be done, because in the former case the blocks were rapidly worn away. Of course, it was necessary to adjust these blocks for each cut. The cylinders bored in this way were approximately straight and true, and the work entirely satisfactory. M. B. STAUFFER.

Scottdale, Pa.

METHOD OF PLANING AN ODD-SHAPED CASTING.

Referring to the accompanying engraving, it is necessary that the end *A* and the socket *B* be interchangeable with another end and socket, and that the parts,

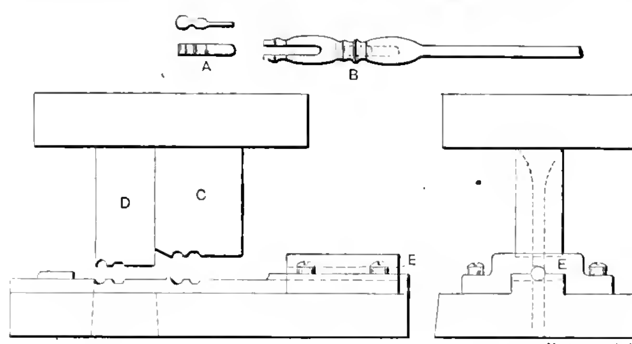


Figs. 1 and 2, showing the Work set up on the Planer.

when in position, line up the same when the extension is in use, as when it is removed and the other end and socket are in position. The length of the extension is such that a very small variation at either end would be sufficient to cause a serious variation at the other end. After several attempts to plane the casting with sufficient accuracy, the following method was decided on as giving the best results: The casting was placed on the planer table with the end *B* down, and with one side of the slot against a tongue inserted in the table slot. The casting was then set with the planer housing by measuring at *a* and *b*, adding enough to *a* and subtracting enough from *b* to allow for finishing. After the end *A* was finished to the required dimensions, the casting was inverted, as shown, and the finished edge placed against the tongue piece in the table. A micrometer measurement *c* was then taken from the tongue to the housing, and one side of the slot in the end *B* of the casting finished to this measurement as at *d*. In this way the finished surfaces at each end of the casting were made parallel, and in the same plane. LEROY K. MOULTON.

A SWAGING AND BLANKING DIE.

A few years ago, I had some small pieces to make as shown at *A* in the engraving. These pieces, I believe, hold the sapphires used on phonographs. The job puzzled me a bit until I hit upon the scheme of running an annealed brass wire through a gang die, and swaging and blanking the pieces from this. At *B* is shown the end of the wire after the swaging and blanking punches have done their work. The swaging punch is shown at *C*, while *D* is the punch that forces the blank



Swaging and Blanking Die for Forming the Pieces shown at A

through the die. The wire is fed through the guide *E*, which keeps it in proper alignment with the working faces of both die and punch. The dotted lines, shown on the swaged end *B* indicate where the next piece *A* will be cut from the stock by the blanking punch *D*. A stripper (not shown) removes the scrap from the blanking punch. The pieces, after coming from the die, are tumbled and then drilled.

New York. JAMES J. KLEIN.

CUTTING OFF STEEL SHAFTS.

The following little kink may be appreciated by many machinists who have had more or less trouble when cutting off steel shafts. By simply turning the cutting-off tool upside down, and running the lathe backwards, it is possible to almost entirely eliminate any digging in of the tool. This method will be found to be far superior to the ordinary method of cutting off stock. Of course, it works to best advantage when using a straight cutting-off tool. It is necessary that the lathe be reversed; or else, if the cross slide permits of the tool being placed on the opposite side of the lathe, in the rear, then the reversing is of course unnecessary.

Birmingham, Ala. JOHN MCLEOD

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

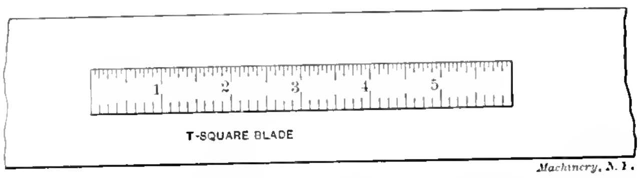
MAKING KNURLS.

A very satisfactory method of making the common knurls, when no other means is at hand, is to turn up the flank in a lathe, then place it in the holder and insert the holder in the tool-post of a shaper. Next clamp a sharp, flat mill file in the shaper vise, flat side up, and run the knurl blank back and forth over it until teeth sufficiently deep are cut. By using a wide file, and shifting the shaper vise, knurls having teeth varying from a considerable angle to those straight across may be obtained. Instead of a file, a specially cut piece of hardened steel is often used. After the knurls are cut, they are hardened and tempered in the usual way and are then ready for use. ETHAN VIALL.

Decatur, Ill.

STEEL RULE RECESSED INTO T-SQUARE BLADE.

The following little kink may be of some value to those readers of MACHINERY who are draftsmen. A 6-inch flexible Brown & Sharpe scale is laid into the T-square blade, which has previously been recessed somewhat to fit the scale, as shown in the accompanying engraving. Shellac is used to



hold the scale in place in its recess. The dividers and compasses may be set directly from this scale, and the annoyance of looking for an ordinary loose draftsman's scale is avoided. Scales graduated to 32ds and 64ths of an inch are convenient for fine work. The writer has found that the Brown & Sharpe scale fitted in this way is very handy. JOHN COAPMAN.

Rochester, N. Y.

A TAPER TURNING KINK.

The usual way of turning a taper in a lathe without using a taper attachment is to set over the tail-stock and use the same centers as are used for straight work. This gives an uneven bearing on the centers, thus wearing the centers away, as can be readily seen from Fig. 1. This method is likely to spoil accurate work. Fig. 2 shows a simple and inexpensive way of overcoming these bad points. All that is necessary

Fig. 1

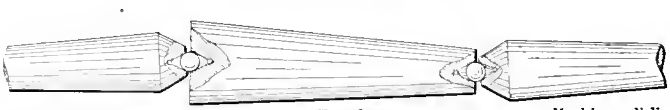


Fig. 2

is to turn up two female centers and put bicycle balls in them. They need not be fastened, as a little oil is sufficient to stick them in place while the work is being put in the lathe. S. A. MCDONALD.

Candiac, Canada.

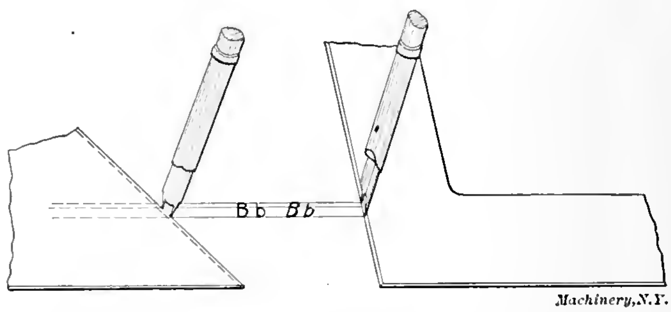
A NEW TRICK IN CAT-HEADS.

Every machinist has had to use some kind or variety of cat-head, and generally when using this same indispensable cat-head, the frame of mind of that same machinist is anything but dee-lighted. The other day I saw a simple method of making a cat-head which made me feel like bumping my head against a brick wall for not thinking of it when I required one for my own use. The man had two levers about four feet long, which had to be turned and machined to a special shape at one end, and the other end was turned round nearly one-half the length of the lever. He procured a bushing which had a hole about ½ or ⅝ inch larger than the diagonal of the lever, and using this as a mold, poured a babbitt cat-head on each of the levers. He used the same bushing on both levers, and then took a light cut over both cat-heads, making them the same outside diameter. Then he adjusted his steady-rest to the cat-head, and finished the job with a smile on his face. J. J. VOELCKER.

Decatur, Ill.

HANDY TOOLS FOR THE DRAFTING BOARD.

If a great deal of lettering has to be done on a drawing, it is convenient to have a gage for a uniform height of the letters. Such gage can conveniently be made of an ordinary pen point, by breaking off the two points and using the two remaining points as a gage. For the height of the capital

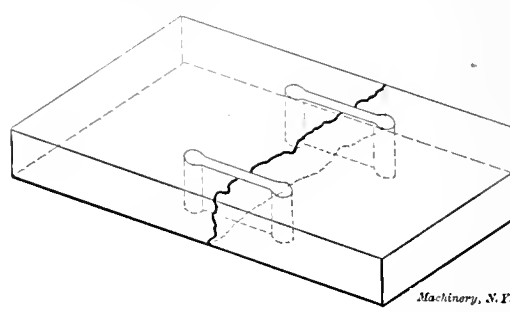


letters point off their space along the vertical side of a 45-degree triangle, and for the height of the small letters use the gage along the inclined side of the same triangle, which will give the right proportion, as shown. I always keep on hand a number of broken-off pen points of various sizes for different gages. MARTIN JOACHIMSON.

New York.

A DUMB-BELL PATCH.

A simple application of a repair "stunt" called a dumb-bell patch, that does not seem to be widely known, is shown in the engraving. The patch, or more properly, the link, gets its name from the resemblance it bears to the dumb-bell, and finds a field of usefulness in joining the parts of a broken casting



that must be held as near as possible to their original position and have no screw heads or indentations in the finished surface. This is accomplished as follows: The broken pieces are put closely together, and the place for the dumb-bell is laid out, after which the casting is drilled and slotted to these lines. A piece of steel is then carefully worked up to fit this opening, but with the distance from center to center of the round ends slightly less than the drilled holes for the dumb-bell. The piece is heated until it is long enough to be driven home, and while cooling, it is riveted slightly to fill perfectly all around, after which the patch can be filed off flush. By this method the broken parts will be held together with considerable force. DONALD A. HAMPSON.

Middletown, N. Y.

* * *

In the May issue we published an article on the "Shop Kinks" page, by Mr. J. J. Voelcker, on the use of the steady-rest. The illustration accompanying this article did not show a driver attached to the work, but, of course, it will be understood that the only function of the leather strip is to hold the work against the head-stock center.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

DEFINITION OF MACHINE TOOLS.

C. L. B.—Please define machine tools.

A.—A strict definition of machine tools is difficult, if not impossible. A machine tool is a metal-working machine, but not all metal-working machines are machine tools, by any means. The standard machine tools are engine lathes, turret lathes, chucking lathes, pulley lathes, screw machines, planers, shapers, slotters, milling machines, gear cutters, gear planers, boring mills, boring machines and drilling machines, these being the chief examples. Then follow key-seaters, broaching machines, nut-tappers, centering machines, bolt threaders, hack-saws, cam cutters, profilers, etc., which are on the borderland. A broad definition of machine tools would include these also, but the narrower sense in which the term is commonly used, does not include them.

CHANGE GEARS FOR MILLING MACHINE WHEN CUTTING SPIRALS.

Machinist.—In the January issue you explained, in a simple manner, to "Apprentice," how to figure change gears for the lathe. I would be pleased if you would explain, in a similar way, how to figure change gears for the milling machine, when cutting spirals.

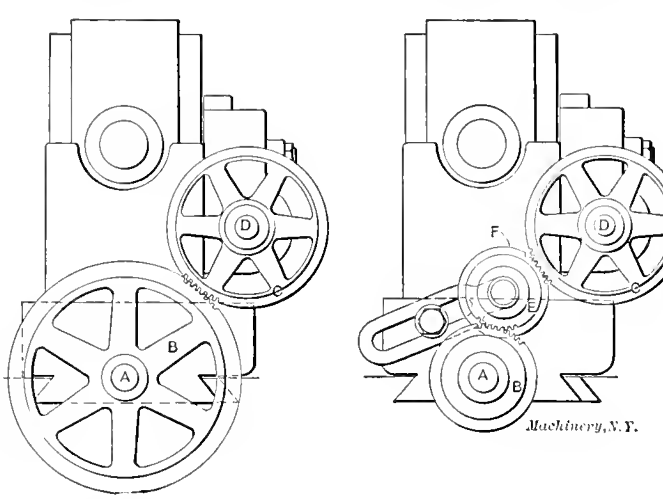
A.—The method for the figuring of change gears for cutting spirals on the milling machine, is, in principle, exactly the same as that used for figuring change gears for the lathe, but it will be necessary to shortly refer to the construction of the mechanism for connecting the index head spindle and the feed-screw to make perfectly clear the fundamental ideas governing the selection of change gears. In Fig. 1, *A* is the feed-screw of the milling machine, and *B* is the gear placed on this feed-screw, commonly called the feed-screw gear. This gear meshes with the gear *C*, placed on the stud *D*, from which, in turn, motion is imparted to the worm in the index head and from the worm to the worm-wheel and the index spindle. The gear *C* on the stud *D* is called the worm gear, because it directly operates the movement of the worm. This expression "worm gear" should not be confused with the worm-wheel, which is placed on the index spindle. The case shown in Fig. 1 is one of simple gearing. In Fig. 2 is shown a case of compound gearing. Here *B* still represents the feed-screw gear, *E* is a gear on the intermediate stud, meshing with gear *B*, and gear *F* is another gear on the same intermediate stud, meshing with gear *C*, thus transmitting motion from the feed-screw to the stud *D* by compounding the gears.

The figuring of change gears for the milling machine consists simply in the selection of the proper gears, *B* and *C*, used in a simple train, as in Fig. 1, or gears *B*, *E*, *F* and *C*, as used in a compound train of gears, as shown in Fig. 2.

In order to figure change gears for the lathe, we remember that it was necessary to first know the number of threads per inch in the lead-screw. Knowing that, we knew how many revolutions the lead-screw had to make to move the carriage and the thread tool one inch along the work. In the case of the milling machine we must know *how far the table travels while the index spindle makes one complete revolution, when gears B and C, Fig. 1, have an equal number of teeth.* This distance is the constant which we used in figuring the change gears, the same as we used the number of threads per inch of the lead-screw in figuring change gears for the lathe. This constant, which may be different for different milling machines, is called the *lead of the milling machine.* We will now see how this constant is found.

Suppose, for instance, that in a milling machine one revolution of the worm gear *C*, Figs. 1 and 2, will produce exactly one revolution of the shaft on which the worm is placed, that is, one revolution of the index crank; and suppose that equal gears are placed on the feed-screw and on the stud *D*, so that one revolution of the feed-screw produces exactly one revolution of the gear *C* and stud *D*. Then, if the feed-screw revolves one revolution, the milling machine table will advance a distance equal to the lead of the feed-screw, because, as we have said before, the lead of the screw is the distance which it will advance in one turn.

Now, when the table of the milling machine moves forward a distance equal to the lead of the feed-screw, or a distance equal to one thread in the feed-screw, the feed-screw turns one revolution, and gear *C* also turns one revolution, the worm-shaft and the index crank turn one revolution, and, there being 40 teeth in the worm-wheel which is mounted on the index head spindle, this worm-wheel, with its spindle, will turn 1/40 of one revolution. To make one complete revolution of the index head spindle, the feed-screw would have to be revolved as many times as there are teeth in the worm-wheel, each revolution, as we have seen, moving it one tooth. The distance which the milling machine table will advance, when the index head spindle revolves one complete revolution, is, as we have said, the lead of the machine. This distance evidently equals the distance that the feed-screw advances the table in one revolution (which is the lead of the screw) times the number of revolutions made. If we assume that the feed-screw has a lead of 1/8 inch, and that there are 40 teeth in the worm-wheel on the index head spindle, the feed-screw, when the gears *B* and *C* are equal, will have to turn 40 times, in order to move the index head spindle around once, and the distance the table will then advance will be



Figs. 1 and 2.

40 times 1/8 inch, or 5 inches. In this particular case, 5 inches is then *the lead of the machine.* If now a piece of work had been affixed to the index spindle, it is clear that this piece of work would have made one complete revolution, while the milling machine table advanced 5 inches, and that the lead of the spiral cut on the work would have been 5 inches.

A general rule for finding the lead of a milling machine may be stated as follows: *To find the lead of a milling machine, place equal gears on stud D, Fig. 1, and on the feed-screw, and multiply the number of revolutions made by the feed-screw in order to produce one revolution of the index head spindle, by the lead of the feed-screw.*

Suppose, for an example, that it is necessary to make 40 revolutions of the feed-screw in order to turn the index head spindle one complete revolution, when gears *B* and *C*, Fig. 1, are equal, and that the lead of the feed-screw of the milling machine is 1/4 inch, then the lead of the machine equals $40 \times 1/4$ inch, or 10 inches.

This rule just given is general, and will apply even if the number of teeth in the indexing worm-wheel were different from that in standard indexing heads, because, in the rule, no consideration is taken of the number of teeth of the worm-wheel directly, but simply the number of turns made by the feed-screw to correspond to one turn of the index spindle itself.

If it is now perfectly clear that the lead of the machine means the distance which the table of the milling machine must move forward in order to turn the work placed on the index head spindle around one complete revolution, it is easy to understand that if we want to get a spiral that is twice as long as the lead of the machine, then we must place gears on the feed-screw and on the stud *D* of such size that

the indexing spindle will only turn half a revolution while the table moves forward a distance equal to the lead of the machine. Suppose, for instance, that we want to cut a spiral, having a lead of 20 inches, that is, making one complete turn in a distance of 20 inches, and that the lead of the milling machine is 10 inches. Then, while the table moves forward 20 inches, we want the indexing spindle to turn once. In order to make the table move forward 20 inches, when the indexing spindle turns around once, the feed-screw evidently must turn twice as many times as it did in the case when the table only moved 10 inches for one turn of the index spindle, in which case we had equal gears on the feed-screw and on stud D; consequently the two studs or shafts, A and D, must be so connected that one will turn twice as fast as the other. The ratio between the speeds then is 2 to 1, which means that the feed-screw, which is required to turn twice while the stud D turns once, must have a gear that has only half the number of teeth of the gear placed on stud D.

If the lead of the machine be 10 inches, and the lead required to be cut on the piece of work is 30 inches, then it would be necessary to have the ratio between the gears 3 to 1, which, of course, is the same as the ratio between the lead of the machine and the lead of the spiral to be cut (30 to 10 equals 3 to 1). We can therefore express the rule for finding the change gears by a simple formula:

$$\frac{\text{lead of spiral to be cut}}{\text{lead of machine}} = \frac{\text{number of teeth in gear on worm stud } (D, \text{ Fig. 1})}{\text{number of teeth in gear on feed-screw}}$$

Expressed as a rule, this formula would read: *To find the change gears to be used in a simple train of gearing, when cutting spirals on a milling machine, place the lead of the spiral in the numerator and the lead of the milling machine in the denominator of a fraction, and multiply the numerator and denominator with the same number, until a new fraction is obtained in which the numerator and denominator give suitable numbers of teeth.*

As an example of the above rules, we will take the case of a milling machine in which we have found that there are 4 threads per inch on the feed-screw, and that 20 revolutions of the feed-screw are necessary to make the index spindle turn one complete revolution when having equal gears on A and B, Fig. 1. On a machine of this kind, assume it is required to cut a spiral the lead of which is 12 inches. The first thing for us to do is to find the lead of the machine. This, as we have already said, is equal to the revolutions of the feed-screw necessary to turn the index spindle one revolution, multiplied by the lead of the feed-screw. As the feed-screw has 4 threads per inch, the lead of the feed-screw is $\frac{1}{4}$ inch, and this, multiplied by 20, gives us $\frac{1}{4} \times 20 = \frac{20}{4} = 5$.

To find our gears we now place the lead of the spiral in the numerator of a fraction and the lead of the machine in the denominator, and multiply both numerator and denominator with the same number until we get a new fraction, in which the numerator and denominator express a suitable number of teeth. Following this rule, we have then:

$$\frac{12}{5} = \frac{12 \times 6}{5 \times 6} = \frac{72}{30}.$$

The gear with 72 teeth is placed on stud D, which, of course, is required to revolve slower than the feed-screw, in order to cut a spiral which is 12 inches, when the spiral cut with equal gears is only 5 inches, or equal to the lead of the machine. The gear, having 30 teeth, is placed on the feed-screw. If it should be necessary to put an intermediate gear between the gear on the feed-screw and the gear on stud D, the number of teeth in this intermediate gear has no influence whatever on the ratio of the speed of feed-screw A and stud D, but serves simply the purpose of transmitting motion from the one gear to the other.

Compound Gearing.

If it is not possible to find a set of two gears that will transmit the motion required, it will be necessary to use compound gearing. In this case the manner of getting the compound gears is exactly the same as that of getting compound gearing for the lathe. We have already explained that the lead of the spiral to be cut is placed in the numerator of the fraction, and the lead of the milling machine in the denominator. We then divide this numerator and denominator into two factors, the same as we did in the case of figuring lathe change gears, and, having divided them into two factors, we multiply each two of these factors by the same number, exactly as before, thus getting the gears we require. As an example, let us suppose that the lead of a certain machine is 10 inches, and that we wish to cut a spiral the lead of which is 60 inches. We then have:

$$\frac{60}{10} = \frac{6 \times 10}{2 \times 5} = \frac{(6 \times 15) \times (10 \times 8)}{(2 \times 15) \times (5 \times 8)} = \frac{90 \times 80}{30 \times 40}$$

The gear having 90 teeth is placed on the stud D, and meshes with the 30-tooth gear F (see Fig 2) on the intermediate stud; on the same intermediate stud is then also placed the gear having 80 teeth, which is driven by the gear having 40 teeth placed on the feed-screw. This makes the gears having 90 and 80 teeth the driven gears, and the gears having 30 and 40 teeth the driving gears, the whole train of gears being driven from the feed-screws of the table.

In general, for compound gearing it may be well to remember the rule given by the formula:

$$\frac{\text{lead of spiral to be cut}}{\text{lead of machine}} = \frac{\text{product of driven gears}}{\text{product of driving gears}}$$

* * *

MACHINE SHOP PRACTICE.*

MACHINING A FIXTURE CASTING—2.

This article on machining a milling machine fixture casting is a continuation of the one published in the May issue of MACHINERY. As there stated, this operation was selected as an example of planing, boring, and milling work. The planing operation was discussed, and we shall now deal with boring the bearing and milling the T-slot in the arm. This casting, which is shown on the Shop Operation Sheet Supplement, is the main part of a fixture used for holding lathe chucks while milling the jaw slots. These chucks are mounted on a spindle which is inserted in the bearing of this fixture, and, as this bearing must be in perfect alignment with the table, the boring is done on the milling machine. The casting is shown set up for boring, on operation sheet No. 64 of the Supplement. Before setting the planed surface of the base against the table, care should be taken to see that both table and base are thoroughly clean, as otherwise inaccurate work will be the result. The recognition of the importance of such small matters is very essential in connection with shop work, and, in many instances, such recognition constitutes the real difference between a good and poor workman.

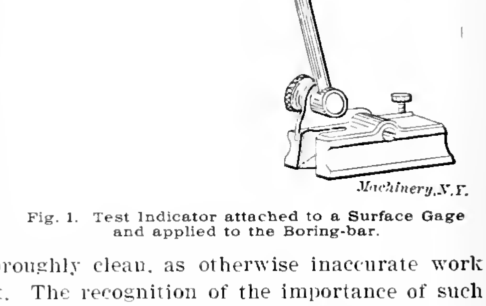


Fig. 1. Test Indicator attached to a Surface Gage and applied to the Boring-bar.

After the boring-bar is inserted in the spindle, a test indicator should be applied to the outer end of the bar as shown in Fig. 1. The indicator A is attached to a surface gage which rests on the table, and the contact point B of the gage is placed against the revolving bar C which, if not in perfect alignment with the spindle, will cause the hand on the gage dial to vibrate, the amount of vibration, of course, depending upon the amount that the arbor is out of true. When adjusting the center of the outboard bearing to the end of the arbor,

* With Shop Operation Sheet Supplement.

care should be taken not to spring the arbor out of alignment with the spindle. The arbor is now set to height by adjusting the knee of the machine vertically, and central with the bosses on the casting by adjusting the table longitudinally. The tool should be set for the first cut so that every part of the hole will be trued up, provided this would not mean too heavy a cut; this is done to prevent the tool from being dulled by the abrasive action of the scale.

After the hole has been bored to size, we come to the final operation of milling the T-slot. The casting should remain in the same position as for boring while the neck of the T-slot is milled with a plain axial cutter, which should remove as much metal as possible in order that the more delicate T-slot cutter shall have a minimum amount of work to perform.

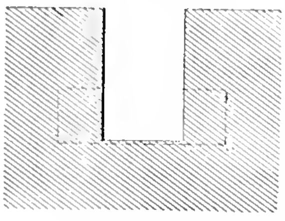


Fig. 2. The First Cut in Forming a T-slot.

A plan view of the work set up on the milling machine table is shown on Shop Operation Sheet No. 65. A right-hand cutter should be used, the direction of rotation being indicated by the arrow. The work will then be fed against the rotation of the cutter, which is preferable, because when the feeding is with the rotation, the cutter is liable to dig into the work, especially if there is any play between the nut and feed-screw. In order to tell whether a cutter is right- or left-handed, notice, when looking at it from that side which is next to the spindle, whether it must revolve to the right or to the left when working; if to the right, it is right-handed, and if to the left, left-handed. After the neck of the T-slot is finished, as shown in Fig. 2, the casting is set up for the final cut as shown on Shop Operation Sheet No. 66. A standard T-slot cutter such as shown in Fig. 3 is used. These cutters have alternate teeth cut on the inner and outer sides, though on some cutters used for this purpose these are omitted, the faces being ground slightly concave. The shank of the cutter should be perfectly clean before it is inserted in the spindle of the machine, and the cutter should be driven tightly in the spindle by tapping it with a soft hammer. All milling cutters which are held by their shanks, and are not supported by the center of the outboard bearing, should be fixed tightly on the spindle as there is a tendency for cutters of this kind to work loose, owing to the vibration due to the cut, which might result in both work and cutter being spoiled. Both cuts for the T-slot might have been taken at this setting of the work by using an end mill for machining the neck of the slot, but in that case a cutter somewhat smaller in diameter than the width of the neck should be used first, as a cutter of this kind, being light, will spring, which would cause the work to be untrue if the neck were finished at one cut. In milling slots of this kind it is preferable, when possible, to

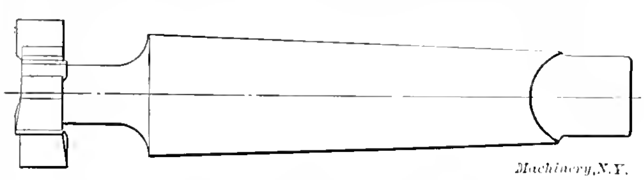


Fig. 3. A Standard T-slot Cutter.

first use an axial cutter because, owing to its greater rigidity, a coarser feed can be used and the work can be finished in less time.

[An axial cutter is one that has teeth on surfaces parallel to the axis, that is, on the cylindrical part. A radial cutter is one that has teeth on the end of a cylindrical body with the cutting edges radial or nearly so. There is confusion as to the meaning of the term "face" cutter. One leading milling cutter manufacturer calls a radial cutter a face cutter, while another manufacturer applies the name face cutter to cylindrical cutters. Our preference is to use the term "face" to designate radial cutters, as it seems to be the generally accepted meaning, and, moreover, is in harmony with the meaning of the word when applied to lathe work. A "faced" surface on a turned piece is always on the end of the cylinder. —EDITOR.]

PACK-HARDENING GAGES.

E. R. MARKHAM *

Pack-hardening, as the term is generally applied, consists in treating steel, generally tool steel, with some carbonaceous material until it will harden in oil. It is well known that steel hardened in oil is less liable to spring than when hardened in water. The tendency to crack is almost entirely done away with, unless the steel is improperly treated in the fire, and it has the maximum of toughness. Now, if we are able to treat the steel so it will be as hard as though dipped in water, and yet have the toughness due to oil hardening, and at the same time reduce the tendency to spring to the minimum, it would seem that we have the ideal method of hardening.

The experience gained during twelve years in charge of large hardening plants, where we not only did our own work, incident to a shop employing several hundred men, but also a large amount of job work from all parts of the country, together with several years spent in introducing the pack-hardening method, leads me to believe that, where it will answer the purpose, it is the ideal method of treating steel. For a number of years I have been giving advice along mechanical engineering lines, and have advised a number of manufacturers to adopt this method of hardening for certain work, and in no instance have I known of its giving anything but satisfaction. It is especially satisfactory when employed in hardening gages of various forms.

The process consists essentially in supplying the surface of the steel with an additional amount of carbon by some material that will not in any way injure the steel. In order to provide the additional carbon, the steel must be packed in

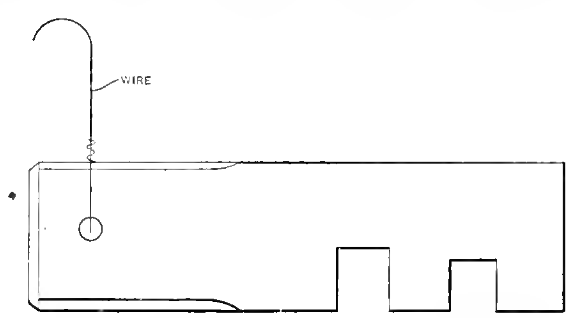


Fig. 1. Piece to be Hardened, and Wire for Handling

iron hardening boxes with the carbonizing material. Some have used charcoal for this purpose. Now, while charcoal is a carbonizing agent, and is used many times in case-hardening machinery steel, and also in the cementation process of converting wrought iron into steel, yet its effect on high-grade steel in the process of carbonizing is not satisfactory, as it renders the steel coarse, and the result similar to blister steel.

No form of bone should be used when pack-hardening tool steel, as bone contains a high percentage of phosphorus, and the effect of this is to make it weak and brittle.

For steel that does not contain more than $1\frac{1}{4}$ per cent carbon (125 points), charred leather gives the best results. Above this percentage I have for years used charred hoofs, or horns, or a mixture of the two. I formerly advocated the use of equal parts of wood charcoal and charred leather, or hoofs, or horns, as the case might be; but now I use no charcoal. The leather, hoofs, or horns, may be used over and over by adding a quantity of new material each time.

The work should be packed in the hardening boxes so no part of any piece of work comes in contact with the iron boxes; in fact, there should be at least $\frac{1}{2}$ inch space between the work and the box. A layer of the carbonizing material should be placed in the bottom of the box, and a layer of work placed on this, taking care that no two pieces touch each other. If we are treating gages, or pieces of steel that are apt to spring unless care is used, we should make sure that they are so placed in the box that there will be as little liability of springing as possible when they are drawn up through the packing material. They must not be packed and

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dumped into the hardening bath, as is the case when ordinary case-hardening is done.

In order to be able to properly handle the work, each piece should be wired with a piece of *iron* binding wire, as shown in Fig. 1, and the pieces so placed in the box that there will be the least resistance possible when drawing them out. At times they may stand on edge, as shown in Fig. 1. For certain shapes, however, it is advisable to stand them on end.

When several layers of work are packed in a box, the wires should be so arranged around the edge of the box that the various layers may be taken out in order, commencing

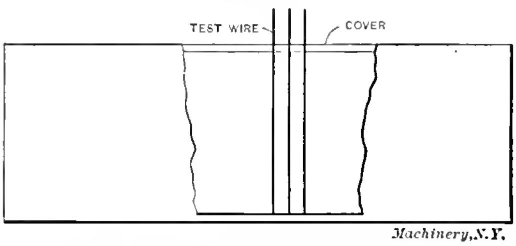


Fig. 2. Hardening Box with Test Wires which enable the Operator to determine when to begin Timing the Heat.

with the top row. This is easily accomplished by marking the sides of the box with chalk, designating the side where the top row of wires is as 1, the one where the second row is, 2, and so on. Unless we adopt some such method, the pieces get all mixed up, and some will be drawn to the surface of the packing material, and will cool before the operator has a chance to dip them.

As in all heat treatment of tool steel, the heats should be as low as is consistent with desired results, and the heats must be uniform throughout the box. It is also necessary that we gage the length of time the steel is exposed to the action of the carbonaceous material. Unsatisfactory results follow any attempt to gage the length of time by the time the boxes are in the furnace. In order that the operator may know when the contents of the box are heated, holes are drilled through the cover of the box at the center, and test wires are run down to the bottom of the box, as shown in Fig. 2. These wires should project about an inch above the top of the cover. The holes in the cover may be of any size to accommodate the wire to be used; however, I generally drill 1/4-inch holes and use 3/16-inch wire. When the box has been in the fire, according to the judgment of the operator, until the contents are heated to a low red, a wire may be drawn, by means of long tongs, and its condition noted; if it is red hot, begin timing the heat; if it is not red, wait a little

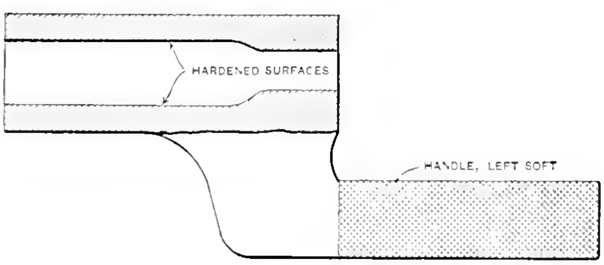


Fig 3. A Gage to be Hardened as indicated.

while, and draw another. Continue so doing until one is drawn that is of the desired temperature. The wires passing down at the center of the box, and between the pieces, will not be red until the pieces are of the same temperature.

The length of time necessary to expose the pieces to the action of the heat depends on how deep we wish to harden the steel. For ordinary snap gages, I have found 1½ hour to 2 hours after the steel is red-hot to work well, but the time must be varied according to the percentage of carbon that the steel contains and its intended use.

Sometimes locating gages are made with the gaging holes made to finish size in the gage. This method is not to be advocated where it is possible to use hardened bushings. In the latter case, the holes in the gage may be made of the proper size for the bushings, and the gage left soft, while the bushings are hardened, ground and lapped, and pressed to place without any tendency to distort the gage. But, when it is necessary to make the gage of one piece, and have the gaging holes to size in the gage without bushings, then the pack-hardening method will be found to work satisfactorily, as the heats may be very low, and the tendency to distortion will be eliminated, provided the processes of annealing and machining have been properly done.

I recall a job of hardening gages that gave a manufacturing concern considerable trouble. The gage was of the form shown in Fig. 3, and it was necessary that the walls of the opening through the gage be hard, yet the opening must retain its shape.

The hole was filled with finely pulverized charred leather; the handle and the portion connecting it with the body were covered with fire clay which was wound with fine iron binding wire to prevent it falling away when baked. The gages were packed in scale collected in the forge shop. This scale came from the outside of pieces of iron and steel as they were being forged. Being free from carbon they absorbed, or took the carbon from the surface of the steel. I should have mentioned that the ends of the opening through the gages were covered with fire clay mixed with water to the consistency of dough, which was allowed to harden before the gages were packed. The fire clay prevented the carbon gas escaping from the leather, as the scale would have taken it up very quickly.

When the gages had been exposed to the carbonizing influence of the leather for one and one-half hour, they were removed from the box in which they were heated, placed in a bath of raw linseed oil, one at a time, and a jet of oil was pumped through the opening after the leather had been removed. The fire clay around the handle and the portion connecting it with the body was left on until the gage was hardened, when it was removed. The walls of the hole were found to be hard, and as the surface of the gage was practically decarbonized, there was little danger of its pulling the piece of steel out of shape. The handle and adjoining portion, being protected by the fire clay, did not harden, or even cool quickly enough to distort, in any way, the gaging portion.

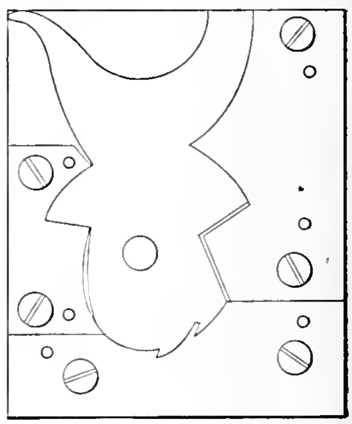


Fig. 4. Receiving Gage which is a Type Advantageously Hardened by the Pack-hardening Process.

I have known a number of instances where pieces which, while not resembling the gage shown in Fig. 3 so far as form is concerned, yet responded nicely to the method of treatment given that gage. Of course, it was necessary to modify the treatment to suit the character of the work. The gage shown in Fig. 3 was made from crucible tool steel. But, considering the small amount of wear to which it was subjected, it could have been made from a low-carbon open-hearth steel, which would have been cheaper, and could have been hardened, in the manner described, as effectively as the tool steel.

Many times receiving gages are made of several pieces which are fastened to a plate as shown in Fig. 4, which is a receiving gage for a gun hammer, and it is necessary that the various portions be gaged accurately, and each portion must bear a certain relation to every other portion.

As shown, the various portions of the gage are made in sections, fitted to place and hardened. Unless these pieces are hardened by some method that eliminates the tendency to spring, they will be of little use after they are hardened. Right here pack-hardening comes in. Pack the pieces in leather in a small iron box, run for one hour after they reach a low red heat, and harden in raw linseed or sperm oil. It will not be found necessary to heat the steel treated in this way as hot as if heated in an open fire and dipped in water. It is not necessary to heat steel in the form of gages quite as hot as if it was made into cutting tools. But, even in the latter case, be sure to keep the heats down, and do not dip in extremely cold oil; in fact, I prefer warm—not hot—oil.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

INGERSOLL COLUMN TYPE COMBINED HORIZONTAL AND VERTICAL SPINDLE MILLING MACHINE.

The column-and-knee type of machine was the first commercial form of miller. It combined the advantages of a reasonable degree of rigidity with great convenience of operation, both as related to holding the work and presenting it to the cutter, and the various adjustments, as well, could be made with the greatest ease. To give greater rigidity to the machine, (though at the cost of quickness in manipulation) there was developed later the Lincoln type of horizontal spindle milling machine—a type which is at the present time extensively used for interchangeable manufacturing and other work in which its advantages are most in demand, and its deficiencies of least moment. Of recent years, the column-and-knee type of machine has been given a rigidity very closely approximating that of the less convenient Lincoln miller, by the use of suitable knee supports, braces, etc.

With the continued use of these machines, it was found that there were many operations which it was inconvenient to perform with the horizontal spindle. For instance, it was soon discovered that the largest quantity of metal could be removed in a given time with the least power, if a cutter of the face mill variety were used in place of the original cylindrical cutter. With comparatively thin work having large areas to be finished with face cutters, a horizontal table and horizontal spindle required that the work be held on a clumsy knee support of some kind. This arrangement was obviously a makeshift, so the vertical attachment to the horizontal miller was designed, and applied to the work of face milling. Though particularly adapted to the use of face and end mills, it soon proved a useful attachment in various ways, being applied to the form and circular milling, and accurate drilling and boring. It was thus possible to finish many parts complete at one setting, that would otherwise have to be reset several times. Owing to the usefulness of the vertical attachment, machine tool builders soon began to build millers in which the frame and driving mechanism were especially designed for the vertical spindle, instead of having it used as an attachment. The vertical spindle milling machine now ranks among the most important of machine tools, and has been extensively applied to the wide range of work to which it is adapted.

There has still been found a field, however, for the horizontal machine with vertical attachment; for one thing, there is the advantage of obtaining a machine capable of performing in a very satisfactory way a wide range of milling at a considerably less capital expenditure than would be required for the two machines otherwise necessary. Besides this it offers the advantage, oftentimes an important one, of being able to finish work complete without removing the part from the machine, since the machine may be changed to use either the horizontal or vertical spindle, as well. For this reason, the horizontal machine with vertical attachment is an exceedingly useful and popular combination. This being the case, it would naturally seem that there might be a field for a milling machine combining the vertical and horizontal spindle mechanisms in permanent form, without the sacrifice of rigidity and consequent producing power which comes from having one of these spindles in the form of an attachment. Such a machine might easily be made, as well, so that on some work both horizontal and vertical spindles could be used simultaneously, thus effecting a material saving in time and cost of work produced. If such a machine is provided with the necessary supports and braces so as to give it a large measure of the ruggedness of the Lincoln type of machine (or its larger counterpart, the planer type miller) the resulting tool should find a wide field waiting for it in the machine-building industry. Such a machine has been designed and is being built by the Ingersoll Milling Machine Co., of Rockford, Ill. It is illustrated in Figs. 1 to 4, shown herewith, and is described in the following paragraphs.

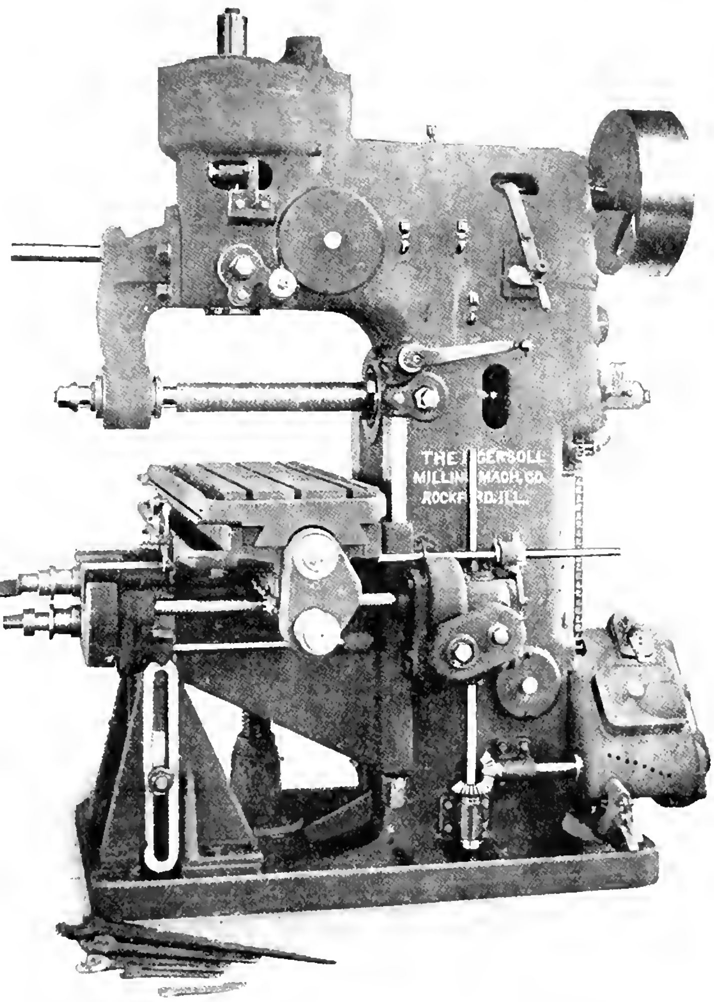


Fig. 1. Ingersoll Combined Vertical and Horizontal Miller.

General Arrangement of the Machine.

As may be seen in Fig. 1, all of the machine below the horizontal spindle is very similar in appearance to the ordinary type of column-and-knee milling machine, though it will be seen that it is unusually rugged for a tool of this kind. Above the spindle, the column of the machine is brought forward to furnish a housing for the vertical spindle, which, owing to the stiff support thus given it, can be carried well out from the face of the column, allowing a considerable range of cross feed. For the same reason, the knee is unusually long, and is therefore well supported at the outer end to give the required stiffness for heavy work and heavy cuts.

In accordance with approved milling machine practice of the present day, the whole machine is driven from a single diameter pulley, and the speed changes are obtained by the operation of positive acting, quick-change mechanisms involving the use of clutches and gearing. As is also required by the best practice, the feeding movement is taken directly from the driving shaft, and the feed changes are made by a positive quick-change gear mechanism. Longitudinal, cross, and vertical power feeds are provided, all of them reversible, and all provided with automatic stops. The out-board support

necessary for the arbor in heavy horizontal milling has not been forgotten, and the usual brace for connecting the knee with this support is furnished, though it is not shown in place in any of the illustrations. The machine will thus be seen to be designed along the lines of the best practice for both the horizontal and vertical types, which it combines within itself.

The Spindle Driving Mechanism.

The mechanism of this milling machine will best be understood by reference to Fig. 2. The power is applied to driving pulley *A*, which is keyed to shaft *B*. This shaft carries sprocket *C* which drives the feed, as will be explained later, and the double pinions shown, which may be shifted to engage either one of the corresponding gears on shaft *D* below them. The shifting of these gears is effected by the handle shown entering the slot in the upper left-hand corner of the column in Fig. 1. Two changes of speed are obtained with this level. Shaft *D* is connected by bevel gearing with the vertical shaft

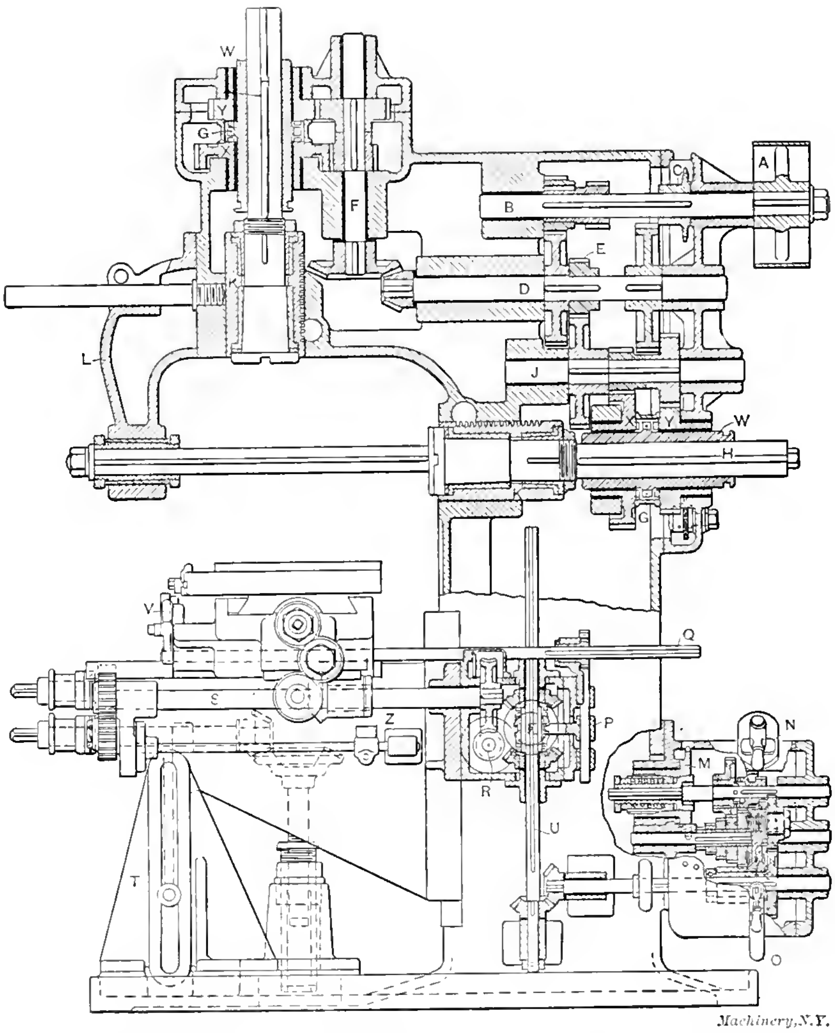


Fig. 2. Vertical Section through the Machine showing Driving and Feed Mechanism.

F, from which motion is transmitted to the vertical spindle. Pinion *E* on shaft *D* meshes with a gear on shaft *J*, from which motion is transmitted to the horizontal spindle. These two spindles are alike in their dimensions and in their driving mechanism, so the same refereuce letters apply to each. Each is supported at the back or upper end in a sleeve *W*, which is keyed to it, and which is provided with clutch teeth *G*. These teeth are adapted to engage corresponding clutch teeth on the hubs of gears *X* and *Y*, which revolve loosely on *W* and in their bearings in the frame. *X* and *Y* are driven by corresponding pinions on shaft *J* for the horizontal spindle, and on shaft *F* for the vertical spindle. It will thus be seen that by the shifting of sleeves *W*, either of two speeds may be given to either of the two spindles or, by putting the teeth *G* in the central position, either spindle may be stopped. Sleeve *W* for each spindle is shifted by the hand levers shown in Fig. 1; one at the back of the column in line with the horizontal spindle, and the other projecting from an opening in the vertical spindle housing. Gear *X* is 13 inches pitch diameter, with four diametral pitch teeth; the smaller one has the same pitch of teeth and is 10¼ inches in diameter. Both have 2½-inch faces, giving a very powerful drive.

Four spindle speeds for each of the vertical and horizontal spindles are thus provided for, with driving pulley *A* running at constant speed. In practice, with belt-driven machines, a two-speed counter-shaft would be used, giving eight speeds in all, ranging from 15 to 100 revolutions per minute. The machine is well adapted for a motor drive, in which case the motor is mounted on top of the column and connected to shaft *B* by means of a silent chain and sprocket wheels. A 10 H. P. motor is used, having a 2 to 1 speed variation, ranging from about 500 to 1,000 revolutions per minute. This would give the same range of spindle speeds as for the belt driven machine, the number of changes being dependent upon the number of steps in the controller.

The front bearing of each spindle is contained in a sleeve *K*, which may be adjusted axially by means of rack teeth cut in it, engaging the teeth of a pinion on a short shaft which projects through the side of the column, and is provided with a squared end for engagement with a hand crank. The axial positions of the two spindles with relation to each other may thus be adjusted to suit the work in hand. This is especially necessary in cases such as shown in Fig. 4, in which both spindles are used simultaneously. The front spindle bearing consists of two tapered journals, one of them being formed on a sleeve adjustable endwise to take up wear. These journals run in phosphor-bronze boxes, supported in the sleeves *K*. The spindles are of hammered crucible steel, 4½ inches diameter in the front bearing. The sleeves or quills *K* are 12 inches long and have 6 inches of adjustment read from graduated scales.

The Feed Mechanism.

As previously mentioned, the feed is driven from sprocket wheel *C* on driving shaft *B*. This is in accordance with approved practice, which makes (so far as possible) the feeds independent of the spindle speed changes. They are nearly independent in this case, being affected only by the 2 to 1 variation of driving pulley *A*, given by the two-speed counter-shaft or by the variable speed motor. The chain from sprocket *C* drives sprocket *M* in the gear box shown at the rear of the base of the machine in Figs. 1 and 2. This gear box contains a quick-change-gear mechanism of the well-known type first introduced in the Hendey-Norton lathe. Eight changes are provided for by the shifting of handle *O*, which controls the sliding tumbler gear, and this number is doubled, giving 16 in all, by handle *N*, which operates a shifting pinion and clutch so as to drive the cone of gears at either of two speeds. The 16 feeds thus given range from 0.48 to 8.9 inches per minute, with the slow speed of counter-shaft or motor; at the fastest speed the feed ranges from 0.97 to 17.8 inches per minute. These rates of feed can be doubled, as described later.

To provide a safety mechanism to prevent damage to the machine in case something should prevent the operation of the feed, and also to permit the feed change mechanism to be operated while the machine is in motion without inducing dangerous shock, sprocket wheel *M* is not directly keyed to the shaft which it drives. Instead of this, its bore is finished with a double taper in which are supported two taper cones, pressed together by the spring shown. One of these cones has a long hub, which is keyed to the shaft. The compression of the spring thus forces the cones together, and furnishes an adjustable frictional driving device between the

sprocket and the shaft, which is sufficient for the heaviest feeds required on the machine, but will yet give way in case of undue strain.

The gear box is connected by a horizontal shaft and bevel gears to the splined vertical shaft *U*. The latter passes through a gear casing attached to the knee, and containing a clutch-and-bevel-gear reversing mechanism of conventional type, operated by clutch fork *P*. The central bevel gear of this mechanism is connected by spur gears with worm *R*, which drives the worm-wheel keyed to horizontal splined shaft *S* from which are derived the various feed movements. The spur gears connecting worm *R* with the bevel gear can be taken off and reversed, being contained in the removable guard shown attached to the front of the casing in Fig. 1. By this means the feeds given in the preceding paragraph can be doubled.

The gearing, shown at the end of the table, connects splined shaft *S* with the table feed-screw for the longitudinal movement. The usual slot is provided at the front edge of the table for the adjustable dog which operates the automatic feed stop. This strikes a tappet connected with lever *V*, which is attached to rock shaft *Q*. The latter extending to the casing containing the reversing mechanism, is splined to a pinion which operates the vertical rack to which the reversing clutch fork *P* is attached. By this means, the dog on the front of the table may be set to automatically stop the feed of the table in either direction. Handle *V* is also conveniently used for reversing the feeds. Connections at the front of the table provide for operating both the cross and vertical feeds by power. The cross feed has the same

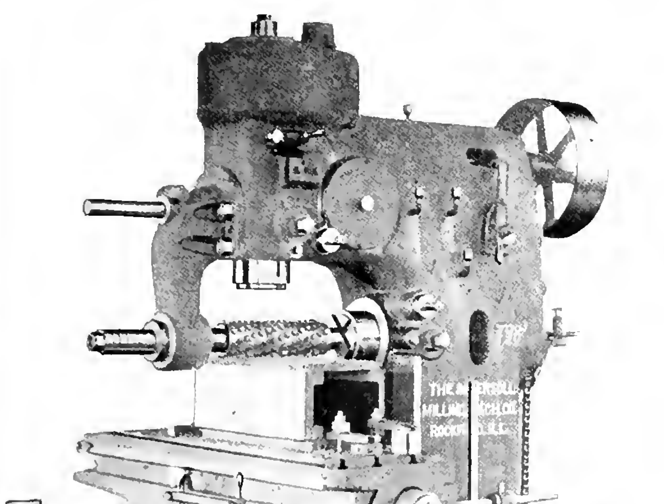


Fig. 3. Using the Machine as a Plain Horizontal Miller.

rate of movement as the longitudinal feed, while the rate of the vertical feed is half that of the other two. Stops are provided for the cross and vertical movements, that for the former being shown at *Z*.

Dimensions and Capacity.

The table is 60 inches long with 48 inches of working length; the full width is 19 inches and the working width 18 inches. It is 5 inches thick, and is provided with three slots cut from the solid, and with drilled holes for stops for the work. The saddle is 60 inches long and 6 inches deep, giving a full support to the table even at the extremes of its travel. The knee is 36 inches long and has a bearing of 28 inches on the column, besides being supported by the heavy outboard support *T*, previously mentioned. The longitudinal feed is 56 inches, the cross feed 16 inches, and the vertical feed 18 inches. As mentioned, the spindles have each a longitudinal adjustment of 6 inches. The maximum distance between the center of the table and the column is 24 inches; the least, 8 inches. The maximum distance from the top of the table to the face of the vertical spindle is 26 inches; the minimum distance with the sleeve extended is 2 inches. The maximum

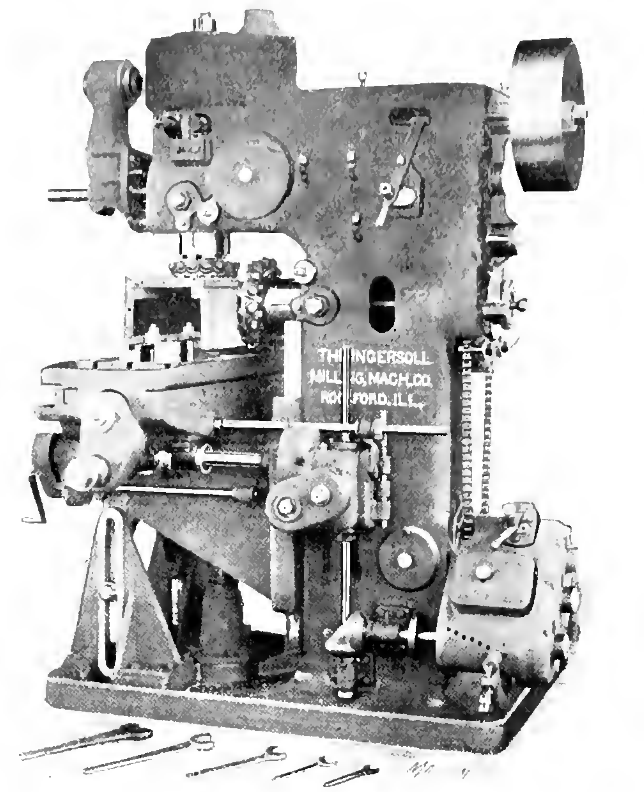


Fig. 4. Using the Horizontal and Verticel Spindles simultaneously in a Face Milling Operation.

distance from the center of the horizontal spindle to the top of the table is 16 inches, and the minimum, zero. A circular table 16 inches in diameter with automatic feed and automatic stop can be furnished if required, at an additional cost. The weight of the machine complete without this table is 9,700 pounds.

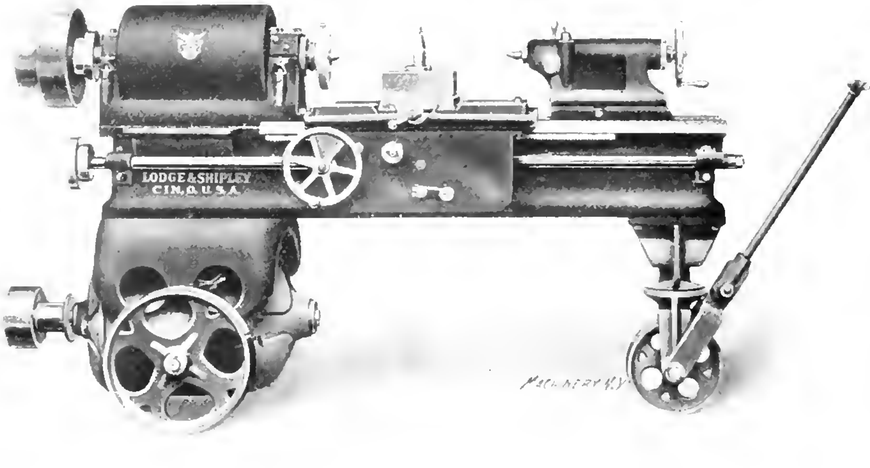
The Operation of the Machine.

In Figs 3 and 4 are two views of the machine in operation. In the first case it is shown with a job of plain slab milling, with the vertical attachment out of commission; as will be seen, the outer end of the cutter arbor is supported by the over-hanging arm (*L* in Fig. 2), so the machine has all the possibilities in the way of accuracy and rate of output found in machines of the strictly horizontal type. In Fig. 4 both spindles are shown in use operating face mills for surfacing the top and side of a hollow rectangular casting. In this case, the outboard support has been loosened and turned up out of the way, being for that purpose swiveled about the stud which carries it. In such cases as this, it will be seen that the output is equal to that of the horizontal and vertical machines combined. As a vertical machine, it should evidently have a greater capacity than the horizontal machine with vertical attachment, and be fully equal to that of the standard vertical machine of the same capacity. The tool has, in fact, been designed by its makers as a general utility machine, able to take the heaviest cuts, either horizontal or vertical, without harmful vibration or other sign of distress.

LODGE & SHIPLEY PORTABLE LATHE.

The lathe shown herewith has been designed by its builder, the Lodge & Shipley Machine Tool Co. of Cincinnati, Ohio, for use in locomotive repair shops for such work as fitting frame bolts, turning up studs, etc., and for doing the various miscel-

laneous fitting work which is met with in assembling heavy machinery. In a word, it will be found convenient for assembling work on any form of machinery so large that it is inconvenient or impossible to move to the lathe the parts into which the work is to be fitted. Bringing the machine to the work, as is made possible by this design, is a much more convenient and economical proceeding.



Portable Lodge & Shipley Lathe for Fitting Work on Heavy Machinery.

As may be seen in the engraving, the lathe is mounted on three wheels so that it is always properly supported, no matter how uneven the floor on which it is placed. The leading truck at the tail-stock end of the bed swivels, and is provided with a handle by which the lathe is drawn from place to place. The "leg" under the head-stock end of the bed is mounted on two wheels, and is arranged to support the motor by which the tool is driven. This motor is of $2\frac{1}{2}$ horse-power and of the constant speed type, fully enclosed. Its armature shaft carries a 2-step cone pulley, belted to a corresponding pulley on the back gear shaft. As the range of work for which the lathe is required is limited, but two speed changes have been provided, resulting in a driving mechanism of great simplicity. The lathe is supplied with a belt feed of two changes, power longitudinal feed, and plain rest. When desired, it can also be supplied with a taper attachment. Nothing which is not required for the simple work it has to perform has been retained in the design of the machine. As constructed, it will do the work for which it is required with great rapidity. If desired by the purchaser, the same tool will be furnished with legs instead of wheels.

THE LE BLOND UNIVERSAL CUTTER AND TOOL GRINDER.

Being convinced, as milling machine manufacturers and users, that sharp cutters are a prime requirement for rapid and economical milling, the R. K. Le Blond Machine Tool Co., 4605 Eastern Ave., Cincinnati, Ohio, has designed and placed on the market a universal cutter and tool grinder. There are a great many machines of this kind made, and perhaps no tool is so far from being standardized in design, each make differing radically in construction from any other with which it may be compared. This new machine likewise differs from others hitherto built, presenting a number of distinctly original ideas in design and construction. These ideas are so strikingly practical and serviceable, however, that the machine is worthy of detailed study. We are permitted to present herewith enough of illustrative and descriptive matter to give a comprehensive idea of the design of the machine.

General Description.

The tool follows in its outlines the general plan of the universal milling machine, with such additional adjustments and movements as are required for the work of a cutter and reamer grinder. As may be seen in Fig. 1, which gives a front view of the machine, the framework consists of a cabinet base, on which is mounted a column surmounted by the grinding spindle head, which is clamped permanently in place. Around this column, marked *A* in Fig. 2, is placed a split sleeve *B*, which may be clamped in any angular position around the vertical axis by handles *C*. The front of this sleeve is provided with ways on which slides the box-shaped knee *D*. A saddle *E*, which may be adjusted towards or away from the column along the top of this knee, is provided with longitudinal ways for the table guide *F*, to which is swiveled, about pivot *G*, the work table *H*. It will be seen that this arrangement differs from that of the universal milling machine only in having the work table swivel on the guide *F*, instead of having the latter swivel on the saddle.

The construction followed is a rigid and durable one, and has been purposely adopted in place of the lighter skeleton design employed in other machines for the same purpose. It will be noted in Figs. 1 and 2 that the sides of the saddle are brought down over its bearing on the knee, and that the ends of table guide *F* project beyond the bearing on the saddle at the extreme limit of the travel in either direction, so that these bearings are well protected from the emery and the grit which always surrounds a machine of this kind. Felt strips are provided for cleaning and oiling the surfaces of the table and saddle bearings as well as the vertical ways on the knee. By this means the continued usefulness of the machine is assured for a long period of years.

The purposes of the various adjustments provided will be better understood when reference is made later on to the different operations for which the tool is adapted.

Details of Construction.

The wheel spindle *J* has taper boxes as shown in Fig. 2, and is driven by a single pulley for a 2-inch belt. The cone on the

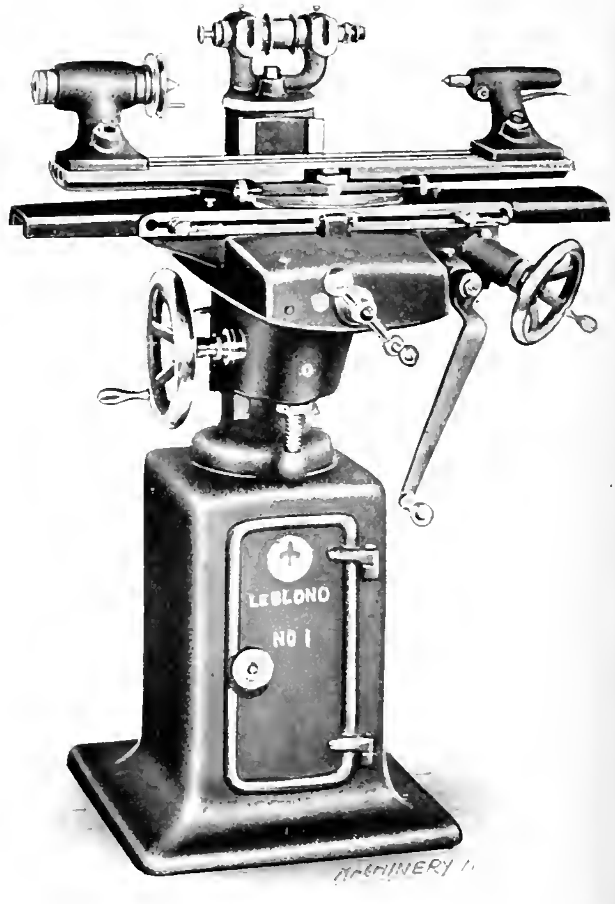


Fig. 1. The Universal Cutter and Tool Grinder built by the R. K. Le Blond Machine Tool Co.

counter-shaft gives three spindle speeds, which should be proportioned to give 3,175, 4,200, and 6,365 R.P.M., respectively. In the engraving, the left-hand end is adapted to the holding of wheels directly on the spindle, between the collars, while a tapered hole for a correspondingly tapered arbor *P*, is pro-

vided at the other end of the spindle. A variety of these arbors may be used with the wheels permanently mounted on them. When this plan is followed the wheels may be removed and replaced without it being necessary to true them up each time. Dust-proof collars are provided, and the oil holes have dust-proof covers, the same protection being afforded all provisions for lubrication throughout the machine.

The head-stock spindle, which is tapering, revolves in a removable sleeve, which can be clamped in the V-block of the universal attachment, described later. The front end is threaded to receive a chuck. The foot-stock has a spring center actuated by a thumb lever. This center can be removed and a special center inserted for grinding reamers. The table is provided with two T-slots, one of them set on an angle, as shown in Fig. 2, for drawing the head- and foot-stock down and forward against the left-hand side of the slot, to insure parallelism; the other at the right provides for the clamping of the various fixtures, vises, etc., that may be used on the machine.

Movements and Adjustments.

The table H, as has been explained, swivels on table guide F about stud G, which is a drive fit in F. The angular movement possible extends through an arc of 90 degrees on either side of the central position, the setting being read from the

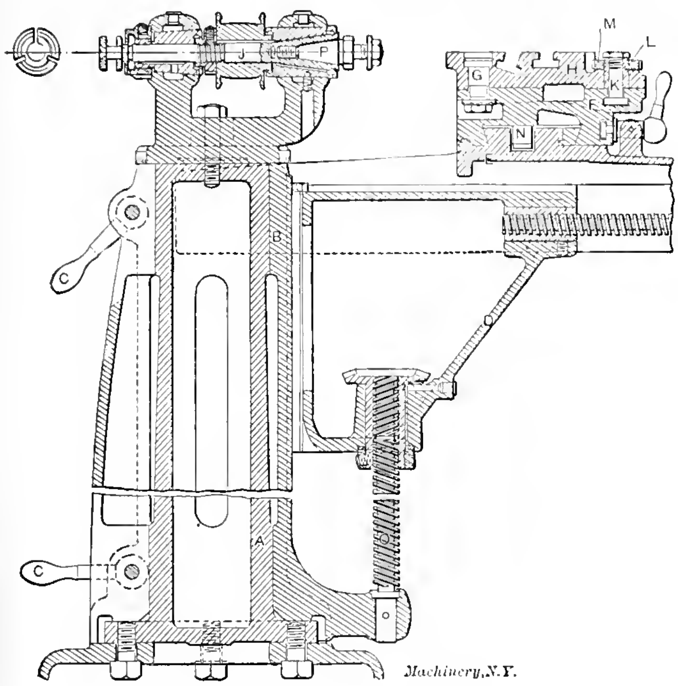


Fig. 2. Vertical Section through the Table, Knee, and Column, showing the General Construction.

graduated surface shown in the engravings. Provision is made for both rapid and fine angular adjustment of the table. The bolt K, by which it is clamped, passes through a threaded sleeve L. If the slotted nut M which is threaded on this sleeve is raised from contact with the boss on the table, the tightening down of the nut on bolt K tightens L down on F, but leaves the table free to be adjusted through the small range permitted by the slot in which L is located. Projecting into this slot are two screws with milled heads, seen in Fig. 1 and other following figures. By adjusting these, the angular position of the table on the table guide may be set very finely to the desired position. When this setting has been obtained, the screwing down of the slotted nut M clamps the table in position.

Table guide F receives its longitudinal movement on the saddle from a shaft carrying a gear meshing with rack N. This shaft passes through the saddle, projecting both at the front and the rear. On either end of it may be mounted a handle for the rapid operation of the table movement. This handle is shown mounted at the front of the machine in Fig. 1 and on the back in Fig. 3. On this same shaft is keyed a spiral gear, meshing with a spiral pinion on the shaft of the hand-wheel seen projecting obliquely downward at the right of the saddle in Fig. 1. By means of this the table may be given a fine angular adjustment. As may be seen at the left of Fig. 5, this hand-wheel and its shaft are mounted in an eccentric sleeve, which may be rotated by the handle shown in back of the hand-wheel, to throw the spiral pinion out of mesh with the gear, leaving the shaft free for the rapid movement by means of the handles described, when this rapid movement is desired. A projecting boss on the top of the saddle is provided with adjusting screws, which act as abutments for adjustable stops in the T-slot in front of the table guide, as shown in Figs. 1 and 2. These stops limit the longitudinal travel of the table.

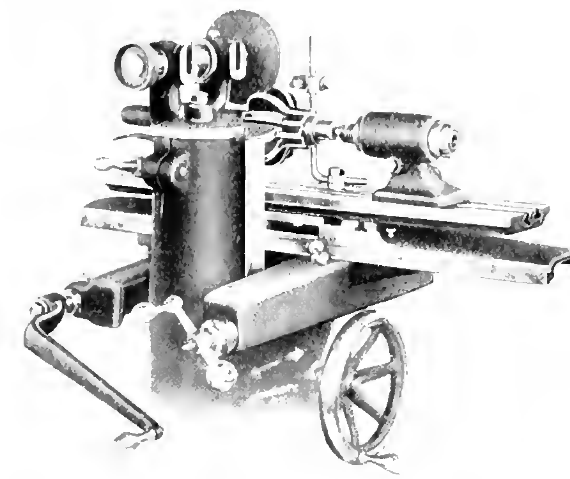


Fig. 3. Grinding a Formed Cutter between Centers

The cross-feed screw is geared with a shaft which passes through to the back of the saddle, so that the movement of the saddle on the knee may be effected through the crank shown at the front of the saddle in Fig. 1, or by that shown at the rear in Figs. 3, 4, 5, etc. This provision for operating either the longitudinal or the cross movements from the rear of the machine is a feature which makes it possible for the operator to work always at the best advantage, so far as the close observation of his work is concerned. It is not necessary for him to take a position which may be convenient for the operation of the hand-wheels, etc., but inconvenient for watching the progress of his work.

The raising and lowering of the knee on the table is effected by screw O, which is connected by bevel gears with the hand-wheel shown at the side of the knee. Graduated dials are provided, reading to thousandths, for the cross and vertical

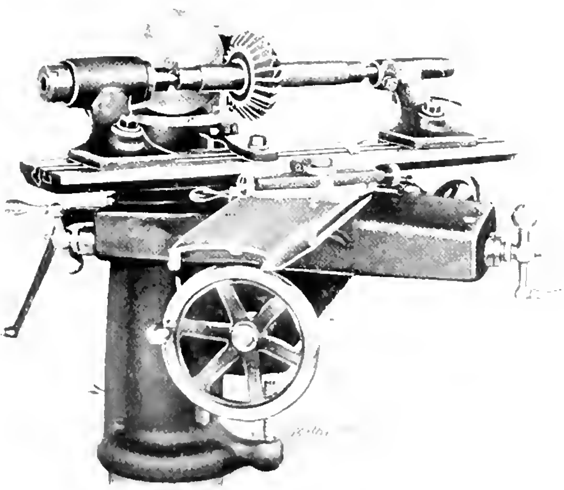


Fig. 4. Table set with Fine Adjustment for Grinding 45-degree Angle Cutters.

movements. All of the various adjustments with the exception of the swiveling and clamping of table H on table guide F, are effected by fixed handles so that the use of a separate wrench is largely avoided. The range of movement provided throughout the machine is such that large saws and face mills can be ground, as well as the smaller work on formed cutters, hobs, reamers, etc.

Grinding Cutters on Centers.

The half-tone reproductions of photographs in Figs. 3 to 8, inclusive, show a sufficient number of the various applica-

tions of the machine to give a good idea of the range of work to which it is adapted. In Fig. 3 it is shown set up for grinding a formed cutter, which is mounted on an arbor between centers, while the radial faces of its teeth are ground. The back of the tooth being ground rests against the stop shown, clamped in the front T-slot of the table. For this work, the operator would stand in the foreground of the picture, with the machine arranged as shown, the operating handle being attached to the back end of the table feed-shaft. The workman can thus easily see the face of the tooth which is being ground—a condition which is not always possible in other machines of this kind.

In Fig. 4 is shown the grinding of an angular mill, also mounted on an arbor between centers, as in the previous case. For this operation, however, the table has to be swiveled on the table guide to the angle of the cutting edge being ground. A disk wheel is used in this case, instead of the dished wheel of Fig. 3, so that the tooth has to be supported from the under side, necessitating the use of a different form of tooth rest. As before, the operator works the table feed from the handle

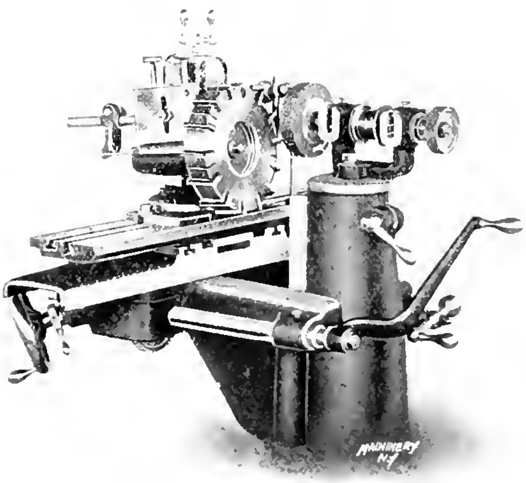


Fig. 5. Grinding Face Mill—Taper Shank held in Universal Attachment.

at the rear of the machine, this being the most convenient position for observing the progress of the work. The table stops are set to limit the movement of the table in one direction, to prevent the wheel from running into the arbor, and in the other direction to allow it to clear the cutter just enough to permit indexing for the next tooth.

The Universal Attachment and its Applications.

In Figs. 5, 6, and 7 is shown the universal head provided with the machine, engaged in holding, for presentation to the grinding wheels, cutting tools of various kinds. Detailed

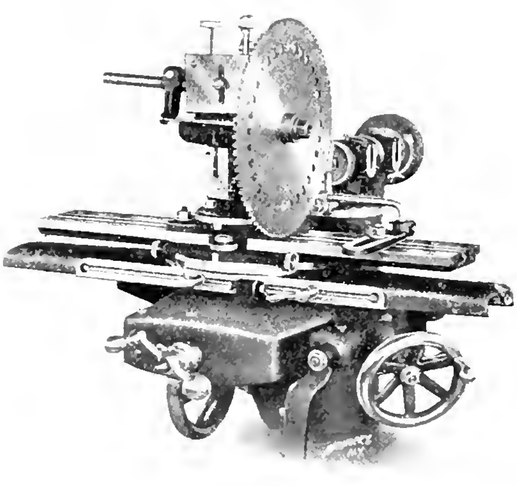


Fig. 6 Grinding a 16-inch Saw held in Universal Attachment

drawings of this head are shown in Fig. 9. It consists of a base Q, to which is clamped the standard R, which may be fastened at any angle about the vertical axis, by means of the bolts shown, the adjustment being read from the graduations on the standard. This column is provided with ways to which is gibbed slide S, which may be adjusted vertically by means of screw T and the attached double crank. Clamped to S, and adjustable on it to any angle about the horizontal axis, is V-block U, the periphery of whose base is also provided

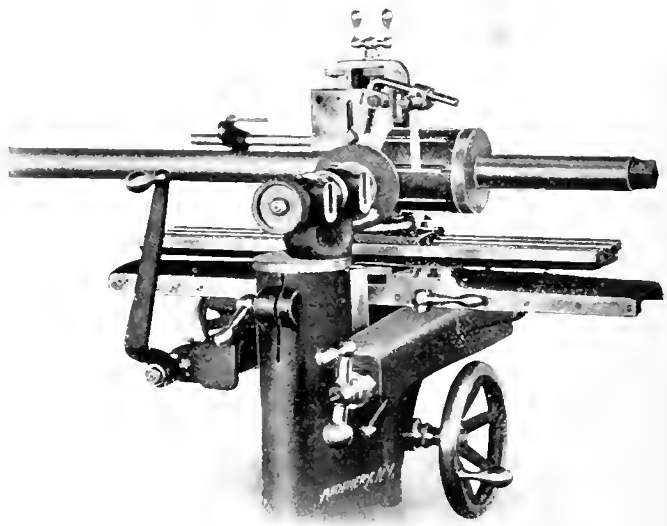


Fig. 7. Sharpening a 5 1-2-inch Shell Reamer without removing it from Arbor.

with graduations by means of which the angular adjustment may be read. Plate X, operated by two adjusting screws W, whose collars enter slots cut in X, is used for holding the work against the V-groove in U. A center stop Y mounted in the holder clamped to adjustable bar Z is used for locating the work as will be described.

The various adjustments provided for this attachment make it of almost universal application. Three of these applications are shown in Figs. 5, 6, and 7. In the first case, we have

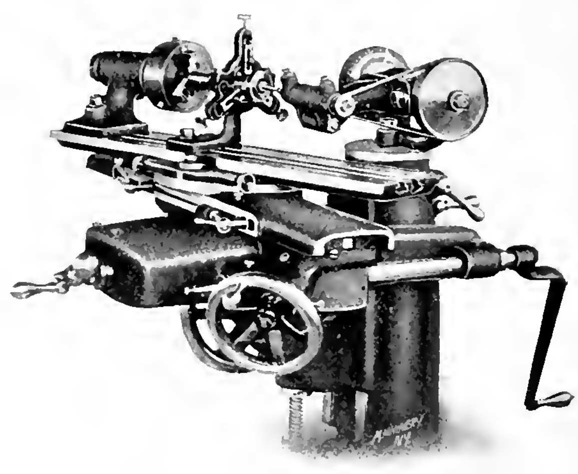


Fig. 8. Grinding a Taper Hole in Spindle, with Internal Attachment.

a face mill being ground on its own taper shank. The shank is inserted in the V-groove of U, and is brought back against the ball point of center Y, which is adjusted for that purpose to the proper position. Then plate X is screwed down to bear lightly on the shank of the cutter by turning handles W, being clamped in this position by the nut and stud provided for that purpose. The tooth rest previously shown is arranged to support the cutter properly for grinding. The whole block U is swiveled on S about a horizontal axis to give the clearance desired. In this case, also, the table is operated with the handle at the back side of the knee.

In Fig. 6 a saw blade of the Higley type is being ground in the taper attachment, which is set in the same way as for the previous case, except that the axis of the taper shank is set in a horizontal position. A cup wheel is being used in this case also. Since it is most convenient to watch this operation from the front of the machine, the table feed handle is placed in front as shown.

In Fig. 7 an inserted tooth reamer is being ground on the long bar on which it is carried, without removing it from the latter. The bar is inserted in the universal head in the

way previously described, and the tooth rest is mounted on the face of the clamping plate of the device as shown. A comparison of Figs. 3, 4, 5, 6, and 7 serves very well to illustrate the adaptability of the form of tooth rest provided.

Cylindrical and Taper Surface Grinding.

Complete provision is made for cylindrical taper and surface grinding in the design of the machine. An example of taper grinding is shown in Fig. 8. The work is secured in a chuck, mounted on the head-stock spindle, while its outer end revolves between the jaws of the back-rest, which is a part

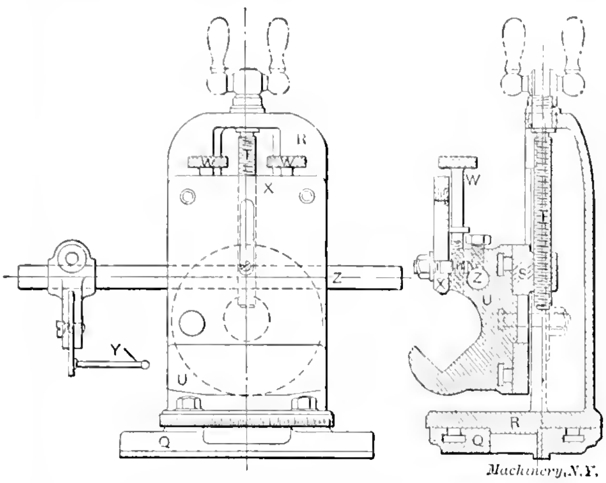


Fig. 9. Details of Construction of Universal Attachment.

of the equipment of the machine. The internal attachment is clamped to the face of the grinding head. It carries a spindle adjustable, as shown, to maintain the tension of the driving belt, which is driven by a pulley mounted on the main spindle in place of the usual grinding wheel. The taper of the table is adjusted on the table guide to the angle required for the taper of the hole being ground. The head-stock spindle is driven by a belt from the drum in the overhead works, which is connected with the main counter-shaft by a 3-cone pulley, giving suitable rates of speed for various diameters of work.

For angular work which may be held in a chuck, the head-stock spindle may be removed from the head-stock and clamped in the universal attachment shown in Figs. 5, 6, 7, and 9. The spindle may then be set to any angle for either external or internal grinding, being driven from the over-head drum as before. For surface grinding, the work may be strapped to the table or a magnetic chuck may be used, or the work, if small, may be held in the adjustable swivel vise which is part of the equipment of the machine.

Gear-cutter Grinding and Other Attachments.

Besides the universal attachment, tooth rests, back rest, internal attachment, and vise, previously described, a number of other conveniences are provided. Among them is a device for grinding, radially, gear-cutters and other narrow formed cutters. This device is shown in Fig. 10. It consists, as may be seen, of a plate bolted to the work table, carrying a swinging gage and two studs, on one of which is mounted the cutter to be ground, while the other carries an adjustable tooth rest. After placing the cutter on the stud (using a reducing bushing if necessary) the swinging gage is brought over until it enters the tooth space, and the tooth rest is brought up until the face of the tooth is forced against this gage. The face of the tooth is then radial, and the slight amount taken off in the sharpening does not perceptibly alter its radial accuracy.

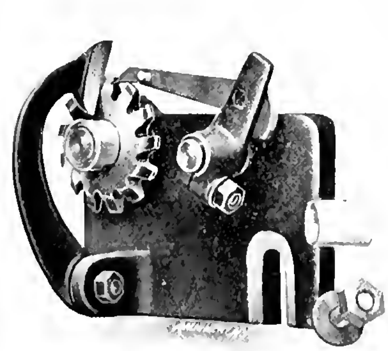


Fig. 10. Device for Grinding Gear-cutters radially.

There are included in the equipment, besides the parts mentioned, dogs for revolving work to be ground on centers, gages for centering the spindle with the work, the requisite wrenches, etc., and a counter-shaft with the necessary tight and loose pulleys, cones, etc., for driving the grinding wheel and work spindles at their proper speeds.

Dimensions and Capacity.

The machine will take 18 inches between the centers, and will swing 8 inches. The working surface of the table is $5\frac{1}{2}$ x 29 inches, and it has a longitudinal movement of 17 inches. The cross movement is $6\frac{1}{4}$ inches, and the vertical adjustment $8\frac{1}{4}$ inches. The machine, as will be appreciated from the previous description, will grind any face of any ordinary shape of cutter, to any angle. It is adapted as well to grinding all kinds of cylindrical and angular work, face mills, end mills, reamers, counterbores, gear-cutters, rose reamers, flat surfaces, punches, dies and other kinds of work. It has been in operation in the shop of the builders for nearly two years, where it has undergone a thorough trying-out on all kinds of operations. During this period, weak points in the design have been eliminated, and many improvements have been made. The builders are now placing it on the market with full confidence in its capacity for doing unusually rapid and accurate work.

FARWELL AUTOMATIC SPUR GEAR HOBBING MACHINE.

The spur gear hobbing process is inherently a very simple operation, as has been brought out in the description of the subject in a previous issue of MACHINERY (see "Gear-Cutting Machinery" in the March, 1908, issue, engineering edition). In most commercial gear-cutting machines of this type, however, the complication required to make them universal in their application has so elaborated the mechanism that the machine is as complex as the orthodox spur gear cutter with its slow feed and quick return, and its automatic indexing mechanism. In Fig. 1 is shown a gear-hobbing machine made by the Adams Co. of Dubuque, Iowa, in which the movements and adjustments have been reduced to a minimum, so that the basic simplicity of the process is fairly shown. The fact that it is not designed for the hobbing of spiral gears, and that it is intended to be fed by hand when hobbing worm wheels, in addition to the particular pains taken to avoid complication, have all resulted in making a strong, simple and inexpensive tool.

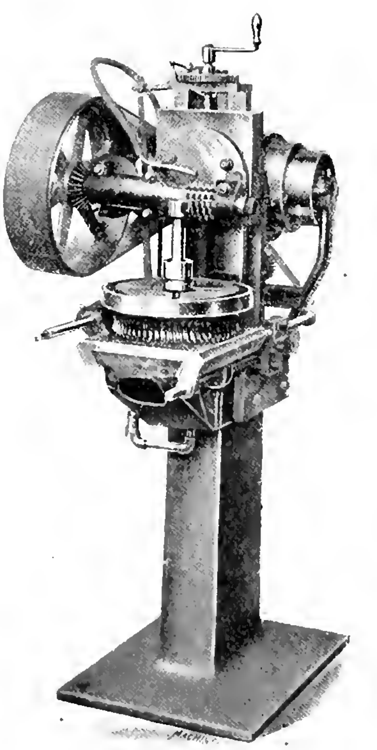


Fig. 1. Simple Spur Gear Hobbing Machine made by the Adams Co., Dubuque, Iowa

A machine of this type must provide means for driving a hob or cutter spindle, which is mounted on a head which may be swiveled to the helix angle of the hob. This hob or cutter must be connected by change gearing with the work spindle or face-plate, so that the two may be rotated together in the ratio of the number of teeth in the gear to the number of threads in the hob. An automatic feed has to be provided for forcing the hob down through the work. These movements are readily followed in Figs. 1, 2 and 3. As will be seen, the frame of the machine is a stout column, provided with a knee along which the work table is adjusted for the diameter of

the blank. The outer face of the column is provided with ways on which the cutter slide is fed. The machine is driven from a cone pulley at the rear, mounted on a counter-shaft supported in a swinging frame; the cutter spindle is driven by a large pulley, belted directly to this counter-shaft. The counter-slide and counter-shaft frame are connected by an adjustable link, so that the proper belt tension is maintained whatever the position of the cutter slide on the column. As before explained, the spindle is mounted on a swiveled head

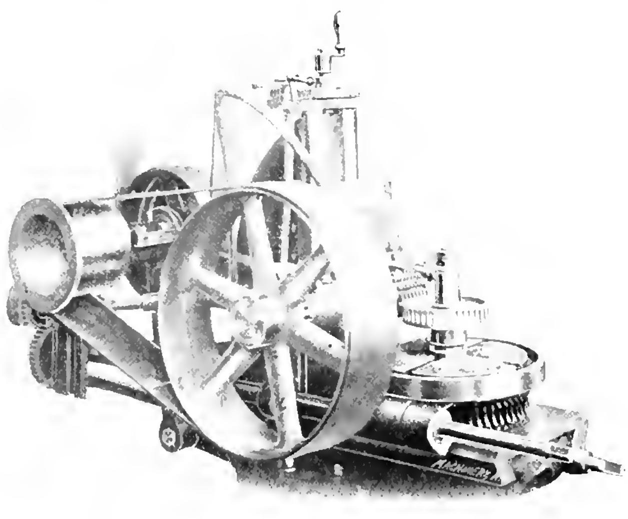


Fig. 2. Side View showing Driving Mechanism and Change Gear Connections.

on the cutter slide, so that it may be adjusted to the helix angle of the hob. The slight angular adjustment required for this is not sufficient to disturb the proper action of the belt which drives the spindle.

The cutter spindle has keyed to it, next to the hub of the driving pulley, a bevel gear meshing with a corresponding gear driving a telescopic shaft which extends toward the rear of the machine. This is best seen in Figs. 2 and 3. At the further end, this telescopic shaft drives one of a pair of change gears, of which the other is connected to the shaft on which is mounted the worm driving the work table worm-wheel. This furnishes the positive connection required between the hob and the work. The change gears are selected to suit the ratio between the number of teeth in the gear and the number of threads (one if single thread, two if double

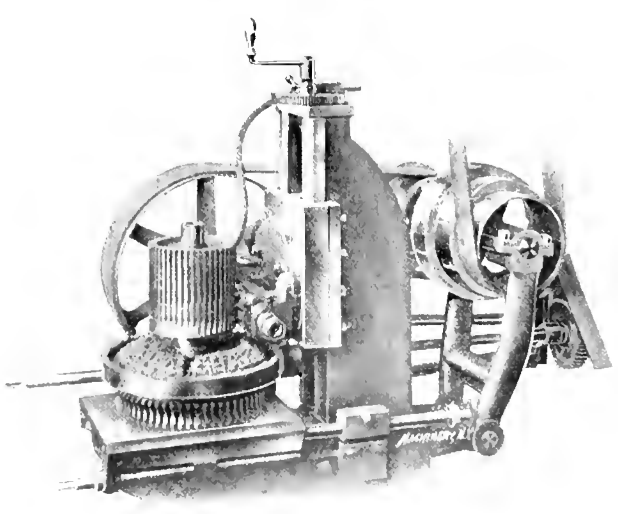


Fig. 3. View from the Right Side showing Stop Screw for Depth of Cut

thread, etc.) in the hob. The table revolves upon a wide angle surface, which gives it great rigidity. This, in connection with the small number of joints, and the large size of the gears and shafts connecting the work table and the spindle, insures a very steady, positive drive for the former. This is essential for accurate work.

The feed of the cutter slide on the head is effected by a ratchet movement, operated from an eccentric on the table worm-shaft. The eccentric rod may be adjusted along the lever operating the pawl, so as to give any rate of feed required. This change can be made without stopping the machine. The ratchet wheel is geared with the screw in such a ratio as to give a very powerful feed. An automatic trip is provided for stopping the feed when the hob has finished its work. Thus no attention is required from the operator other than that of putting in the blanks and taking out the finished gear. One operator may thus run several machines or attend to the gear-cutter while operating other tools.

A rigid stop is provided, as shown in Figs. 1 and 3, against which the table saddle may be run, to give the proper depth of teeth. Instead of setting this stop by micrometer graduations, a hardened steel gage is provided which is of a thickness equal to the depth of tooth required for the desired pitch. To set the stop, the table is advanced until the hob just scratches the outside diameter of the blank. The stop is then screwed up until the gage block is held between it and the saddle, when the gage block is removed and the table advanced to the stop, giving precisely the correct depth, if the blank has been properly sized. A careless operator cannot spoil work, as is often done when the depth is set by micrometer gage.

A small plunger pump is provided which forces a stream of lubricant upon the cutter and work if desired. The knee is hollow, and forms a tank for holding this lubricant, which is conducted thither by holes in the hub of the table. For hobbing worm-wheels the spindle is adjusted to a position central with the blank, the automatic feed being thrown out. The saddle is then fed inward along the knee by hand until the teeth have been cut to the proper depth.

The capacity of the machine is for blanks up to 12 inches in diameter and 6 inches face. The spindle is driven by a pulley 15 inches in diameter, for a 4-inch belt. The cone pulley at the rear provides for three speeds, and is driven by a $2\frac{1}{2}$-inch belt from the overhead counter-shaft. Either a single or two-speed counter-shaft will be provided. The hobs are regularly right-hand, single thread, 3 inches in diameter, and 3 inches long, with $1\frac{1}{4}$-inch arbor hole. Other sizes, of course, may be used. The hob may be moved axially so that the entire length can be used before sharpening is required.

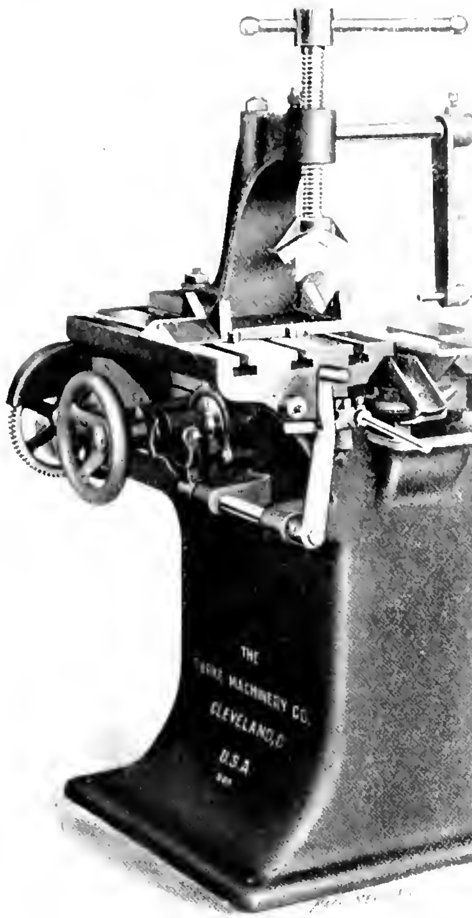
This tool should be an exceedingly useful one for work within its range, which includes automobile gearing and change gearing for machine tools. The manufacturers claim that the output is far ahead of that of any other type of gear-cutter for spur gears, on the sizes to which it is adapted.

BURKE MACHINERY CO.'S CUTTING-OFF SAW.

Few machine tools have been developed so rapidly during the past few years, and in few lines have so many new and radically different designs been brought forth as in the territory of cutting-off machines. In the accompanying half-tone engraving, a new 12-inch cutting-off saw is illustrated, presenting a number of interesting features. The machine consists principally of a main column or frame, provided with ways in which the saw carriage travels. This saw carriage supports the driving worm and worm-wheel and the saw itself, which is bolted directly to the worm-wheel. At the front of the saw carriage is mounted a hardened steel casting which acts, at the same time, as a guide for the saw and as a stripper for carrying away the chips from the saw teeth. The worm shaft is driven by means of a key, mounted in a gear sleeve, placed at the rear end of the frame, this gear sleeve in turn meshing with a pinion on one end of which is mounted the driving pulley. For actuating the feed mechanism, the same pinion engages with a system of gearing driving a worm shaft on the outside of the machine, through which power is transmitted to a worm and worm-wheel, the latter of which has square jaws cast on one side. A sliding clutch engages with these jaws, and a cross-shaft is thereby operated, having at one end a pinion engaging with a rack, which is mounted on the lower side of the saw carriage. This latter travels over an oil-pan, cast in the frame of the machine, which permits one inch of the saw-blade to be at all times immersed in oil.

At the front of the machine is mounted a lever, actuating the outer part of the feed engaging clutch, the clutch being

held out of engagement by a spring. When the saw is running, and this lever is pulled over until the clutch engages, the lever is held by a catch on the front of the machine. Through one end of this catch is passed a short rod, which can be set so that the clutch is automatically tripped at any



Burke Machinery Co.'s New Design of Cutting-off Saw.

desired position, the carriage coming in contact with the end of the rod, thereby throwing out the catch and permitting the lever to return to its original position. Between the driving pinion and the feed worm-wheel shaft is mounted a gear held in position by flanges lined with leather, while a spring mounted on the shaft carrying these flanges gives the necessary compression between the flanges. The compression can be increased or diminished by the tightening or loosening of a nut turned by hand.

The size of machine illustrated will cut circular stock up to 3 inches in diameter, or I-beams up to 5 inches high. The travel being 9 inches, permits flat stock 9 inches wide to be cut off. A guide block is furnished for small round or square stock, as well as suitable clamping device for holding the stock in position. When these devices are not in use, the machine presents a large clamping table with no part of the machine projecting above it, and this permits a great variety of work to be done on the machine. Iron can be cut off at various angles, sprues on castings can be removed, and many other operations performed which cannot be carried out on cutting-off saws of ordinary type. The machine shown in the half-tone is provided with a single pulley drive, but for machines which are to be used for cutting-off tool steel, machine steel, cast iron, and brass, where a large range of cutting speeds would be desirable, a cone pulley may be placed on the driving shaft instead of the standard tight and loose pulley, and a suitable counter-shaft is furnished.

Owing to the construction of the drive, back lash and torsional strain are eliminated, which is so common in arbor-driven saws, constructed with a worm-wheel on one end of the saw arbor and the saw on the other, with the bearings in the center. The makers have found from their own experience that, on account of this fact, the machine can very successfully be used in sawing tubing, by using a fine-tooth saw and clamping the friction clutch tightly. In order to prevent the chips from the saw from getting into the worm-wheel, a gear case covers this entirely.

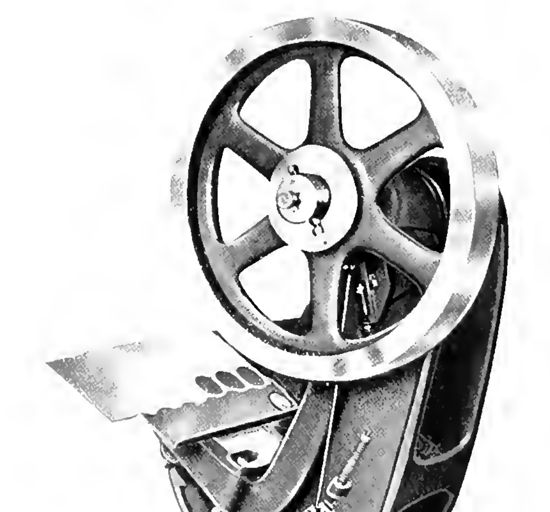
A 20-inch saw is also being prepared for the market by the makers, the Burke Machinery Co., 1837 Thirty-fifth St., Cleveland, O. This saw will have a capacity for cutting off $5\frac{1}{2}$-inch diameter round stock and 12-inch I-beams.

BLISS PRESS FITTED WITH STAGGER FEED.

A considerable saving of stock can be effected in blanking round shapes, by cutting them from a sheet of stock in rows "staggered" with each other, instead of cutting them in series from the strip as is usually done. Various plans have been tried for guiding sheet stock in the blanking press, so that the alternate rows of holes will be staggered with each other, but most of these have been complicated in design and unsatisfactory in operation. The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., has recently designed and patented an arrangement of great simplicity for effecting this. It is shown in the accompanying engraving, applied to a press of the single pitman, inclinable type.

The sheet from which the blanks are to be cut is placed on the table and fed against a stop finger, which, together with the back gage, locates the work for the first cut. The press being operated continuously, after the first blank is separated, the stock is again shifted against the stop finger and the ram comes down again; pressure is applied to the sheet continuously to bring it against the finger gage, and the operation is continuous. As the sheet progresses, the scrap is sheared off by means of a knife which cuts a true and straight edge for gaging on the second run.

The sheet having been passed through once to punch out the first row of blanks, a treadle is pressed which brings a



Bliss Press fitted with a Special Feed which staggers Alternate Rows of Blanks, and thus saves Stock

second stop finger into play, set at a distance of about half the diameter of the blank from the first stop finger. By this means the cut on the second row is started in a position between the two first cuts in the previous row. In the second stroke of the plunger, this stagger feed finger is automatically released and the operation continues, as before, to be gov-

erned by the back stop and regular stop finger. On every alternate row the operator throws this secondary finger into engagement.

As an illustration of the saving it is possible to effect, the case may be taken of a sheet of tin 20 x 28 inches from which it is desired to cut blanks 2¾ inches in diameter. By the ordinary method of slitting the tin into strips and running them through the press, 70 blanks could be obtained from the sheet. By the method of feeding provided in this machine, 76 blanks may be cut from the same sheet. Another case to which the machine has been applied is in the manufacture of bottle caps, for which a 1½-inch blank is necessary. With the usual arrangement, 234 blanks could be obtained from a sheet of tin; with the method used in the press shown, the same sheet yields 270 blanks. This shows very plainly the advantages to be obtained from the use of the device.

The mechanism is designed for continuous and rapid operation, and the gage system is so accurate that decorated stock can be successfully handled. Another feature of the device is the fact that the knives for separating the scrap remove it entirely from the blanks, and cut it into small pieces, thus greatly facilitating the work of disposing of it.

STEAM TURBINE DRIVEN OIL EXTRACTOR FOR CHIPS.

Figs. 1 and 2 illustrate a simple but ingenious machine made by the Oil & Waste Saving Machine Co., 1307 Real Estate Trust Bldg., Philadelphia, for extracting oil from chips, turnings, etc. The important feature of this construction is the fact that the spindle is driven by a direct connected steam turbine of the impulse type. The exhaust steam from this is led through the chips from which it liberates the oil so thoroughly that the centrifugal force effects a nearly perfect extraction, thus leaving the contents of the basket in a dry condition.

The machine is well arranged for rapid and convenient operation. The machine is shown in Fig. 1 at work extracting the oil, and in Fig. 2, with the basket of chips lifted from the body. The removable basket in which the chips are placed rests on the turbine disk or rotor, and is held in

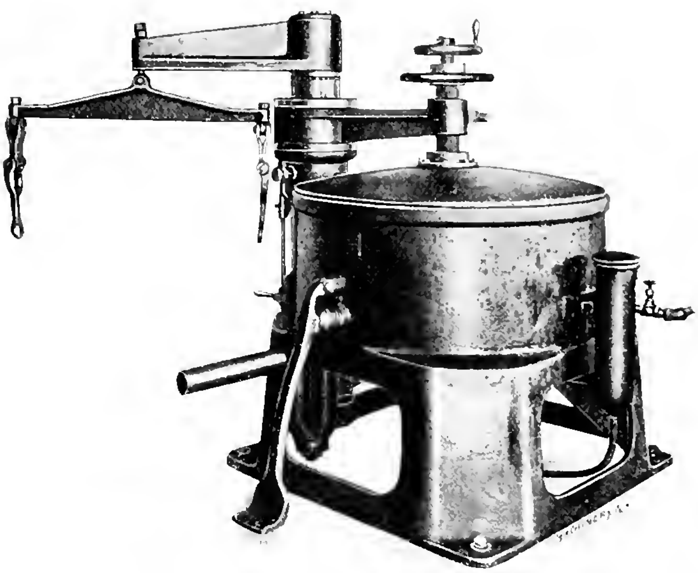


Fig. 1. Centrifugal Oil Extractor for Chips, driven by a Steam Turbine, and using the Exhaust for Freeing the Oil.

place by an inner cover clamped by the smaller of the two hand-wheels shown attached to the radial arm projecting over the machine from the column at the rear of Fig. 1. The lower hand-wheel is used for raising and lowering the outer cover of the casing. These two covers, when raised, may be swung back out of the way on the arm which carries them.

For raising the chip basket from the machine, a steam hoist is used. This consists of a plunger fitted into the cylindrical body of the column at the rear of the machine and provided with a swinging crane arm and sling for grasping the basket as shown in Fig. 2. Steam is admitted beneath the ram by a hand operated valve. The hoist is automatically held at the upper extreme of its travel by a catch, so that it is not necessary to keep the steam pressure on constantly. When so held, the basket may be swung out to one side and the dry chips dumped into any convenient receptacle. To replace the basket after filling it (either from a chute or by shoveling) the hoist arm is swung back into position, and the catch pulled out, allowing the plunger and basket to descend. The latter is so arranged that it seats itself in position on the rotor. The arms carrying the basket and the cover are ar-

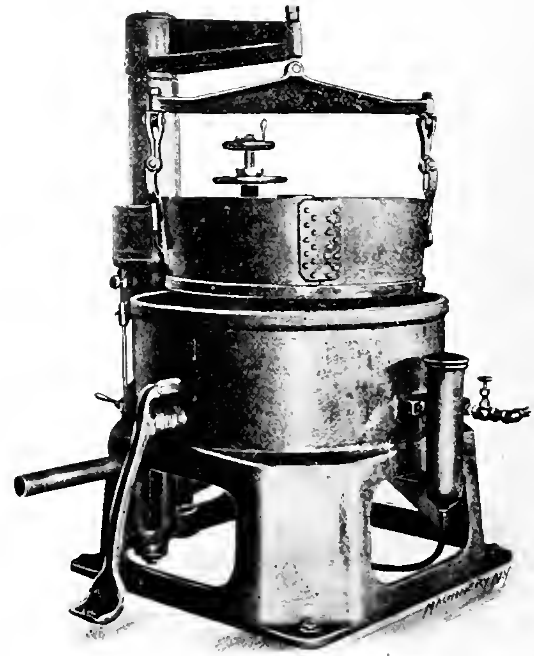


Fig. 2. Using the Steam Hoist to lift the Basket from the Separator.

ranged with ball and roller bearings so that the entire operation of loading and unloading, exclusive of filling the basket, lasts but two or three minutes. The extraction of the oil is thoroughly accomplished in six or eight minutes. The oil is discharged from the pipe seen projecting from the left side of the base. The reservoir at the right side is for supplying lubricant to the step bearing.

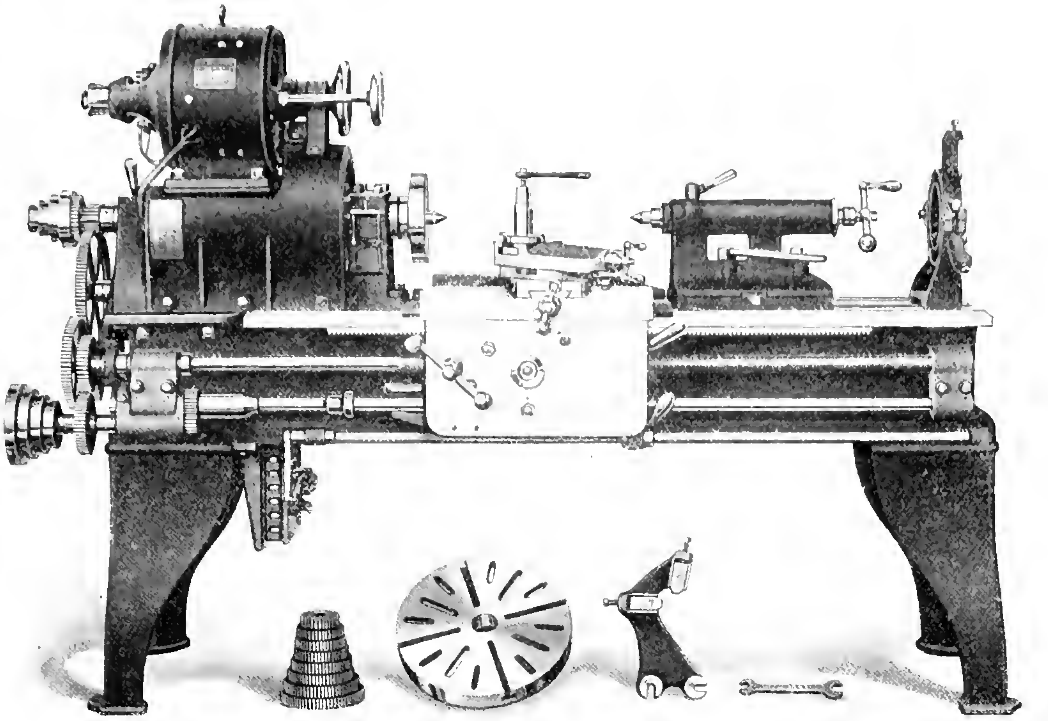
The machine has a basket capacity of 3½ cubic feet, or very nearly three bushels. It is now in operation in a number of plants throughout the country, and has proved to be very satisfactory. It is a development of the makers' waste reclaiming machine, which separates the oil by the combined action of steam and centrifugal force obtained from a steam turbine in the same way as here described. The absence of troublesome quarter-turn belting and high-speed counter-shafts is a very favorable point in the design.

RAHN-CARPENTER 16-INCH MOTOR-DRIVEN LATHE.

The Rahn-Carpenter Co., Cincinnati, Ohio, is applying to its line of engine lathes the style of motor drive shown in the engraving. The use of a variable speed motor and the convenient location of the controlling mechanism make the arrangement a most satisfactory one.

The motor used is the Lincoln variable speed machine which we have previously illustrated. (See "New Machinery and Tools in the March, 1906, issue of MACHINERY.) In this motor no electrical controller is required. The turning of the small hand-wheel projecting from the front of the motor frame moves the cone-shaped armature longitudinally. When it is by this means withdrawn from the taper pole-pieces, the air gap and consequently the magnetic reluctance is increased, decreasing the magnetic flux and increasing the number of revolutions per minute. A speed ratio of 8 to 1 is given by this means, with infinite gradations, the number of changes not being limited by the number of contacts on a controller. This ratio of 8 to 1, combined with the back gear ratio, covers the entire range required on a lathe of this size.

Since no controller is required, a simple starting box only is used, placed beneath the head-stock end of the bed. This is operated by a splined shaft running lengthwise of the bed, connected with a handle at the left of the apron, convenient to the operator at all times. The motor is reversed by the double throw switch shown on the front bearing of the head-



The Rahn-Carpenter 16-inch Lathe as arranged to be driven by a Lincoln Motor.

stock. When set for any given speed the motor maintains that speed almost constantly under varying loads, the drop in speed from full load to no load comparing favorably with the best constant speed motor practice. The special commutator poles provided prevent sparking at all speeds, even with as high as 50 per cent overload.

It will be seen that the motor is mounted low down on the head-stock, close to the spindle, so that the top-heavy construction often found in electrically-driven lathes is avoided. This tends to steadiness of running and consequent accuracy of work. The armature and the spindle are connected positively by gearing. The head-stock is well ribbed and firmly bolted to the bed. The spindle is of high-carbon steel, ground, running in adjustable boxes of the best gun metal.

The lathe, in general, fills the requirements for modern practice with high speed steel. It is rigid and simple in construction, accurate and easy to operate. The carriage is gibbed to the bed both front and back, with a broad bearing for the rest. The apron is of simple design, with all feeds convenient to the hands of the operator. The rack and all the gears are made of steel, and the stud pivots are hardened and ground. The change gearing connects the lathe spindle and the lead-screw directly, and is very simply set for any thread within the range of the machine, it being necessary to change only the gear on the lead-screw.

AUTOMATIC SLOT MILLING ATTACHMENT TO GARVIN MILLING MACHINE.

In the accompanying half-tone and line engravings we show an attachment recently devised by the Garvin Machine Co., Spring and Varick Sts., New York, for automatically operating the milling machine for performing such work as milling drift slots in taper sockets, cutting slots in tool-posts, milling keyways with end mills, and other similar operations in which a groove or slot is cut by feeding successively deeper and deeper with an end milling cutter. The function of the attachment is to feed the carriage back and forth within limits determined by the required length of slot, at the same time feeding the saddle in toward the column by a small amount at each reversal. An automatic stop is also provided for arresting the cross feed movement when the proper depth of slot or keyway has been reached.

The device is operated by the regular telescopic feed shaft of the machine. The mechanism for controlling the automatic movements is attached to the side of the regular feed box as shown in Fig. 1. The mechanism will best be understood from the line drawings, Figs. 2 and 3. Shaft *A* runs constantly in one direction, driven by the telescopic feed shaft. It is connected with worm *B*, driving the feed worm-wheel *C*, by tumbler gears *D* and *E*—a part of the regular mechanism of the machine. Shaft *A* is also geared with and drives sleeve *L*, from which, as will be explained, the controlling movements of the attachment are operated.

Stops *G* and *G'* are adjusted in the T-slots under the front edge of the table to agree with the range of movement required for the length of slot or keyway which is to be cut. These stops act on plungers *H* and *H'*, whose lower ends in turn rest upon and actuate a cross arm attached to lever *K*, pinned to rock shaft *J*. This rock shaft carries at its inner end a fork *Q* whose arms encircle the hub of clutch member *O*, keyed to shaft *F*. Springs *M* force this sleeve forward against clutch body *N*, keyed to sleeve *L*, which latter is driven constantly (as before explained) from shaft *A*.

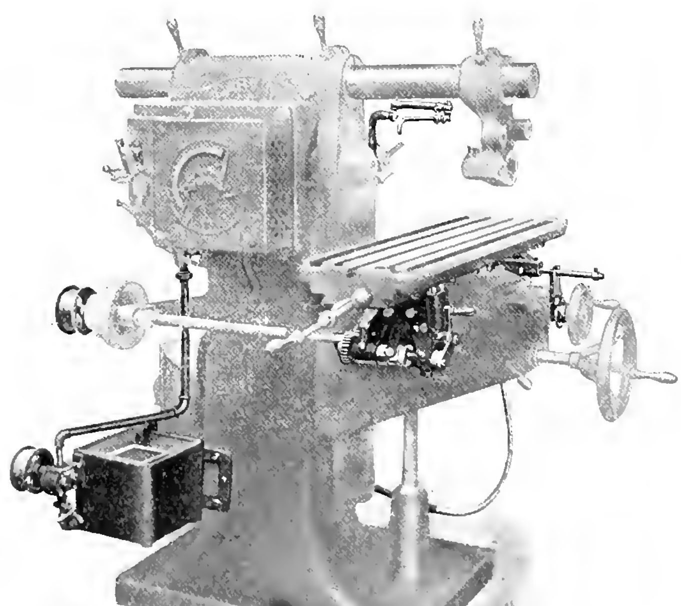


Fig. 1. Automatic Slot Milling Attachment applied to Garvin Plain Milling Machine.

With the table traveling in the direction of the arrow in Fig. 3, stop *G* presses down the top of plunger *H*, rocking shaft *J* so that the right-hand arm of the fork is raised while the left one is brought inward toward the hub of member *O*. By the action of a cam surface on *O*, the latter is by this action released, and allowed to be forced inward by springs *M*, until

the multiple disk friction clutch contained in N engages revolving sleeve L to shaft F. When a half revolution of F has taken place, the cam surface on O engages the pin in that arm of the fork which is now depressed and runs up on it, thus releasing the friction and arresting the rotation. At the outer end of F is a crank disk with a crank-pin P connected by the link, as shown, (see also Fig. 1) with a mechanism for operating the tumbler gears by which the feed is reversed.

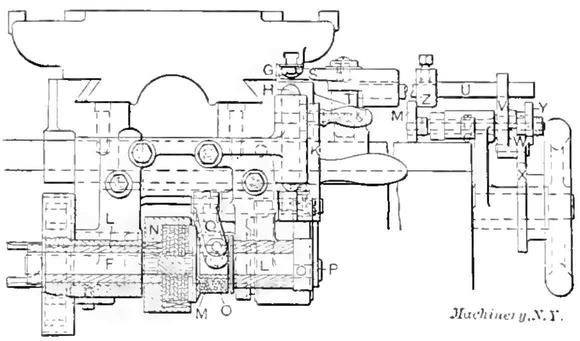


Fig 2. Section through Reversing Mechanism attached to Feed-box of Milling Machine.

From this it will be seen then that when G strikes H, the half revolution thus given to F by the shifting of fork Q throws the tumbler gears over and reverses the direction of rotation of B, and consequently the direction of the feed. The table now moves in the opposite direction from that indicated by the arrow, until stop G' engages stop H', which rocks arm Q in the other direction, allowing another half revolution of F, again throwing the tumbler gears, by means of crank-pin P and the attached link, backward. The reversal of the table feed is thus seen to be automatic and continuous.

The cross movement, feeding the end mill at each reversal of the table movement, is effected by stops R and R' located in the same T-slot which carries G and G'. These dogs alternately strike lever S, which is pivoted in a vertical axis about stud T. Rod U, which is an extension of lever S, is thus vibrated back and forth as the table is reversed. Rod U engages a slot in lever V, to which (above and below its pivot) are attached pawls W and W', engaging ratchet wheel X keyed to the cross feed shaft. Paul W, it will be seen, acts on the right-hand reversal, while pawl W' acts on the other. A cam Y may be thrown to raise both pawls out of engagement with X to stop the feed. The rate of inward feed is adjusted by setting stops R and R' to give greater or less swinging movement to U.

As was stated previously, however, an automatic feed stop is provided which arrests the feeding of the saddle on the knee when the proper depth of cut has been reached. This is accomplished by setting dog Z at the proper position on rod

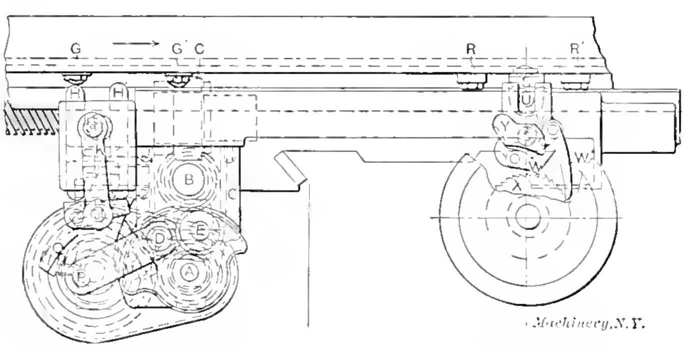


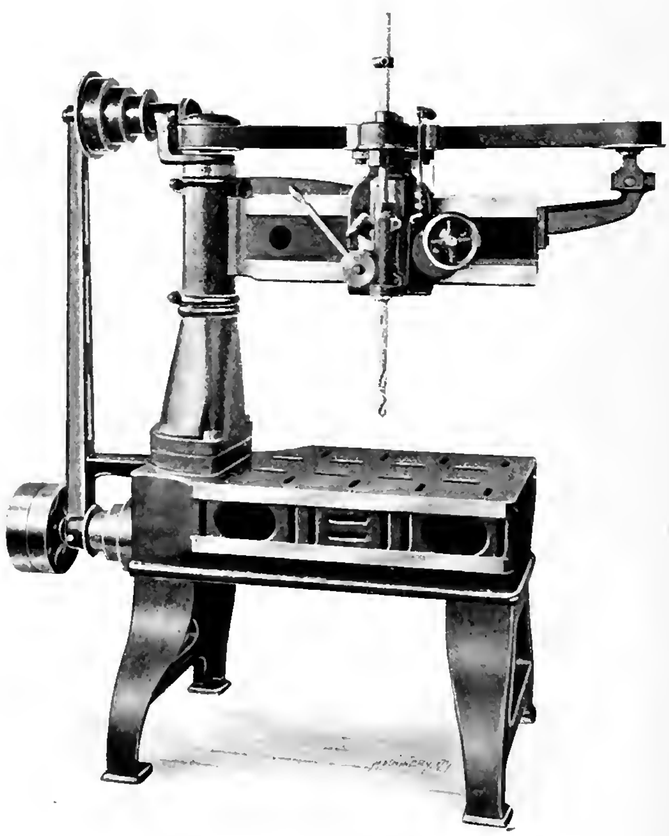
Fig 3 Front View of Reversing and Cross-feeding Mechanisms.

U, so that when the desired inward movement of the saddle has been effected, Z will strike tappet M as the lever U is thrown over at the reversal, thereby drawing inward, strongly, cam Y, which is attached to the same pivot as M. This pressure on Y prevents pawls W and W' from falling back into the ratchet on the backward stroke, thereby stopping the feed.

An especially notable feature of this device is the fact that it effects complicated automatic movements in a plain machine of standard type. The attachment is comparatively simple and need not be removed from the machine when the latter is being used on regular work. It is simply necessary to uncouple the rocker actuated by plungers H and H' from lever K, this being done by a small screw at the front of the machine. The feed is reversed by hand by a small handle seen at the front of the speed box. Pump and piping, as shown, are essential for washing the chips out of the slot being milled. These will be provided when ordered. The attachment can be applied to the Nos. 12, 13, 13½ and 14 milling machines, and the No. 2 universal machine made by the builders.

NEW SENSITIVE RADIAL DRILLING MACHINE.

The machine here illustrated forms the first of a range of sizes designed more especially for dealing with bulky and awkward castings, etc. The box-section table, the working surface of which is 3 feet 6 inches by 2 feet, enables angle plates to be dispensed with, and, of course, permits long work to be operated on at the ends. The arm, which is well ribbed, swings on the column, and can be locked in any position. The spindle, which is of tool steel, is 1 inch in diameter, and is



Radial Drill Press of English Design.

belt-driven as shown, a tightening device being provided for the belt. The spindle revolves in a long sleeve which has an adjustable cap. The thrust is taken on ball bearings. The driving pulley of the spindle revolves in a long bearing, relieving the spindle of strain, irrespective of the tightening of belt. The head is moved along the arm by rack and pinion operated by the hand-wheel shown. The pulleys are turned all over to insure correct balance, and have a long bearing on their studs. The usual adjustable collar is provided on the spindle for repetition work. The machine being self-contained, as regards the counter-shaft, can be driven direct from the line shaft, the steps of the three-speed cone pulley taking a 2-inch belt. The fast and loose pulleys are 10 inches diameter by 2½ inches wide. The vertical movement of the spindle is 5 inches and that of the sliding head 8 inches. The spindle is bored to take No. 2 Morse taper. The distance from the arm to the table is 18 inches; the maximum distance from center of spindle to center of column is 2 feet 6 inches. The counter-shaft is speeded from 280 to 340 revolutions per minute, and the floor space taken up by the base is 4 feet 4 inches by 2 feet 6 inches. The machine weighs about 1,200 pounds, and is built by A. Haworth & Co., Luton, England. J. V.

SELLERS HIGH-POWER DRIVING-WHEEL LATHE.

There is no better example of the great efficiency that can be obtained from machine tools specialized for definite operations, than the modern driving-wheel lathe as developed for the work of the railroad shops. These have been continually increased in rigidity and driving power, taking advantage of the new-found possibilities in high-speed steel, until at the present time the matter of handling the work, clamping it in place, changing and adjusting the tools, etc., has become of greater importance than the time spent in the actual turning operations. This being the case, the recent developments in this line of machinery have been particularly directed toward the matter of securing greater convenience and rapidity of operation, and, at the same time, all the advantages of high cutting power are retained. A recent and most interesting example of this development, the driving wheel lathe built by Wm. Sellers & Co., Inc., of Philadelphia, Pa., is herewith illustrated and described.

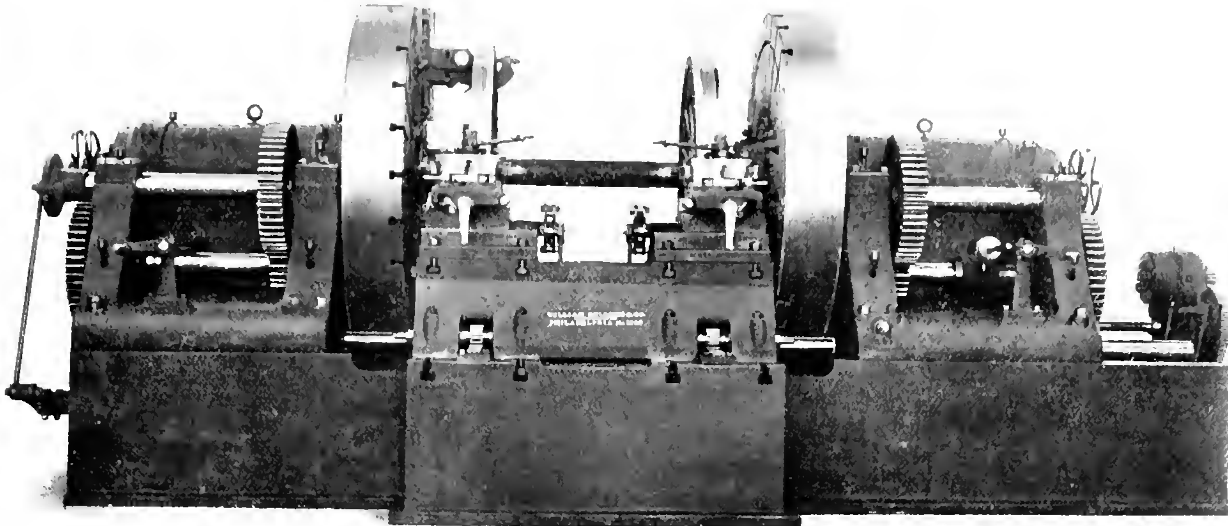


Fig. 1. The Sellers High-power Driving-wheel Lathe.

Head-stock Driving and Adjusting Mechanisms.

As may be seen in Fig. 1, the lathe consists of a bed on which are mounted two head-stocks carrying heavy spindles and face-plates, and a tool bench carrying two tool slides, one for each wheel. The machine is electrically driven, the main motor being partially seen at the rear in the end view of the machine in Fig. 3. Power is transmitted to the right-hand head of Fig. 1 by the heavy splined shaft shown running lengthwise of the bed beneath the face-plate. The end view of the machine in Fig. 3 best shows the driving connection. This splined shaft is provided with a pinion meshing with a gear on an intermediate shaft, which in turn meshes with a gear on the driving pinion shafts. The driving pinion engages internal gear teeth in the rim of the face-plate. The connections for the movable head are similar, except, of course, that the first pinion of the train is splined onto the driving shaft and moves with it as the head-stock is adjusted.

The pinions for driving the face-plates are located in nearly the same horizontal plane as the tools, and on the same side of the center. The cutting strain is thus transmitted directly through the face-plate and drivers without imposing any pressure on the spindle bearings. The spindle caps are made in one continuous piece for each head, producing a nearly solid support for the hardened steel step which is placed at the end of the spindle for taking the thrust. Secured to the face-plates are flanged bearings through which the sliding center spindles pass, which support these spindles and reduce their overhang when extended into the work. These bearings are supplied with split taper bushings for taking up the wear and maintaining an easy fit without allowing lost motion and consequent chatter. When desired, these bushings may be closed tightly on the spindle, thus forming an additional clamp.

The motor provided for driving the lathe is of ample size and has a speed range of 2 to 1, which, together with the mechanical change provided, controlled by the handle seen at the front of the left-hand end of the head stock in Fig. 1, gives spindle speeds of from $\frac{3}{4}$ to $1\frac{1}{2}$ turns per minute, with numerous intermediate steps.

The small motor shown at the extreme right-hand end of the bed in Fig. 1 operates a screw by means of which the left-hand head-stock is shifted outward for removing the work, or inward for placing the work on the centers. It does not drive the screw positively but through the medium of a friction clutch, which will slip if the mechanism meets with undue resistance, such as would be the case, for instance, if it were attempted to throw in the traversing movement before the head-stock clamping bolts had been loosened.

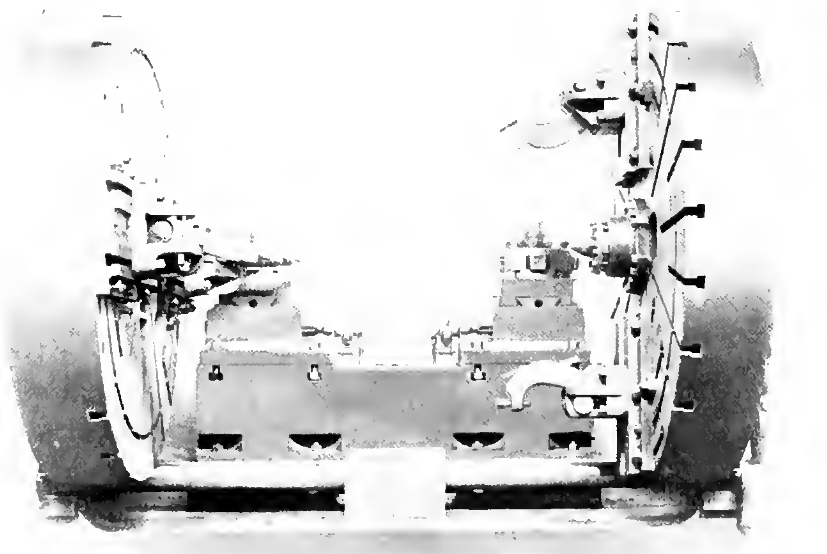


Fig. 2. View of the Double Face-plates showing the Floating Drivers.

The Wheel Clamps or Driver.

A most important feature of the machine is the means provided for driving the work. With the tremendously heavy

cuts taken, the rim of the wheel must be so held that there is no possibility of slippage. The drivers used are best seen in Fig. 2. There are two on each face-plate, located at right angles to each other, as required for the "quartering" of the driving wheels. The drivers consist of slides bolted to the face-plate, carrying holders in which are supported drivers of the C-clamp order. These are so mounted that they float in the holders, being pivoted horizontally (in the position shown

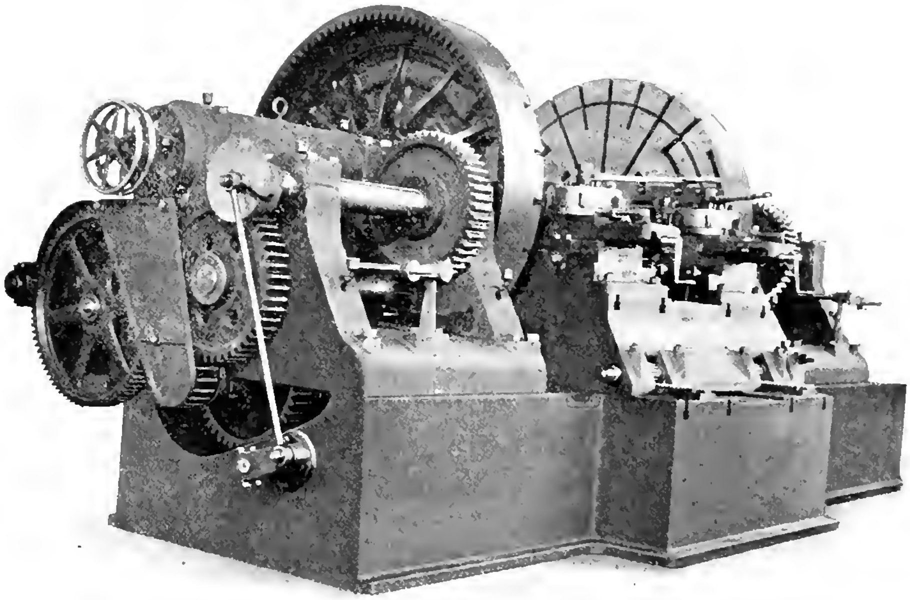


Fig. 3. End View, showing Driving Gearing and Feed Motion.

at the left of Fig. 2) in a block which itself is pivoted about a vertical axis in the holder. The pivot which provides for this latter movement has considerable play in the holder, so that the clamp can adjust itself within limits to the position of the rim of the wheel.

In Fig. 2 the drivers are shown in three positions. The upper one to the right is held by a spring latch in position for inserting and removing the wheel. The one beneath it is unlatched and in position for clamping. When the face-plate is revolved, the drivers will automatically open and latch. The driver on the left shows the gripping jaw in the floating block to which the clamp is pivoted. After the clamps have been swung in under the rim and tightened down, any tendency of the work to slip at once cants the C-clamps about their radial pivots, thus more tightly gripping them on the work. By this means assurance is given that the driving power is always sufficient for the work in hand, and this is done without side strain on the wheel rims. A further ad-

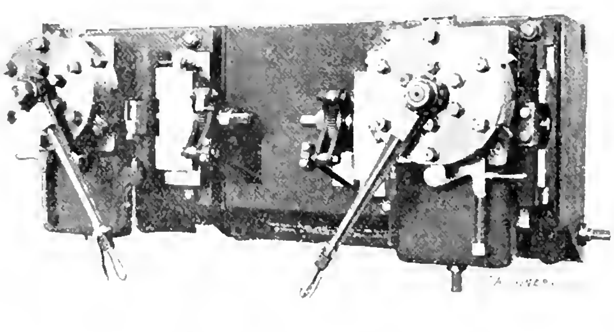


Fig. 4 Top View of Tool Bench, showing the Two Tool Turrets and the Slides on which they are mounted.

vantage is that the drivers are self-contained, without loose parts to be removed or replaced in changing wheels. They are clamped by one set-screw by an ordinary short wrench, the clamping action previously described being depended upon to give the necessary power for driving. It will be seen that these drivers can be manipulated with great rapidity.

As may be seen in Fig. 2, the slides on which the drivers are mounted may be adjusted through a limited distance for angular position about the axis of the spindle. This makes provision for wheels having both odd and even numbers of spokes. Graduations are provided for this angular setting, as well as for the radial position of the drivers on the slides, so that the operator can set the machine for the number of spokes in the wheels and the inside diameter of the rim before the work is placed between the centers. To change from the setting from that for wheels of right-hand lead to that for left-hand lead, the driving pinion for the head at the left of Fig. 1 may be thrown out of engagement with the gear it meshes with, by means of the handle shown at the front, operating the rack and pinion withdrawing movement. This disconnects the face-plate from the driving shaft, so that the other one may be revolved for 180 degrees, after which the connection is again thrown in.

Provisions for Holding and Feeding the Tools.

The bench (see Fig. 4) on which the tool slides are mounted is supported on a forward extension of the bed. It is adjusted in and out on this extension for the diameter of the work by means of a rack and pinion movement, operated by a ratchet wrench, as plainly shown in Fig. 1. The slide rests mounted on the bench are heavy and capable of taking heavy cuts. The bases of these rests are arranged to swivel on the bench to accommodate different angles of wheel tread. The slides are each provided with a ratchet feed motion, connected by a ball jointed rod with a rock shaft in the bed of the lathe. This rock shaft is operated by a slotted crank on the right-hand driving pinion shaft, as is best seen in Fig. 3. The adjustment of the crank-pin toward or away from the center of the crank determines the rate of feed.

Each slide rest carries a cross slide on which is mounted a tool-carrying turret. The mounting of the tools for this machine in a turret is an important improvement, securing great rapidity of operation. These turrets (as is best seen in the top view of the tool bench in Fig. 4) are located in position by manually operated locking bolts held in place by coiled springs. The handle for locking and unlocking the right-hand turret will be seen just at the right of, and below it. The long levers pivoted above the turrets serve the double purpose of clamping and unclamping them, and of indexing them to new position. When the spring plunger is thrown into engagement with the slotted disk at the hub of the lever, the indexing movement can be operated. When the plunger is free from this disk, the movement of the lever clamps or unclamps the turret. The turrets are of steel. A micrometer screw and stop conveniently placed at the side of the cross slide enables the wheel to be rough turned to the desired diameter without calipering. The stop can be swung aside when finishing. The front of the openings in the turrets for the forming tools are made with a slight taper to fit which a corresponding taper is provided in the tool sockets. The latter are thus accurately centered and securely held against side motion. This construction also permits a reduction in

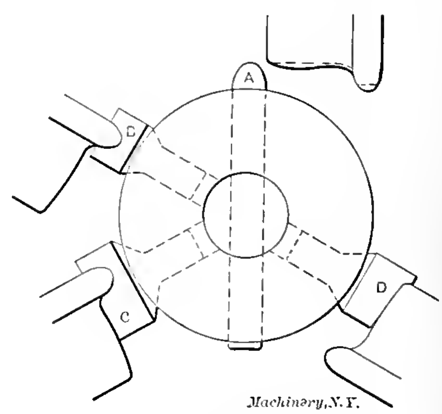


Fig. 5. Usual Arrangement of Tools for Truing up a Worn Driving Wheel.

the size of the tool body without decreasing the broad bearing surface which supports the tool near the cutting edge.

The Order of Operation.

The usual arrangement of tools is somewhat different from that shown in Fig. 4, being indicated in Fig. 5. The first tool *A* is a roughing cutter which may conveniently be made with a long shank extending clear through the turret, a hole being provided for this purpose in the central stem. The forming tools are not subject to so great wear, and may be conveniently made with shorter shanks. After the tread has been rough turned with *A*, the turret is indexed and the tool *B* is used for sizing the flange. Tool *C* is next brought into position for finish forming the flange, and a portion of the tread. Tool *D* forms the other half of the tread and rounds the corner.

The operation of a machine of this kind certainly presents a powerful contrast with that of a wheel lathe of ten or twenty years ago, whose operation was one of the "soft snaps" of the railroad repair shop.

NUTTALL FLEXIBLE INSULATED COUPLING.

The illustrations show an improved flexible insulated coupling manufactured by the R. D. Nuttall Co., Pittsburg, Pa. The coupling consists of two interlocking spiders of cast iron construction which are insulated by means of solid rubber cylinders. The only other parts are two steel rings used to hold the rubber cylinders in position. The rubber members provide ample insulation and at the same time give the desired flexibility. It is furnished in sizes from 5 H.P. up.

Fig. 1. Nuttall Flexible Insulated Coupling.

This flexible coupling is especially desirable where electric motors are direct connected to machinery which is subject to vibration, as, for example, a tube mill or a coal pulverizer in a cement plant, where the coupling relieves the motor from

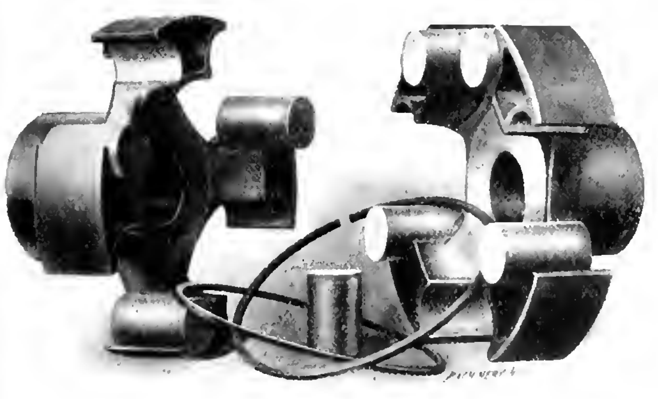


Fig. 2. Parts of Nuttall Flexible Insulated Coupling

the shocks and jars of the machine. In addition, the end thrust of the crusher is overcome and the motor bearings run without heating.

YALE & TOWNE ELECTRIC TRIPLEX HOIST.

As is well-known, the Yale & Towne Mfg. Co., 9 Murray St., New York, has been for many years building a triplex hand-operated hoist, which has found extensive use for all purposes for which a hand hoist can be used. This company also manufactures a well-known electric hoist, which has found much favor for heavier service, particularly for eye-beam trolley systems and for use with traveling cranes. The builders of these hoists have recently placed on the market a new one which occupies a field mid way between the other two, being a hoist of practically the same construction as their hand-operated triplex type, but driven electrically.

The front and end views of this machine are shown in Figs. 1 and 2. The arrangement consists essentially, in the case of the 1-ton electric triplex hoist shown, of one of the builders' regular 2-ton triplex hand-operated blocks, provided with a motor and a controller, the motor being mounted on one side of the block and the controller on the other, as seen best in Fig. 2. The pinion shaft of the hoist is connected by chain and sprockets directly with the armature shaft of the motor. This latter is of the series wound crane type, ruggedly constructed, and designed to take care of the varying loads and varying speeds met with in hoisting work.

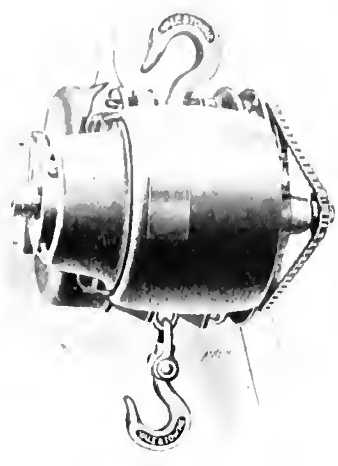


Fig. 1. Side View of the Yale & Towne Electric Triplex Hoist.

The chain drive is very efficient, and in combination with the high workmanship and good material used in the gearing of the hoist proper, insures a very low current consumption. The load is positively sustained at all times by means of a Weston brake. The gearing is shown in Fig. 3 where it is

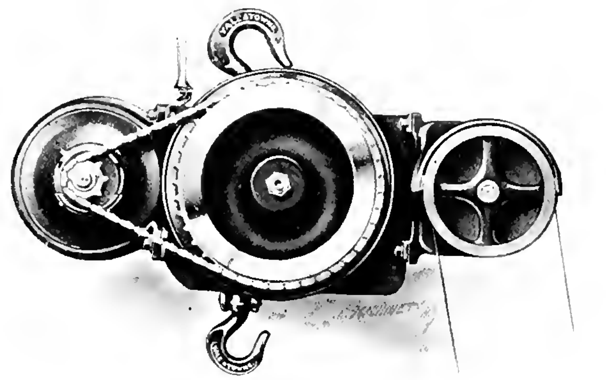


Fig. 2. End View showing Auxiliary Hand Chain Drum.

compared with that used in the hand-operated 1-ton triplex chain block, both of these being intended for the same loads. The parts have been made much heavier for the electrically operated machine, to provide for the wear and tear resulting from the more rapid and severe operation it is subject to.

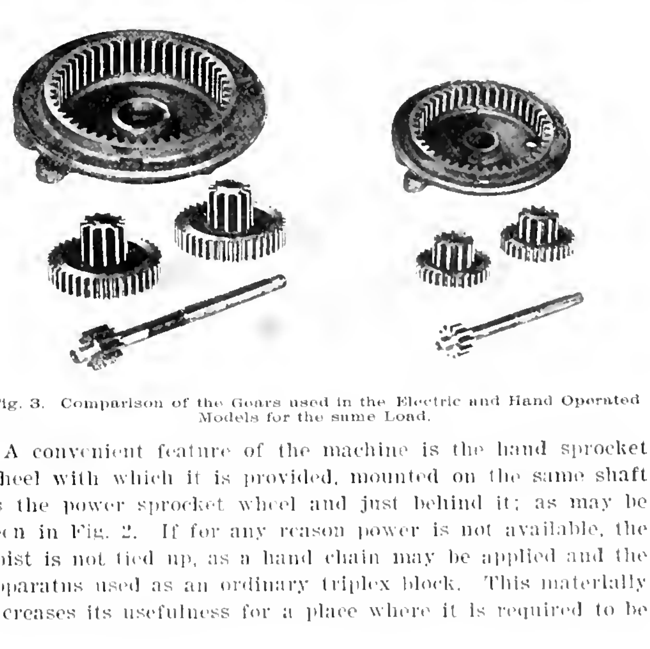


Fig. 3. Comparison of the Gears used in the Electric and Hand Operated Models for the same Load.

A convenient feature of the machine is the hand sprocket wheel with which it is provided, mounted on the same shaft as the power sprocket wheel and just behind it; as may be seen in Fig. 2. If for any reason power is not available, the hoist is not tied up, as a hand chain may be applied and the apparatus used as an ordinary triplex block. This materially increases its usefulness for a place where it is required to be

used occasionally at night, or at any time of the day when power is shut off. It is provided with a safety automatic stop to prevent over-travel of the hoist hook.

This hoist, it will be seen, is adapted to solving the problem of short frequent lifts. For handling 50 pounds or a ton it is five to ten times as fast as a hand chain block, and will do the work of several ordinary laborers. It is especially economical for serving machine tools, running on trolley track, and handling finished parts in the assembling shop. It may be attached to a small traveling crane, swinging jib crane or trolley track, or it may be lashed to shear poles or any other temporary rig. Its installation is very simple, involving simply hooking the hoist in place and attaching two wires for the current. The controller is operated by means of two pendant cords.

While designed primarily for motor service and short lifts, a recent test with this machine was undertaken in which a load of one ton was lifted 10 feet high and lowered the same distance, thirty times in two hours without injury to the machine. This, however, is heavier service than it should be required to undergo. The service for which it would naturally be used consists in lifting loads ranging from 50 pounds to a ton, to a height simply to clear the floor, or at most for a lift of 3 or 4 feet onto some machine. When operated thus, the hoist is suited for reasonably continuous service.

Although, as stated, this hoist has only recently been placed on the market, the design has been developed for some time, and a number of them have been in use in various places under severe conditions, so that it is known that the device is a thoroughly practical one in all respects.

STURTEVANT VERTICAL COMPOUND ENGINE GENERATOR SETS.

The B. F. Sturtevant Co., Hyde Park, Mass., has recently completed the design of a line of vertical compound engines direct connected to generators for small electric lighting and power plants. Success in service of this kind depends quite as much on low cost of up-keep, and freedom from continual attention, as it does upon economy measured in pounds of steam per horse-power per hour, though this latter point is an essential one in all except units of the very smallest size. To fill these conditions this line of engines has been designed, special attention being given to simplicity, reliability, durability and continued economy throughout a long life.

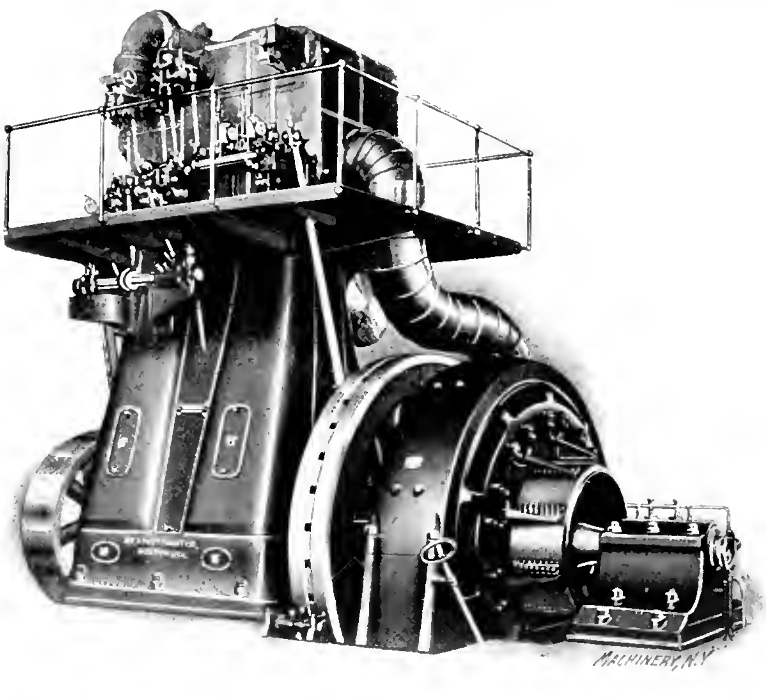


Fig. 1. Sturtevant Engine Generator Set, adapted for the Factory Power Plant.

The item of economy requires that the engine shall be made compound, since steam can be used more economically with a comparatively simple valve gear in two cylinders than can be done in any possible single cylinder design of engine, even though every refinement known to the engine builder is used. The steam distribution is effected by six valves of the gridiron type for each cylinder—two exhaust valves, two steam valves and two cut-off valves riding on the steam valves. Exhaust valves and main slide valves are driven by eccentrics fast to the main shaft, while the cut-off valves are operated by an eccentric controlled by the governor, which is a modification of the well-known Rites inertia type, placed in a

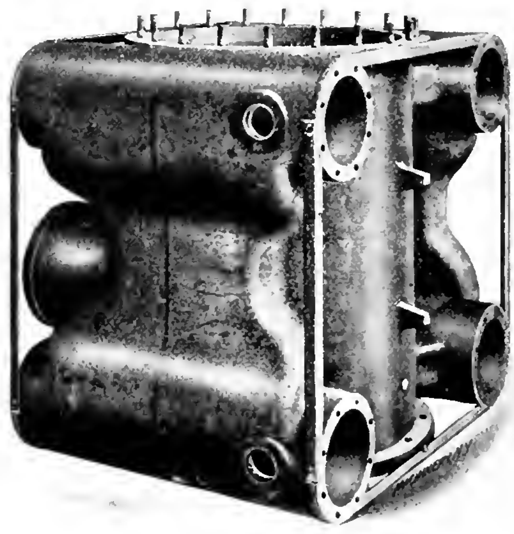


Fig. 2. Method of attaching the Lagging to the Cylinder Casting.

separate fly-wheel. This governor is sensitive enough to regulate the speed so that the variation between no load and full load is less than 2 per cent—sufficiently close for electric lighting. This form of valve gear tends toward high economy, and it permits the cut-off to be adjusted without in any way altering the other functions of the steam distribution, giving the same results as are obtained with the Corliss valve gear. The valves are placed in the cylinders, so that the heads can be removed without disconnecting the valve-gear.

The reciprocating parts are enclosed by a cast iron frame, but are rendered accessible by the removal of oil-tight cover plates or doors. A water shed partition is provided at the top of the frame which prevents the water from the stuffing box from becoming mixed with the lubricating oil in the base. The entire engine is equipped with a system of forced lubrication which positively and automatically supplies oil to all bearings, under a pressure of from 10 to 20 pounds per square inch. A small, independent pump forces oil through the crankshaft web and crank-pin to the connecting-rod, and through the connecting-rod to the cross-head pin. This continuous supply of lubrication reduces friction to a minimum, and makes it unnecessary to make adjustments in the wearing surface except at long intervals.

A neat detail of the design of these engines is the method of supporting the lagging, shown in Fig. 2. As will be seen, the cylinder casting itself is of simple form, both high- and low-pressure cylinders being exactly alike except as to diameter. Angle irons are beveled off to fit the cylindrical surfaces of the valve chambers on each side, as shown, and these furnish the framework to which the lagging is easily attached. The cylinder thus does not have to be complicated to furnish supports for the lagging, though the latter is properly held and applied in a very neat and simple fashion. Provision is made for using indicators without disturbing the lagging or opening the doors of the oil-tight casing.

These engines are made in sizes ranging from 225 indicated horse-power and 150 kilowatt capacity, to 750 horse-power and

500 kilowatt capacity, running from 200 to 160 revolutions per minute. The generators are of the 10-pole type manufactured by the builders, directly connected to the engine shafts by a flanged coupling. They are capable of carrying an over-load of 50 per cent for 2 hours without serious sparking. The insulation will not deteriorate after continuous operation at normal temperature.

The design of these engines is the result of filling the requirements of the builders for their own factory power plant. They proved so satisfactory for the use to which they were applied, that they are now furnished as a regular product of the company, and are recommended as specially adapted to medium-sized factory and power plants.

WILMARTH & MORMAN COMBINATION DRILL, CUTTER, AND REAMER GRINDER.

The well-known "Yankee" drill grinder made by the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., is shown in Fig. 1 provided with an attachment for grinding cutters and reamers. This adapts the tool to doing nearly everything required for keeping the cutting tools in condition in the average tool-room. The attachment is of substantial construction, and is firmly attached by a bracket to the main column

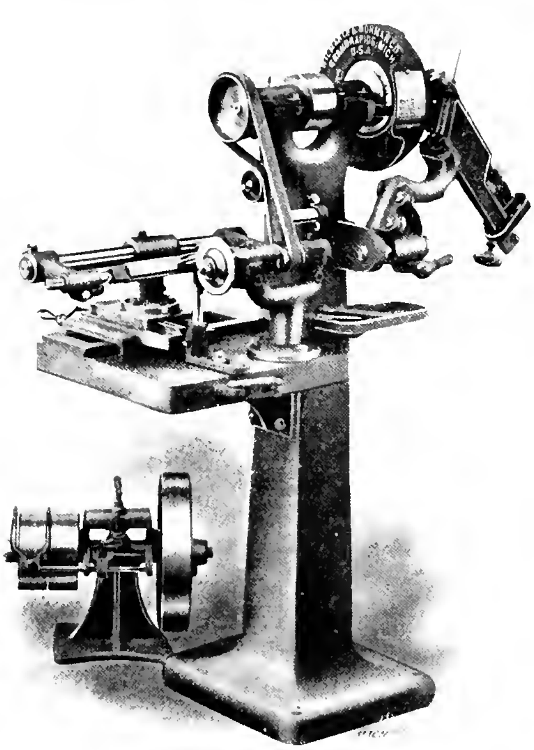


Fig. 1. The Yankee Drill Grinder provided with a Cutter and Reamer Grinding Attachment.

of the machine. It may be supplied with any of the grinders made by the builders, so that the entire equipment will be suited to the range of drills and cutters used by the purchaser.

As may be seen in Fig. 1, the spindle of the attachment is driven from a pulley on the main spindle of the machine by a belt which passes over an idler so that the proper tension may be maintained. The stand which carries the spindle is mounted on a table which forms the base of the attachment. This table is provided with dove-tail ways on which is mounted a slide operated by a hand lever from beneath, as is more plainly seen in Fig. 2. This slide carries dove-tail ways extending at right angles to its line of movement, on which is mounted a second slide, operated by the screw and ball crank shown. This second slide in turn carries a swiveling head which may be adjusted so that the bar it carries may take any position between that parallel with the wheel spindle, and one at right angles to it.

In Figs. 1 and 2 the operation of grinding a reamer is shown. The head which is adjusted in parallelism with the wheel spindle carries a bar provided with centers on which the reamer is supported. A tooth rest is furnished which supports the tooth of the reamer just under the point where it is being ground, so that the hand of the operator may cause the reamer to follow the spiral path of the tooth as the slide is moved back and forth by the hand lever. The adjustment for diameter is, of course, obtained by the ball crank and adjusting screw.

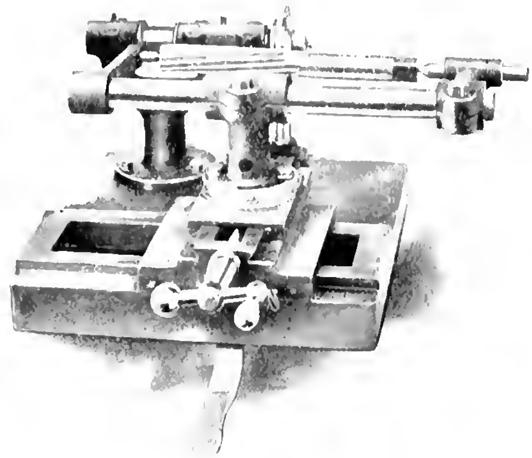


Fig. 2. Grinding a Spirally Fluted Reamer.

The operation of grinding a face mill is shown in Fig. 3. In this case the tooth rest is mounted in the work-carrying head, and moves with the cutter as it is shifted back and forth past the edge of the wheel by the operation of the handle. For grinding the periphery of the cutter, the head is swung around

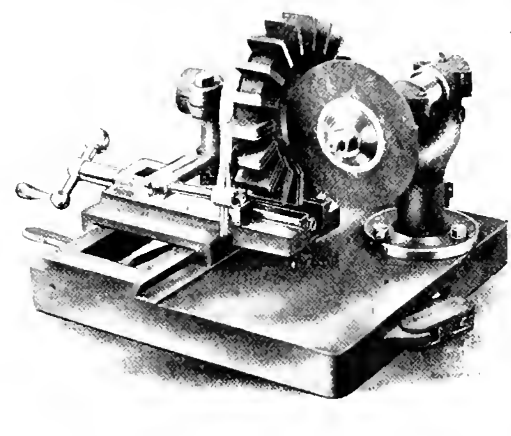


Fig. 3. Sharpening the Face of an Inserted Tooth Cutter.

through 90 degrees to present the other edge of the inserted blades to the wheel. In Fig. 4 a 45-degree angle cutter is being ground in the same manner, though with the head set, of course, to the proper angle. The proper clearance is readily obtained by adjusting the height of the spring tooth rest.

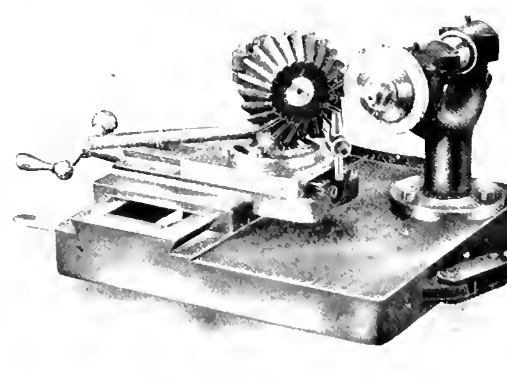


Fig. 4. Grinding a 45-degree Cutter.

The method of formed cutter grinding employed is shown in Fig. 5. A gear-cutter is here being sharpened. A special attachment is used in place of the swiveling head previously shown. This attachment comprises a small table mounted on the cross slide, which table carries a vertically adjustable stud on which the cutter is placed. In setting the device to grind the teeth of the cutter radially, the sliding table is first set

so that the grinding face of the dished wheel is in line with the center of the cutter. In this position the slide is fastened to the base by a thumb-screw provided for the purpose. The micrometer attachment of the stud is then operated to center a cutter vertically with the center of the wheel. The gage provided is then set into position which corresponds with the grinding edge of the wheel. The cutter being thus held, the spring tooth rest or index dog is brought up to bear on the back of the tooth. The grinding is done by moving the slide in and out by the crank, a couple of turns giving sufficient movement. The work is indexed by hand from tooth to tooth, backing up each time against the tooth rest.

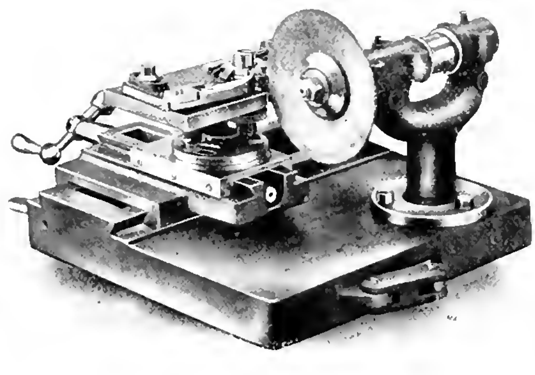


Fig. 5. The Attachment for Sharpening Gear-cutters.

With this convenient attachment, cutters and face and side mills up to 8 inches in diameter may be ground. For angle cutters such as shown in Fig. 4, the diameter limit is 8 inches. The gear-cutter grinding attachment will take work up to 6 inches in diameter, while reamers 8 inches in diameter and with flutes 8 inches long are within the capacity of the machine. The attachment is substantially built and firmly attached to the column of the drill grinder. The bearings, ways, and all other details of construction are carefully designed and fitted, with the idea of giving the machine a long and useful life.

VERTICAL DOUBLE SPINDLE MILLING ATTACHMENT.

The accompanying half-tone and line engravings illustrate the application, construction, and use of a new vertical double spindle attachment, which has been designed by the Kearney & Trecker Co., Milwaukee, Wis., for some special work. The manner of mounting the two heads is plainly shown in Figs. 1 and 2. In Fig. 2 one of the vertical heads is sectioned through the center of the vertical spindle, while a section of the other is shown through the center of the milling machine arbor. On the arbor of the milling machine are placed two spiral gears *A*, which engage with spiral gears *B* on the vertical spindles *C* of the attachment. The gears mounted on the arbor are larger in diameter than the gears on the vertical spindles, which permits the use of angles of helices more favorable for a drive of this kind than if the gears were of the same size. The angles are 54 degrees for the driver, and 36 degrees for the driven member.

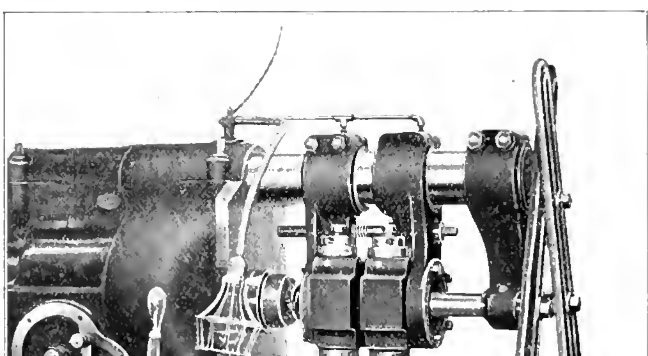


Fig. 1. Kearney & Trecker Vertical Double Spindle Milling Attachment.

An outline of the top surface of the work to be milled in this particular case is shown in Fig. 3, which also indicates the application of the mills. It is evident that in order that both cutters may run against the cut, when cutting the shoulders *E*, one must rotate in a left-hand and the other in a right-hand direction. This is taken care of by the direction of the helix in the spiral gears. The two heads can be adjusted in relation to each other by the adjusting screws shown both in the half-tone, Fig. 1, and in the line engraving, Fig. 2 at *D*, immediately below the overhanging arm. In the special case for which this attachment was built, it was necessary that the distance *F*, Fig. 3, should be maintained in all the pieces milled, regardless of the wear of the cutters. The adjustment between the heads was introduced for this reason, and permits a movement of one-quarter of an inch after the device has once been set up and mounted in place. Of course, a greater adjustment could be obtained by furnishing a spiral gear on the arbor which could take its end thrust against the bearings in the housing, in place of against the arbor itself, leaving the arbor without collars.

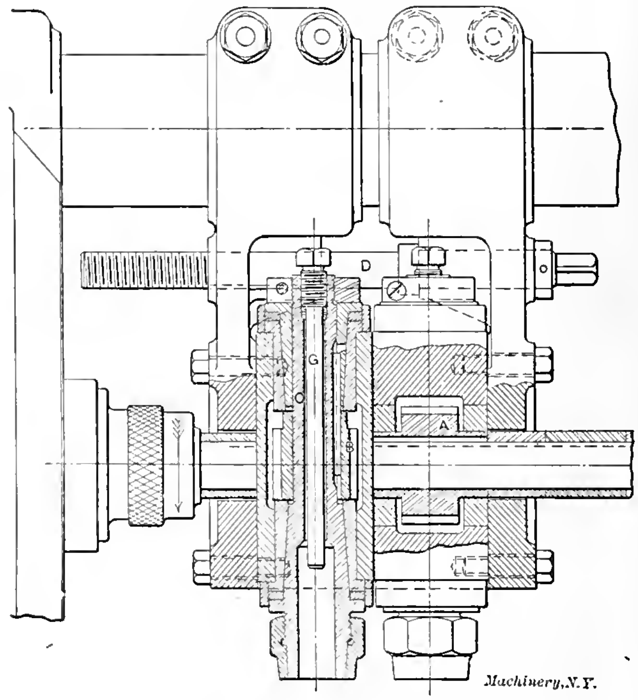


Fig. 2. Design of Vertical Double Spindle Milling Attachment.

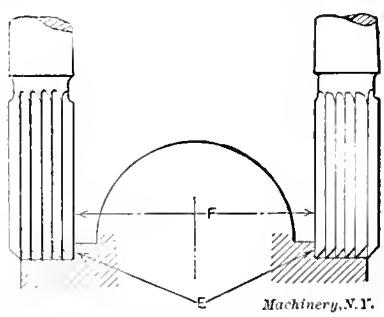


Fig. 3. Example of Uee of Double Spindle Milling Attachment.

In order to make it convenient to set the spindles square with the top of the milling machine table, the casting containing the spindle bearings is made separate from the parts that are clamped to the overhanging arm. The cutters and arbors used in these spindles have straight shanks, and are backed up by screw *G* shown passing through the hollow spindle in the section in Fig. 2. This arrangement permits a slight vertical adjustment of one cutter, in order to bring both cutters to an exact level, when this is required.

MOTOR DRIVE OF THE ACME AUTOMATIC MULTIPLE SPINDLE SCREW MACHINE.

In applying the motor drive to its well-known multiple spindle automatic screw machine, the National Acme Mfg. Co. of Cleveland, Ohio, has introduced a number of improvements which tend toward a considerable increase in the effi-

ciency of the tool. These improvements include positiveness of drive, elimination of belting and counter shaft, simplifying the setting up of the machine, and increasing the output.

As may be seen in Figs. 1 and 2, the driving motor is mounted on a bracket at the rear of the machine. Its armature shaft carries a pinion which meshes with a large gear on the driving shaft of the machine, taking the place of the

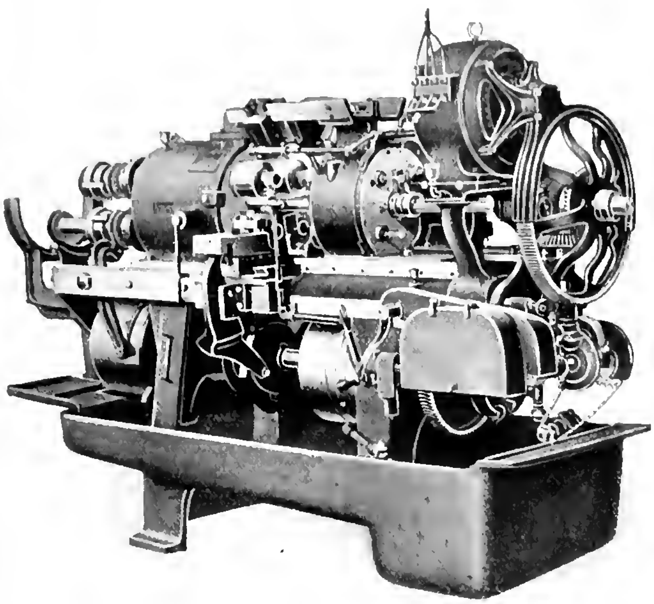


Fig. 1. The Acme Automatic Screw Machine arranged for Motor Drive.

driving pulley furnished with the belt-driven styles. In Fig. 2 will be seen gearing which furnishes a back gear connection between the driving gear and the shaft on which it is mounted, so that either of two rates of speed may be used.

The driving gear is connected with a short horizontal shaft at the base of the machine by the vertical shaft and bevel gears shown. The oil pump is driven from this shaft by a chain and sprocket wheel connection; since the driving gear always runs when the spindles are revolving, a supply of oil

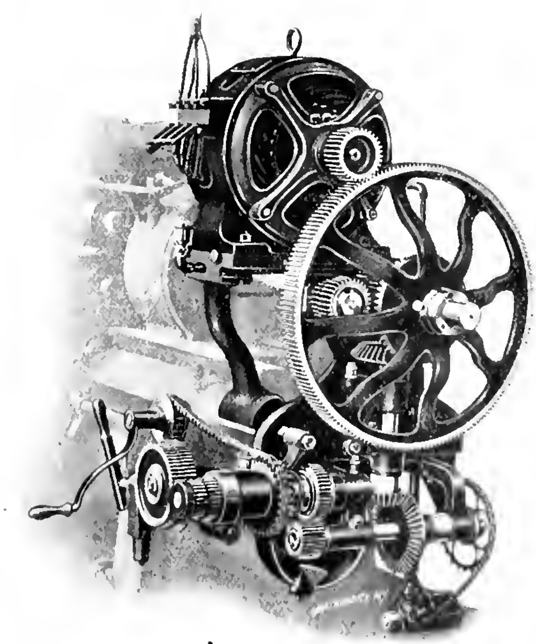


Fig. 2. Arrangement of the Driving Gears

to the work is assured under all conditions when it is possible for cutting operations to take place. In this respect it is far superior to the usual belt-driven pump, in which the breakage or slipping of the belt means disaster to the cutting edges of the tools. A clutch, operated by a convenient handle, is provided for changing the speed of the cam-shaft from fast to slow. The crank shown is attached to the worm-shaft driving the cam mechanism, the power feed being operated by a chain of the silent type, leading to clutch. Change gears are provided for altering the rate of revolution of the cam-shaft and the consequent rate of production of the machine.

It will be seen that when the clutch is in the central position, the sprocket wheel driving the cam mechanism is entirely free on its shaft, so that the hand operation by means of the crank is rendered very easy, the entire transmission mechanism being entirely out of operation. The clutch lever may also be used for operating the tools intermittently in setting up or in testing. The same mechanism is used for the single belt drive, the large driving gear being replaced by a pulley which, if desired, may be directly connected with the clutch pulley on the line shaft, the counter-shaft being then unnecessary. In the motor-driven machine, any standard motor may be used without alteration, the size being properly selected for the size of the machine used, ranging from 3 to 5 horse-power. The machine shown is the builder's No. 56 size, arranged as exhibited at the Atlantic City convention of the Master Mechanics' Association.

CHAMBERSBURG LINE OF STEAM DROP HAMMERS.

The Chambersburg Engineering Co., Chambersburg, Pa., a firm which has had wide experience in building steam hammers, was the pioneer in the development of this machine as specialized for drop forging. The employment of the steam drop hammer for this work was necessitated by the increased use of large drop forgings for parts formerly made of malleable iron, or steel castings. The first of these machines put on the market for this purpose, were capable of doing larger and better work than the previously used board drop hammers, and were less expensive to maintain. Like all new machines, however, a number of weaknesses developed in the severe service to which they were put. The builders have carefully corrected these weaknesses as fast as they have appeared, and have now developed a line of drop hammers that have proved to be thoroughly satisfactory in the service exacted of them.

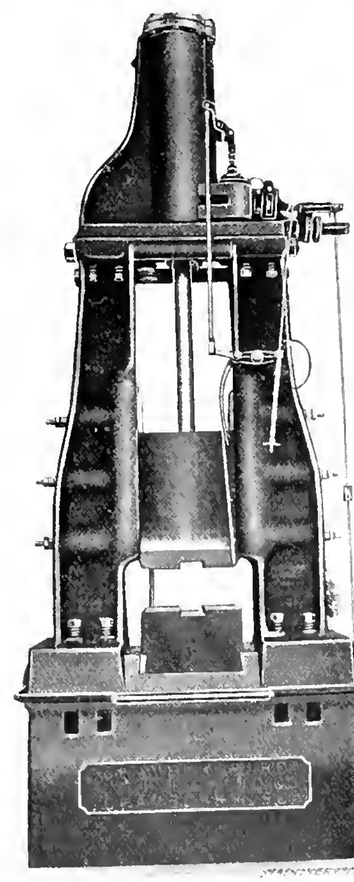


Fig. 1. The Standard Chambersburg Steam Drop Hammer for Drop Forging and Similar Work

The standard form of the Chambersburg steam drop hammer is shown in Fig. 1. A special feature of the construction is the form of tie-plate used, which is provided with ledges or lips fitting around the top of the frames and around the face of the cylinder, thus taking the strain off the bolts and holding the upper members of the hammer in line. The anvil also lips the frame on four sides, relieving the anvil bolts and preventing the shifting of the frames on the anvil. This arrangement makes the hammer very rigid and keeps it in permanent alignment—an important consideration in producing first-class forgings. The hammers are quick acting, re-

quire but little attention, and are always under the control of the operator. The frames and anvils are made of air furnace iron, except where extra hard service is required of the machine, in which case steel castings are used. The hammer shown in Fig. 1 has steel side frames and a cast iron anvil.

In addition to this standard design, the firm has built a slightly modified style, of which an example is shown in the 6,000-pound drop hammer in Fig. 2, built for the Bethlehem

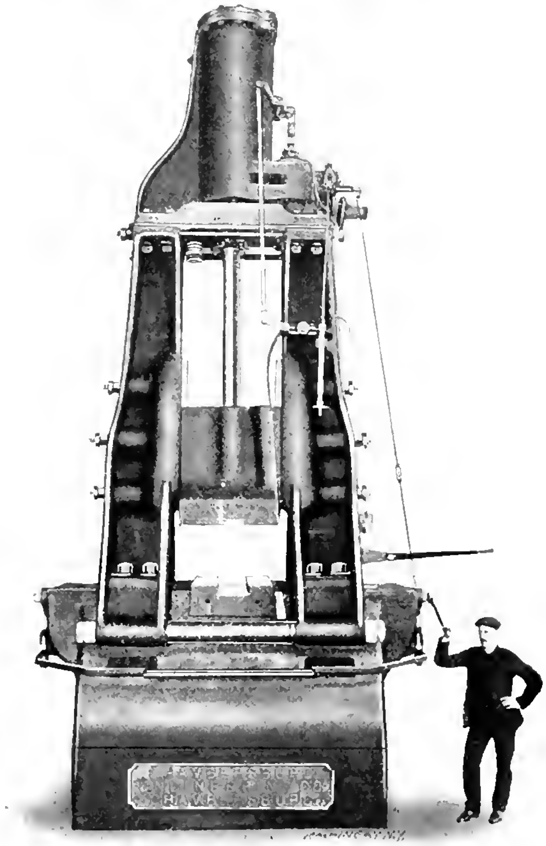


Fig. 2. Special Form of Drop Hammer furnished to the Bethlehem Steel Co.

Steel Co. The special feature of this design is the method of aligning the dies, by adjusting the frames on the anvil, instead of employing the usual taper gibs in the die-block and ram. These hammers have cast steel anvils and frames, and have been successfully used on the heaviest kind of drop forging work.

ARMSTRONG SHORT RATCHET DRILL.

A new ratchet drill of a design which differs from those in common use has been brought out by the Armstrong Bros. Tool Co., 113 N. Francisco Ave., Chicago, Ill. The principal feature of

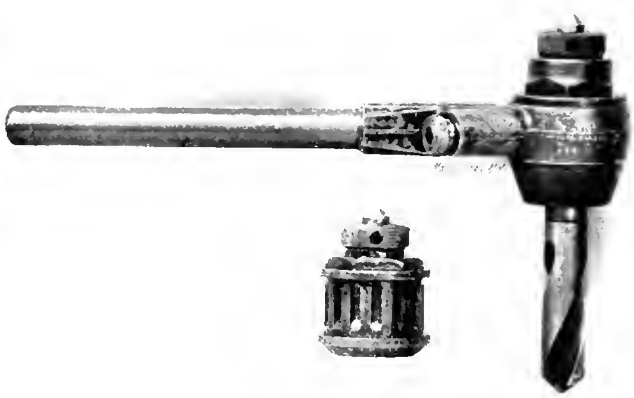


Fig. 1. Armstrong Short Head Ratchet Drill.

this appliance, designated by the makers as the Armstrong short ratchet drill No. 2, is that the mechanism for feeding has been designed in such a manner as to make the head of the tool shorter and more compact than usual. How this has been accomplished can most easily be seen from the line engraving, which shows at the left a section through the head of the type furnished for taking drills with No. 3 Morse taper shanks, and at the right, a type intended for square taper shanks. This latter construction gives a head shorter than that of any ratchet drill made, length of feed considered.

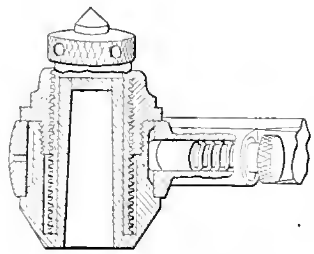


Fig. 2. Head for No. 3 Morse Taper Shanks. Length, 3 3-4 inches; Feed, 2 3-4 inches.

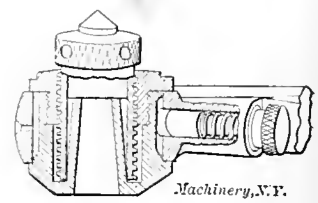
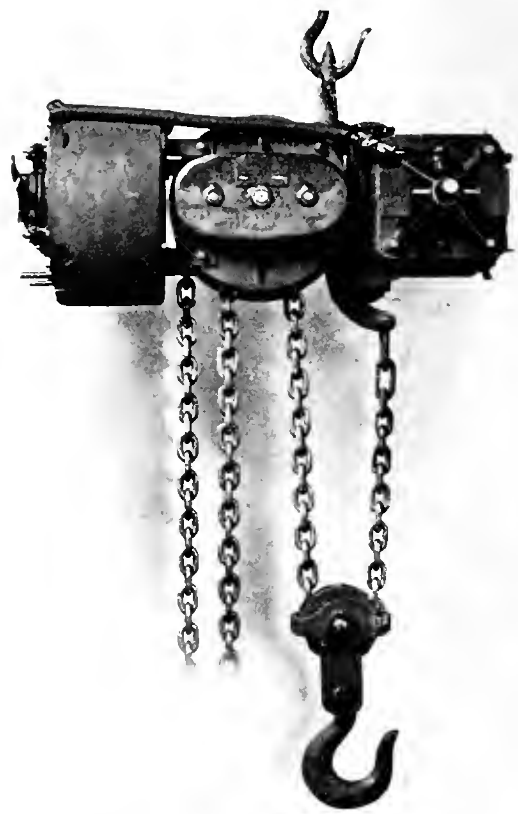


Fig. 3. Head for Square Taper Shanks. Length, 2 3-4 inches; Feed, 1 1-2 inch.

There are no castings used in the construction of these drills, all parts being made either from drop forgings or from bar steel, the pawl and center being of tool steel, hardened.

NORTHERN ELECTRIC CHAIN BLOCK.

A new electric chain block has been brought out by the Northern Engineering Works, 26 Chene St., Detroit, Michigan. This hoist is designed to supplant the ordinary hand chain block, suspended by a single hook. It is known as the Northern C type electric chain block, and is a modification of the original C type placed on the market three years ago. The present design embodies several improvements over the old one, one of the advantages obtained being a shorter space between the hooks, insuring higher lifts under low ceilings.



Northern Engineering Works C Type Electric Chain Hoist.

Referring to the half-tone illustration, it will be seen that the hoist is of the same general design as the hand chain blocks, excepting that it is driven by a crane motor with a standard crane controller having ample resistance. The block can be operated at several different speeds, and it is possible to obtain a speed ten times faster than that obtainable by hand-power. At the same time a hoist of a given capacity is of about double the size and strength that it would be if designed for hand-power. This larger factor of safety is used on account of the more severe service to which the electrically-driven block will be subjected. Worm gearing, bevel gears, and planetary gear combinations have been avoided in the design of the hoist, and spur gears cut from solid steel blanks are used throughout. This increases the life of the block, and

decreases the amount of repairs necessary. All gearing is properly covered, and the principal gears run in oil.

As compared with the ordinary drum hoist, a block of this design has the advantage of suspension by a single hook, and tipping or getting out of line will not force the sprocket chain out of the sprocket groove, as would be the case with a wire rope on a drum. The hoist can also be swung sideways without meeting with this difficulty.

Motors of any standard make can be used, and will be furnished for either direct or alternating current. The sizes range from 1 to 6 tons capacity, and the hoists are intended primarily for moderate service, especially over tools in boiler shops and machine shops, in warehouse service, and in some kinds of foundry service.

MILWAUKEE 16-INCH LATHE.

The lathe shown herewith, built by the Milwaukee Machine Tool Co., Milwaukee, Wis., is designed to meet the requirements of manufacturers in need of a high-grade tool of simple construction, combining durability, power, and high cutting capacity. It is at present built only in the 16-inch size, which can be furnished in any length of bed desired from 6 to 16 feet. The head- and tail-stock are strongly made, fitted to a V bearing at the rear and a flat bearing at the front. The head-stock has two large oil reservoirs located beneath the spindle, supplying oil to the bearings by a wick. The tail-stock is so designed as to leave ample clearance for the compound rest when the latter is used for angular cuts. The carriage is fitted to the V's at both front and rear. The apron has a clutch for engaging the longitudinal feed, and a sliding gear for the cross feed. The feeds are reversed in the apron, and a safety lock is provided for the split nut. Special care has been taken in the design to place all the handles so as to be most convenient to the operator.

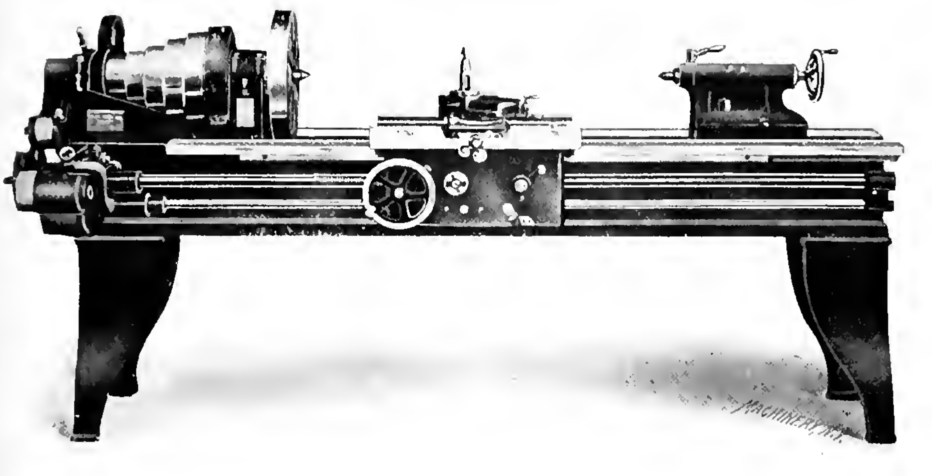


Fig. 1. The Milwaukee 16-inch Lathe.

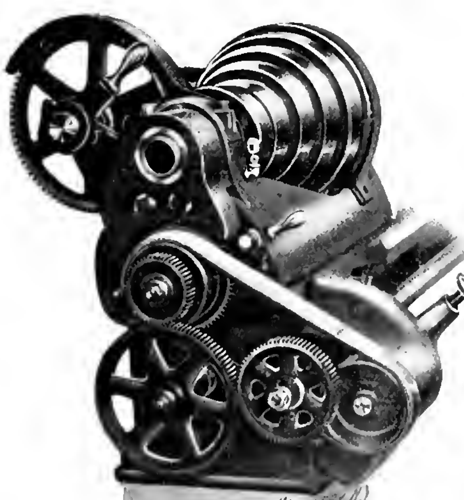


Fig. 2. End View of Head-stock.

A feed box giving four quick changes is provided, driven from the spindle by a wide belt furnished with a belt tightener conveniently located. The change gearing may be used to provide an additional feed when a coarse, positive roughing cut is required. For thread cutting, the different pitches are obtained by change gears in the usual way. The following dimensions will give some idea of the proportions of the design. The main spindle bearings are of phosphor bronze, the one at the head end being 3 3/16 inches in diameter by 5 inches long. The spindle has a 1 9/16-inch hole through it from end to end, and is made of high carbon crucible steel, cut from the solid, and accurately ground. The cone pulley takes a 2¼-inch belt, and is 11 inches in diameter on the largest step. All the important pinions and gears are of steel, cut from the solid. The net weight of the machine with an 8-foot bed is approximately 2,500 pounds, complete. The equipment regularly furnished includes a counter-shaft, compound rest, steady rest, follower rest, large and small face-plates, and all the necessary change gears and wrenches.

SCHELLENBACH 16-INCH GEARED HEAD LATHE.

The John B. Morris Foundry Co., 933 Harriet St., Cincinnati, Ohio, has placed on the market an engine lathe involving so many original and ingenious features that it is difficult to know where to begin in describing it. The main purpose of the design was to build a lathe adapted to the use of high speed steels to their full capacity, on work of all diameters from the smallest to the full swing of the lathe, and still preserve all the quickness and convenience of operation found in the usual engine lathe. In the actual working out of the design, however, not only has the convenience of the standard engine lathe been retained, but this new machine "goes it one better" even, being built on lines so original that little of standard lathe design is in evidence. Among the features of the tool, should be mentioned the Schellenbach taper attachment, the provision for using the rack in roughing threads, to save the lead-screw from wear, a support for the carriage, directly beneath the work, provision for sixteen changes of speed in the head-stock, and the use of a face-plate drive for both chuck and face-plate work of large diameters. It would be impossible to go thoroughly into the details of the machine within any reasonable space, but the description we give herewith, with the illustrations, will serve to give a general idea of the construction of the lathe and the advantages which it is intended to furnish.

The Head-stock and Spindle Gearing.

As has been stated, the head-stock gearing gives sixteen changes of speed from a single speed driving pulley, loosely mounted on the spindle. One of these drives is direct, the pulley being clutched to the spindle for the purpose. Seven of the speeds are obtained by gearing applied to the spindle, while the eight slower ones drive the face-plate through a pinion meshing with the internal teeth cut in its rim. An index combined with the mechanism for changing the head-stock gearing shows the operator the diameters for which the spindle speed he is using is suitable, for various cutting speeds ranging from 20 to 60 feet per minute. The operator need not know the number of revolutions per minute of the spindle, as he can thus deal directly with the diameter of the work in hand and the cutting speed in feet per minute desired. The various movements of the sliding gears in the head are so interlocked as to make it impossible to engage them wrongly, so that making changes can be done quickly without fear of a false move.

Provision is made for motor drive in the original design of the machine. Cored openings are made through the head-stock, so that a motor may be attached beneath the bed and

connected directly by a belt or chain with the driving pulley of the spindle, or with a sprocket similarly placed. Where it is desired to mount the motor above the head-stock and connect it by gearing with the spindle, the hinged cover provided for the change gear mechanism is cast with a motor base, making but a very slight alteration in the design of the machine. Owing to the great number and range of the speed changes in the head-stock, a constant speed motor may be used for driving, no electrical changes of speed being required. The maximum increment of speed in the mechanical changes is only 28 per cent in two successive steps.

The face gear is of steel, and is secured to a flange on the spindle on the outside of the front bearing. It extends out

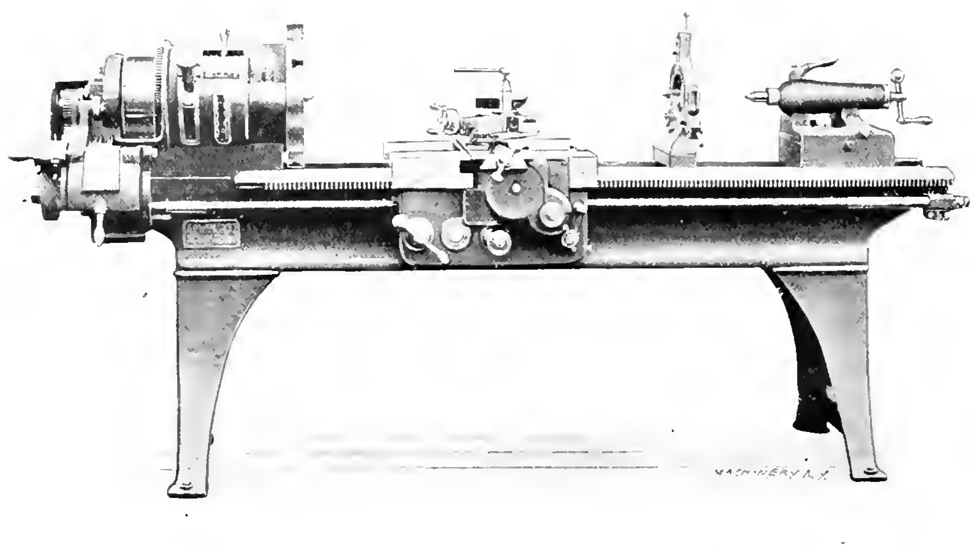


Fig. 1. Schellenbach Geared Head and Feed 16-inch Lathe.

through the head-stock and is threaded to receive the face-plates or chucks. Since the driving pinion is placed on the front side, it is properly located to resist the action of the cut without causing undue strain on the top cap of the front spindle bearing. The spindle itself is of forged crucible steel, bored throughout its length, and ground true. The head-stock casting is of box construction, with the sides extending above the center of the spindle, tying the front and back bearing together to resist end thrust. Excepting for the opening for the driving pulley, it is entirely enclosed, though the interior is rendered accessible by releasing a single screw and throwing back the hinged cover mentioned.

Feed Change Mechanism.

The form of quick change gear device used is one that is entirely novel, so far as we are aware. The handle seen projecting from the change gear casing is not used in shifting the gears, as might be imagined, but is simply employed for raising the lid of a receptacle in which loose change gears are placed. The one of these gears desired is slipped by hand on a stud, which is thrown into engagement with that one of three intermediate gears, which is at the time set to engage it. As there are eight change gears, this gives 24 feeds or pitches of thread. A second change is provided which doubles this number, making 48 changes in all, ranging from 2 to 112 turns per inch. The connections are such that the threading, turning, and facing movements are all at the same rate, so that one dial reading may be used for all three. It is the belief of the designers of this machine that this quick change device combines all the simplicity and directness of drive of the old style of change gearing with the ease of operation of the later forms of quick change mechanism. The steel gears used are slipped on by hand and do not require to be held by a nut, cotter pin or other device. Power is transmitted from the spindle to the screw in as direct a manner as in the regular form of engine lathe, and there is no complicated mechanism to be damaged by accident or wear out in use.

The Carriage, Tail-stock, and Bed.

The design of the bed may be best understood by reference to Figs. 2 and 3, in which the arrangement of the ways and the bearing of the carriage and tail-stock on them is plainly shown. The carriage is very deep and strongly ribbed to resist the torsional and direct stress produced by the cutting action. The legs are set well in to give better support, and are of wide span. The carriage runs on a V at the front side of the bed and a flat bearing at the rear, and is also supported on a central sliding surface to which it is held by gib *A* and strap *B*. It has often been customary to give the carriage an inner bearing on the flat ways which serve also for guiding the tail-stock, but this has the disadvantage that the wear produced by this carriage bearing disturbs the vertical alignment of the tail-stock spindle. This supplementary bearing at *A*, it will be seen, gives the carriage strength where it is most needed, providing, in combination with the regular bearings, a firm support to the tool, whether it is working on large or small diameters.

The tail-stock also slides on a V at the front side of the bed, and on a flat bearing at the rear. Not only is this arrangement of the ways the simplest for obtaining a good fit, but it is the most durable as well. The tail-stock is clamped from the front side by screw *C*, which bears against the point of clamping lever *D*, pivoted at *F* and provided with a short lever arm which engages the under side of the ledge in which strap *B*, in Fig. 2, takes its bearing. The bearing points in this arrangement are made of tool steel. It will be seen that a very slight pressure exerted against screw *C* will cause the clamp to bear very tightly under the shear of the lathe bed. The side adjustment of the tail-stock can be effected independently of the clamping of the base to the bed, an arrangement met with on many larger lathes to insure against slipping back when setting tapers for heavy work. All the adjusting screws of the tail-stock, and every other adjusting screw in the lathe, for that matter, can be operated with the tool-post wrench.

Apron and Cross Slide Mechanism.

As shown at *E* in Fig. 2, the rack is set with the teeth on the vertical face instead of on the under surface as usual.

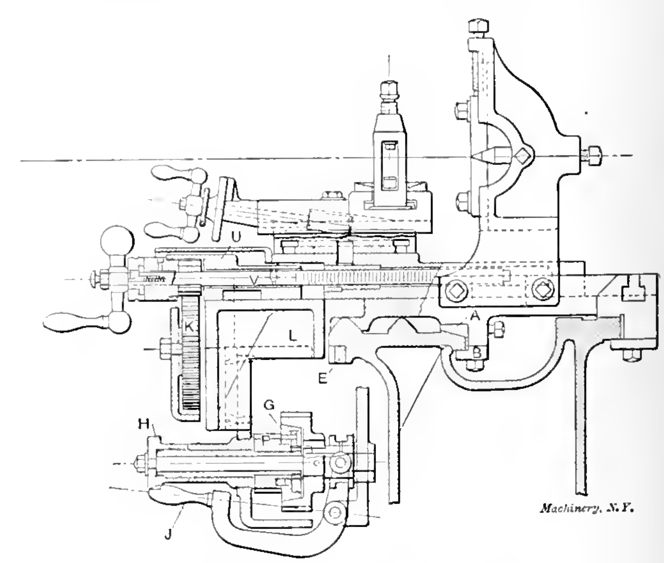


Fig. 2. Section of the Apron, Carriage, and Bed.

This permits setting the pinion shaft in a vertical position, so that it has a bearing in the apron on each side of the pinion, making a very strong and durable mounting. The rack and pinion feed is driven from the spline of the lead-screw through bevel and spur gearing, connected by the friction *G*, operated by knob *H* in the usual manner. The ratio of this connection is such as to give the same travel per revolution for the lead-

screw as is given the carriage when the split nut H in Fig. 3 is thrown into action. The rack is cut with such accuracy that it may be used with confidence by the operator for rough threading, to within a few thousandths of the finished size, using the lead-screw only for the fine finishing chips, thus greatly prolonging its useful life. In this use of the rack and pinion in threading, a positive connection is engaged in place of friction G, shown in Fig. 2. This positive connection is operated by lever J. The split nut does not require a locking device to prevent its engagement at the same time with the friction feed, since both give the same movement and both may be thrown in together without damage of any kind. The upper end of the pinion shaft projects through the top of the carriage and is provided with a dial graduated to read to 64ths of an inch.

The power cross feed is transmitted from the apron gearing to the cross feed screw through an intermediate gear K, shown in Fig. 2. The movement given this screw, as has been explained, is the same as that given the carriage by the lead-screw or the rack-and-pinion feed, so that the table of feeds and threads serves for facing and scroll cutting as well as for the longitudinal movements. The compound rest slide is tipped up slightly, as shown in Fig. 2. This brings the handle sufficiently high to avoid interference with the cross feed screw, at the same time allowing the rest to be made very low and rigid. The top slide is offset to clear the tail-stock when set at or near 90 degrees. Its feed screw, as well as that for the main cross slide, is provided with a graduated collar reading to thousandths of an inch.

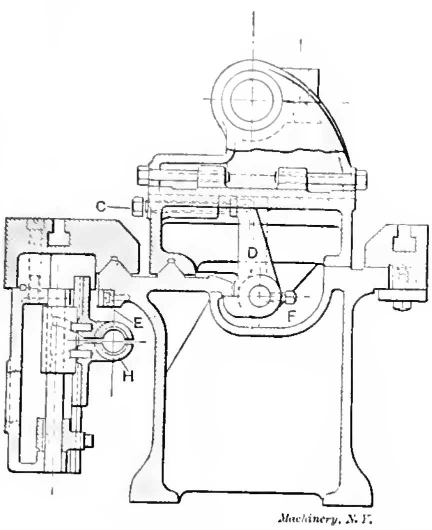


Fig. 3. The Tail-stock and the Method of Clamping it.

The apron is tongued, grooved and bolted to the carriage. All the handles and levers are placed in convenient position and about the same location as found in the conventional apron. Owing to the position of the legs at the end of the bed, and to the fact that the split nut is placed at the left side, it is possible to run the carriage to the extreme end of the bed, where the mechanism is exposed for examination without removing the apron.

The Taper Attachment.

The most radical departure in construction from the conventional lathe design relates to the form of taper attachment

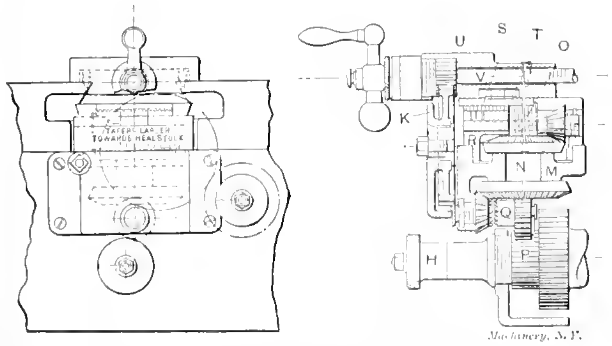


Fig. 4. An Ingenious Taper Attachment operated by the Apron Gearing.

used. A "dummy casting" L, Fig. 2, is removed and in its place may be inserted the casting holding the mechanism comprising the taper attachment, shown in M in Fig. 4. This casting carries the double vertical bevel gear N, meshing at the upper end with a bevel pinion, driving screw O. The lower gear of double gear N is driven from pinion P on the friction, through clutch Q, which may thus be operated to engage or disengage screw O from positive connection with the rack and pinion feed of the carriage. Screw O is carried on a pivot in swivel block R, which may be adjusted about the axis of N. R carries a guide on its upper surface in which slides the bronze half nut S, engaging screw O. To S is pivoted the block

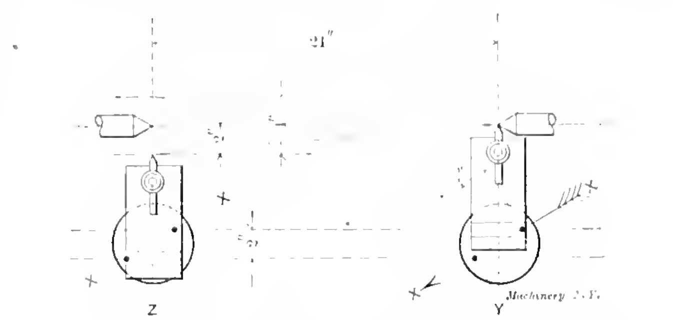


Fig. 5. Diagram illustrating the Principle of the Taper Attachment.

T, which is seated in a cross groove in the base of cross slide screw carrier U, which is in turn dove-tailed into the same ways in which the cross slide is dove-tailed.

With mechanism arranged in this way, it will be seen that when (by the operation of the power feed or the apron hand-wheel) the carriage is traversed by the rack and pinion movement, a corresponding movement through the train of gears just described is imparted to nut S and block T by the rotation of screw O. If the angular adjustment of R is set so that the axis of O is parallel with cross slide, screw O will transmit all of this longitudinal movement to holder U and cross slide screw V, which will thus be moved axially. If, on the other hand, R is adjusted through an angle of 90

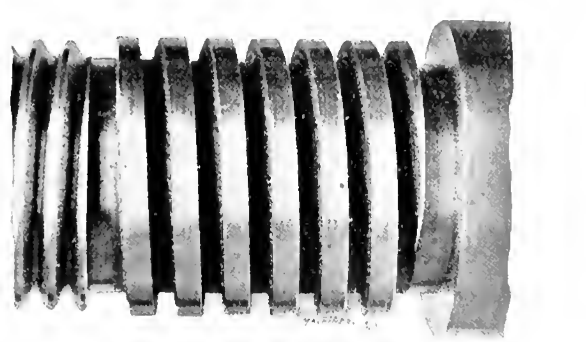


Fig. 6. A Square Thread roughed with the Rack Feed and partly finished with the Lead-screw.

degrees so that the axis of O is parallel with the center line of the lathe, the half nut S and block T will have a movement in the same direction, the latter sliding freely in the groove in U without imparting motion to it. In any intermediate position within these two a greater or less movement will be imparted to U for a given travel of the carriage, depending on the sine of the angle at which R is set. In a travel of 24 inches, with block R set as shown at the right of Fig. 4, the full travel of block U, 4 inches, is obtained. This gives a taper of 8 inches in 24 inches, or 4 inches to the foot, the maximum for which the attachment is adapted.

In Fig. 5 is a diagram showing the action of the device when set at an intermediate position between two extremes. As shown, in traveling from position Y to position Z, a distance of 24 inches, nut S and block T in Fig. 4 have a movement of 4 inches on axis X X. This, with the angular setting given, results in a cross movement of the cross feed screw of 2 inches, giving a taper of 4 inches in 24 inches, or 2 inches per foot. For tapers smaller toward the head-stock, block R is adjusted around the other side of the zero point, graduation being provided for the setting as shown at the left in Fig. 4.

Before the pin which engages clutch Q can be operated, the casing holding gear K has to be removed. This disconnects the power cross feed mechanism, which is, of course, never used at the same time as the taper attachment. When the taper attachment is in use slide U also has to be loosened, it

being located firmly in place in the top of the carriage for ordinary straight turning. The mounting of the taper turning device on the apron instead of at the back of the machine, is a great convenience.

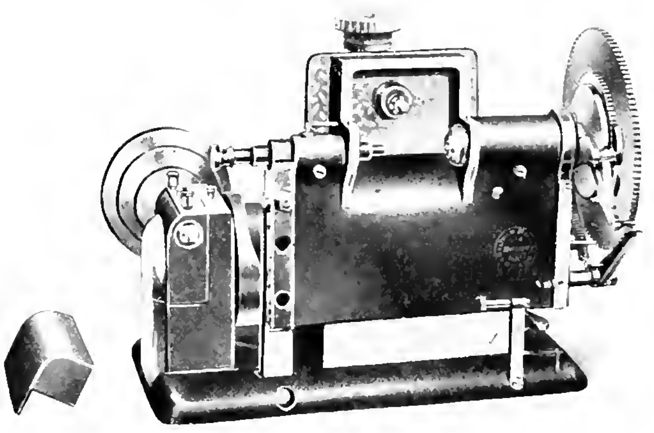
Accessories.

The follow rest provided straddles the tool slide, being clamped to the carriage on each side, furnishing a firm, steady support to the work. It has three jaws. The back rest is separate from the base by which it is attached to the ways, and may be reversed on that base so as to face either way. This provision overcomes the difficulty ordinarily met with in the usual construction where the V and a flat way are used for supporting it, in which case the steady rest is ordinarily irreversible. The counter-shaft provided is operated by two friction pulleys. Where it is not thought necessary to drive in both directions, two forward speeds may be used, thus giving 32 changes to the head-stock spindle instead of the 16 provided by the head-stock gearing with the single speed counter-shaft. This machine is manufactured at the present time in 14-, 16- and 18-inch sizes, and may also be supplied with the 3-step cone type of head as well as in the style here illustrated. It is also made with plain change gears in place of the quick change devices we have described.

A number of samples of work done on this machine have been sent us, all of them interesting, of which we have room for but one. This (see Fig. 6) illustrates the use of the machine in roughing threads with a rack feed and finishing them with a screw feed. As will be seen, a roughing cut has been taken in the square threads shown, followed by a finishing chip which has been carried to but half the depth, showing both cuts plainly. This is an operation that may be followed on threads of fine pitch, great care having been taken in the cutting of the rack to make it match the lead-screw accurately.

WALTHAM AUTOMATIC PRECISION GEAR-CUTTING MACHINE.

We show herewith an illustration of a precision gear-cutting machine recently designed by the Waltham Machine Works, Newton St., Waltham, Mass. Like other machines for



Precision Machine for Cutting Clock and Instrument Gears, etc.

precision work the movements are cam operated, from a shaft driven through worm gearing by the grooved cone pulley shown at the left. This worm gearing is enclosed and runs in oil, but can be removed without disturbing other parts of the machine. The movements effected by the cams on this shaft are the feeding of the work past the cutter: separating the cutter and the work for the return stroke, and indexing. The latter movement takes place while the work is being returned, thus making a considerable saving of time over those machines in which the cutter travels back in the tooth cut, and has to be held clear of the work longitudinally before the indexing can be effected. The index disk is proportionally of large diameter (10 inches), and is arranged to cut from 12 to 240 teeth.

A noticeable feature of the machine is the complete protection afforded to the index plate, cams, and other working parts, from the chips produced by the cutting operation. These are very troublesome, especially if the work is of brass or some similar material. As may be seen, the head- and footstock spindle project through two side plates in the work slide, which are so arranged that a cover with a scraped fit may be brought down over them, entirely enclosing the cutter and work, and forcing the chips to drop directly down in front of the machine instead of flying all over the mechanism.

If desired, the machine may be arranged for going twice around the work, taking two cuts through each space, automatically shifting to a slightly deeper cut the second time around.

The capacity of the machine is for gears up to 3 inches in diameter when the chip protection is used; for cutting iron and steel without the protection, blanks 4 inches in diameter may be handled. The machine may be furnished with a heavier spindle if required, in which case gears as coarse as 24-pitch may be cut. The construction of the machine is in line with that of the automatic watch machinery built by the same firm, being provided with hardened steel pinions and other working parts, and finished with the utmost accuracy.

ROCKFORD MACHINE & SHUTTLE CO.'S SENSITIVE DRILL.

The Rockford Machine & Shuttle Co. of Rockford, Ill., is building the sensitive drill press shown in the accompanying illustrations. The construction is simple and rigid, and a number of new features are provided in the accessories furnished with the tool.

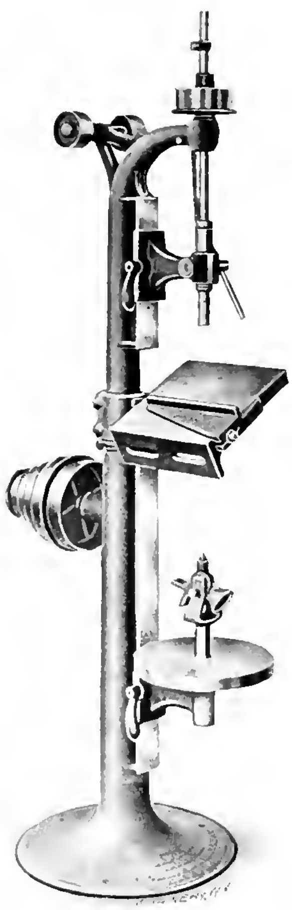


Fig. 1. Drill arranged to use Tilting Square Table.

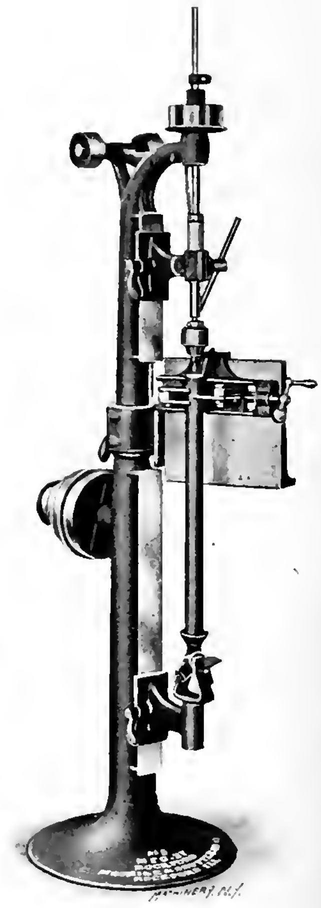


Fig. 2. The Centering Attachment in use.

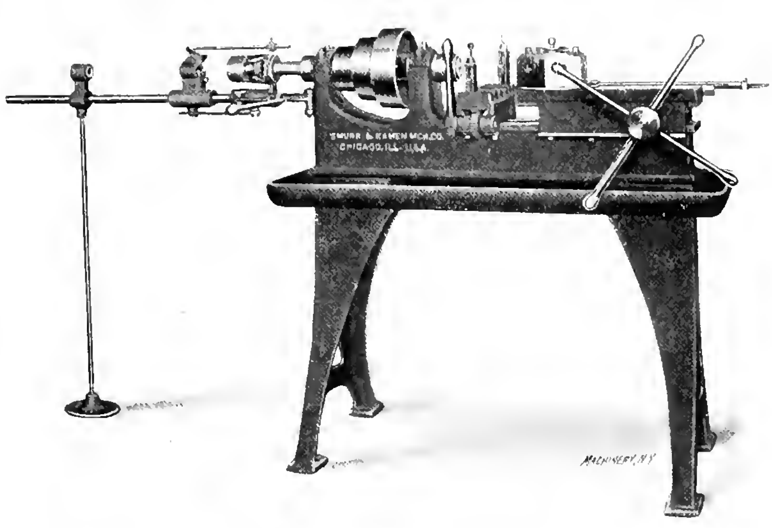
As will be seen in Fig. 1, the regular table provided can be tilted to any angle for work that requires holes to be drilled out of the perpendicular. A squared straight-edge is provided for lining up work. This may be conveniently used as a V-block for round parts. One edge of the table is widened to provide a clamping surface for work which is more conveniently held at the side than on the top of the table. On ways at the bottom of the column is fitted an arm carrying a circular table, as shown in Fig. 1, which may be used for holding work when the upper table is swung around out of the way.

This table revolves on a stem in the arm, and may be removed and replaced with the combination center vise shown in place in Fig. 2. This, it will be seen, contains three forms of centers: a cup center, a pointed center, and a V center. The cup center is shown in use.

In Fig. 2 the upper table has been tipped into a vertical position and has a centering vise clamped to its face. A piece of stock is being centered with a combination center drill. The vise is located in line with the spindle of the machine by a taper pin which fixes the swinging arm of the table in proper relation to the spindle. The lower end of the work is being held on the cup center as shown. This makes an arrangement fully as easy to operate as the usual horizontal centering machine, for stock which is not too long to be outside the range of the machine.

SMURR & KAMEN PLAIN HEAD SCREW MACHINE.

The Smurr & Kamen Machine Co., 97-101 S. Clinton St., Chicago, Ill., has been for some time building a plain screw machine which it has been trying out in actual use in the shops of customers, to determine its durability and efficiency. The results of the use of these machines have been so satisfactory that it has been determined to place them actively on the market, where it is believed that the simplicity and effectiveness of their design and the accuracy of their construction will give them a permanent standing.



The Smurr & Kamen Plain Head Screw Machine.

The feature of prime importance in getting good results from a screw machine is the accurate alignment of the center of the spindle with the center of the turret holes, and the maintenance of this alignment throughout the life of the tool. This prime feature is taken care of in the machine shown herewith by providing such sliding surfaces and gibs that the turret can be adjusted either vertically or sidewise to bring the holes back into alignment with the spindle as soon as they are thrown out of position by wear. The vertical movement is taken care of by a taper gib placed between the turret slide saddle and the bed of the machine. The adjustment of this gib alters the vertical position of the turret to allow for the wearing away of the bearing of the turret on its seat. This wear is much more rapid than that of the spindle in the box, thus necessitating occasional re-alignment. The turret slide is gibbed to the turret slide bed by taper gibs instead of by a more common and less expensive plain strip adjusted by set-screws. The bearing obtained with a taper gib is much more satisfactory, extending the full length of the slide instead of being concentrated around the points of the set-screws.

The turret is hexagonal in shape, so that heavy tools can be fastened to the face, giving better support than when the shank only is used for holding them. Instead of the usual hand lever for clamping the turret after the indexing, an ingenious arrangement is provided by means of which this clamping is effected automatically by the action of the pilot wheel which operates the slide. This is a most satisfactory arrangement, greatly enhancing the accuracy and the usefulness of the tool, since, with the usual construction, the workman is free to clamp the turret or not, as he pleases, and he often neglects to do so. As this arrangement does away with the necessity for the usual stud for clamping, it is possible to feed' stock clear through the turret, or to use drills with shanks of indefinite length. The standard automatic indexing mechanism is used for the turret. A large index ring and a lock bolt of the horizontal type are employed. The latter is supported on either side by steel taper gibs, by the adjustment of which it is possible to maintain the parallel alignment before referred to for lining up the center of the spindle.

The wire feed is of a new design developed by the builders. It is continuous in its action to the full length of the bar used, it being unnecessary for the operator to stop his work to push a sliding head or clamp collar back for a new grip on the stock. The counter-shaft provided has two friction clutches for reverse motion. Special attention has been given to the design of these clutches, which are provided with unusually large area of gripping surface. In the case, for instance, of the machine shown, the friction face is 9½ inches diameter and 1¼ inch wide.

It will be seen that nothing startling or revolutionary has been undertaken in the design or construction of these machines. The plan of the builders was to follow lines which, while original, were not so radical as to be of doubtful usefulness, but every effort was made to provide the user with a tool that would not require rebuilding at the close of every busy season. The best of material is used, all the duplicate parts being made with jigs and fixtures on the interchangeable plan, and full use being made of accurate surface plates, straight-edges and test indicators in measuring and testing the separate parts and the finished machine. These provisions, with the means furnished for preserving the vital alignment of the turret holes and the spindle, should make it a most accurate and durable machine.

This screw machine is made in five different sizes, ranging from 10 inches to 18 inches swing over the bed, and with a maximum automatic chuck capacity of from 2 to 2¾ inches.

EASTMAN KODAK CO., Rochester, N. Y. Copying camera for making copies of drawings, tracings, etc., on bromide paper without the use of a negative.

BOSTON TOOL CO., 207 Bridge St., Cambridge, Mass. A new threading tool which is said to greatly reduce the time required for threading, especially on such difficult material as cold rolled steel. The tool straddles one thread and cuts the adjacent faces of the two threads on either side. Since but one face of the thread is cut at a time, the chips are free to roll away from the work, and very heavy cuts may be taken. The device is made in the shape of a circular forming tool held in a suitable holder, or, as a plain straight face forming tool. A special cutter is required for each pitch.

WHITNEY MFG. CO., Hartford, Conn. Chain belt and adjustable pulley for high speed and light, noiseless service. The chain is composed of center blocks, rivets and special side links. A piece of formed leather is wrapped around each pair of side links and is held in place by a steel link on the top surface. The chain belt thus made runs over grooved pulleys, and nothing but the leather comes in contact with these pulleys, making the belt noiseless at the highest speeds. The chain center gives great flexibility even when running over the small pulleys, and prevents the belt from stretching. The flanges of one of the pair of pulleys are made adjustable to keep the proper tension on the belt.

AN AMERICAN MECHANIC IN EUROPE—3.

THE THIRD OF A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

TURIN, ITALY, May 14, 1908.

Trade Conditions in Austria.

The machine industry in Austria has, generally speaking, not suffered very much from the general depression. The machine export business of Austria is mostly confined to Hungary, Turkey, and to the smaller states on the Balkan Peninsula. The exports to the larger industrial countries in Western Europe are small, and, therefore, a depression in these countries is not felt to any large extent in Austria. Aside from this, many of the machine shops, especially those devoted to railway equipment, are engaged in filling orders for the Austrian State railways, and this does, of course, influence the machine building trade throughout the country.

Present Industrial Conditions in Italy.

A depression in the industries in Italy is plainly in evidence, and in addition to the general business depression experienced everywhere, the dullness in Italian business has also a local cause. A short time ago the automobile industry in this country passed through a severe crisis, and several firms failed. As this industry is one of the largest of the machine industries in Italy, the machine tool business suffered to a great extent because of the loss of one of its best customers, and many of the leading machine tool dealers report a drop in business of from 20 to 80 per cent, mostly in machine tools, and to a smaller extent in small tools. In spite of this, however, the present sentiment seems to be optimistic. The automobile trade, according to reports from various factories, is improving, and one concern, Fabbrica Automobili Itala, Turin, is now working full time with full force. It is also stated that the shops devoted to railway equipment have on hand large orders from the Italian Government. Since the railways passed into the hands of the government in 1905, many long-needed improvements in the rolling stock have been undertaken, or are under way, and this means more work for the machine shops. The railway equipment shops need more tools for executing their orders, but they are postponing the buying, expecting prices to go down.

The Machine Tool Market in Italy.

The Italian machine tool industry does not as yet amount to very much. There are only a few small factories for machine tools, but judging from the extensions being completed for these factories, Italy may soon produce a large part of the machine tools for its own use. At present, however, machine tools from nearly all countries—America, Germany, England, Sweden, etc.—are sold and used. As there is but little chance to talk about favoring a home industry in this case, both dealers and users are able to judge and compare the different makes of machine tools in a fairer manner and with less prejudice. The prevailing opinion is that American machine tools are, in general, better than the makes of any other country, but this does not mean that there are not some German makes considered superior to some American. It is considered here that the superiority of the American machines lies principally in the design, which is to the credit of the American draftsman, but also, although in a smaller degree, in the workmanship.

The claim that American machines are not strong enough, which is so often heard in Germany, both from dealers and users, is not mentioned here so much; in fact, only two persons out of a dozen whom the writer has interviewed on this subject, had anything to say to this effect, and one of these persons, a manufacturer, admitted that it was common practice here to use the machines for much heavier work than they were ever intended and built for. An interesting fact, needing no comments, is that in the automobile shops visited by the writer, he found that the large majority of machines used were of American make, and only a few of German and English manufacture.

It may not be out of place to mention that although the workmanship of American machines is good in general, there are sometimes found deplorable examples of carelessness of inspection in some of the machines of American manufacture. A few days ago the writer, when calling on a machinery dealer, saw a machine of American make which this dealer had sold and delivered, but which afterward had been returned, because of not being satisfactory, there being blowholes in the castings in places where such could not be tolerated, and several other defects. It must be added, however, that the dealer himself was very much surprised, and said that it was the first trouble of the kind that he had met with. The only reason for mentioning this is to suggest that too much attention cannot be paid to thorough inspection of machine tools before being sent abroad, in order to prevent occurrences of this kind, which, while everybody over here acquainted with American machine tools knows to be exceptional, still will prove harmful.

"Talking Points" in Selling Machine Tools.

The ease with which a machine can be sold depends, of course, in the first place upon the real merits of the machine, that is, on the amount and on the kind of work the machine is able to do; but so-called "talking points" have also proved themselves to be of great importance. Of two machines which are, in general, capable of doing the same amount of work, and are sold for the same price, the one possessing the largest number of talking points will prove to be the best seller. These points are, in the first place, of course, features of real merit in the machine, but in the second place, also features which are of no great importance as far as the working of the machine is concerned, but which nevertheless will attract the attention of the prospective buyer. One feature will draw the attention of one person, another, that of another person, the difference depending largely upon the technical standpoint of the man in question, and, therefore, one feature may be presented to good advantage at one time and in one country, while the same feature may be of less importance in another country and to other customers, depending on the conditions.

The general appearance of the machine, the smoothness of the unfinished cast surfaces, etc., is a point which some buyers pay attention to, while others do not. In Italy, the smoothly finished machine is preferred to the one of a coarser appearance. The writer had an opportunity to compare two lathes, capable of doing the same work, and which sold for about the same price, but one of these lathes was said to sell much better than the other. The special talking points for this better seller were simply that there was, in the first place, a less number of gears in the speed change mechanism running at the same time, and therefore there was less wear and less frictional loss; and in the second place that the pinion for engaging the rack for transmitting motion to the carriage could easily be disengaged, thus permitting the carriage to be pushed back and forth by hand, a feature which really is of small importance. In the stock-rooms of the same dealer a drill press could be seen which was said to sell well. The special feature about this was that instead of the spindle sleeve only being fed down, the whole spindle head with the bearing was fed down with the spindle, on account of which the spindle was less apt to get out of alignment on account of looseness and wear in the bearings. Another point which is found more frequently in German machines than in those of American make, is that nuts which often need to be loosened and tightened for the sake of adjustment are made with handles instead of being hexagon for adjustment by a wrench.

The Italian Automobile Industry.

Up to a few months ago the automobile industry, as already mentioned, occupied one of the leading places in the Italian machine industry. The Italian automobiles have succeeded in establishing for themselves a very high reputation, mostly because of having won prizes in a great many important international automobile contests. A great deal of the success of the Italian motor cars has been due to the importance with which the designing department in Italian motor car factories has always been regarded, and the older Italian automobile concerns have developed designs of very high standing. Nearly all the automobiles made here are of a high class and high priced, and the efforts of the designing department, as well as of the construction department, have been more

in the direction of obtaining the best possible motor car, than in the direction of turning out a car at a price within the reach of the average buyer. Although both the magneto high tension, and the low tension ignition systems are used in the motors, the first mentioned seems to be the one used to the largest extent. This system is more adapted to the high speeds used in automobile contests, while the low tension ignition system is better for ordinary speeds.

Italy as compared with America has an advantage because of its cheap labor. America has supplied Italy with its latest and most up-to-date machine tools, and Italy has been keen enough to learn and adopt a part of the American system of manufacturing, and is now, because of the cheap labor, able to put more efforts into getting the very best possible workmanship. An Italian firm can afford for the sake of good appearance, a thing which attracts the buyer with the long purse, to put exceedingly high finish on parts where it is really not needed; but this increases the reputation of the cars.

In automobiles where lightness is of great consequence, the quality of material used must be the very highest. The gears used in motor cars are, of course, one of the most important of the details, and some of the best concerns stated that they were using a special French steel for the gears, this steel having been developed especially for automobile gearing. The cylinder casting is a part on which much skill and thought has been expended by the designer as well as by the foundryman. The cylinders, because of being subjected to very high temperatures, simultaneously with high pressures, will develop severe internal stresses, which have to be taken care of both by the design and by the manner in which the cylinders are cast. A few of the Italian motor car makers, among them Isotta Fraschini, Milan, do not make their own cylinder castings, but buy them from France and Germany. Other concerns, as R. Züst, Milan, and Fabbrica Automobili Itala, Turin, make their own castings. Although the cast iron used in these cylinders is prepared with special care for the purpose, it seems that the largest importance is placed on the making of the molds.

Foundry Practice in Italian Automobile Factories.

At the outset, the Fabbrica Automobili Itala used wooden patterns for the molding of the cylinders, but in the long run, these became worn, and, therefore, produced castings of untrue dimensions, and besides, other troubles were found to present themselves when using wooden patterns. They, therefore, now use patterns of aluminum not only for the cylinders, but at present make all their patterns from this material. The best material to be used for the molds and cores themselves, has required careful study. For the sake of binding and hardening purposes the molding sand is mixed with potash, sugar, and salt, which mixture is carefully worked in a rotary mixer of the ordinary type, having crushing rolls and mixing blades. This material is used for molds of all kinds, as well as for cores.

Vent holes in the small cores are made in a manner similar to that mentioned in one of my former letters as being used in a German foundry. A thread coated with tallow is put in the core, and when the core is heated for drying purposes, the tallow melts, and the thread can easily be pulled out. A new system of molding is being adopted here and has, in fact, already reached a high degree of perfection. The idea is to divide up the mold into a few integral parts, which can be made entirely separate from each other in the same way as the cores are already made separately from the mold proper. These parts are then assembled to make up a complete mold. This simplifies greatly the art of molding, and also saves a large amount of time and labor, because each integral part, being made separately from the other parts, can be produced in a large number at a time, and stored away until needed for the purpose of assembling the complete mold, which can be done at any time, immediately before the metal is ready to be poured. The writer had an opportunity of seeing a mold for a cylinder piston, made according to this system, assembled and again taken apart. This mold was made in three parts, the first part constituting the bottom of the mold and the core, and the second part being the outer walls, which are made heavy in order to stand the strain produced by the hot metal when poured, and the third part was the top piece, having the necessary holes for pouring and for the vent. The three parts were made to fit nicely into each other, being easy to assemble and still permitting strong joints, a thing which is of great importance. This system is as yet used only for pieces of comparatively simple design, but it is expected that within a short time the same system will be used even for more complicated molds, as, for instance, for the cylinders. These are as yet made in the usual way.

Italian Shop Practice.

During the visits to several of the large automobile shops in Italy the writer had an opportunity to see some of their working methods. It was found that these were very similar in the different shops. A few remarks as to the practices in vogue will give an idea of the present standard of Italian shop practice. The first operation in finishing the cylinders was, of course, to finish the two end surfaces. This was done in a planer. Six to eight cylinder castings are clamped in a line on the planer table, and these are finished by taking one roughing and one finishing cut. When the two end surfaces are finished, the cylinder is set up in a vertical boring mill, where the cylinder proper is bored out to about 0.01 inch below the correct size. This operation is performed by using a special boring tool consisting of a main body, fastened in the toolholder, in which are inserted three single cutting tools arranged at angles 120 degrees apart. The cutting points of these tools are not at the same distance from the center, but arranged so that the first tool takes the first roughing cut in the cylinder, the second tool the second roughing cut, while the third tool takes the final finishing cut. The use of a three-pointed tool with 120-degree angle between the points produced a good balance of the cutting resistance, and the roughing cut, being divided up into two cuts, does not need to be very heavy.

From the boring mill the cylinder was taken to the grinding machine, where the bore was ground to the true size. The internal grinding machine used for this purpose was built so that the cylinder could be placed stationary on the machine, the center of the grinding spindle having a circular or planetary motion around the axis of the cylinder, so as to bring the wheel in contact with each point of the cylinder bore. The next operation is to finish the valve seats. This is done in a vertical boring mill by a double cutting tool, which is made according to the angle of the seats. The tool is marked so as to indicate the depth to which it should be fed down in order to get the seats accurate. Afterwards the sides of the flanges are milled in a horizontal milling machine, the necessary holes drilled, and the other small operations carried out in turn.

The turning of the crank-shafts always involves some difficulties. In the Fabbrica Automobili Itala the crank-shafts were turned in the following way. The first operation was to center the shafts for turning the journals. These were then turned, and the outer plain surfaces of the cranks and the outer ends of the cranks faced. In order to get the centers for turning the four crank-pins, a round fixture was put on at each end of the shaft, these fixtures having the centers drilled into them. With these fixtures on, the shaft was placed between the centers in a lathe, and one of the fixtures was clamped by means of an independent chuck. With the shaft thus fixed, one crank-pin after the other was turned, and the inner sides of the cranks faced. The remaining flat surfaces, which could not be finished in the lathe, were later finished by milling. The journals and the crank-pins were turned somewhat oversize, leaving enough for grinding the crank-shafts, which were held in the grinding machine in the same manner as described for the turning operation.

These indications of Italian shop practice show that work is done very much in the same way as in American shops.

Prospects of the Italian Automobile Manufacture.

It is interesting to note the opinions of a large number of leading machine tool dealers and other persons of technical standing in Italy, regarding the future of the Italian automobile industry. Most of these people do not seem to believe

that Italian automobiles are actually superior to American cars, but answered questions regarding this subject with a smile, saying that Italian automobiles had had "good luck" in contests, but expected that within a few years American motor cars would be imported to Italy.

Wages in Italy.

The wages paid to the average skilled workman in Italy—the machinists, molders, pattern-makers, etc.—vary from 4 to 6 lire ($0.80 to $1.20) per day, and men of more than average skill, such as tool-makers, are paid from 6 to 8 lire ($1.20 to $1.60) a day, all based on a ten-hour day. These figures are as stated by the automobile factories. These used to be the best paying shops in Italy, but on account of the crisis, the wages in the automobile shops were reduced a short time ago, so that the figures given can be considered to be reasonably accurate for all Italian machine shops. Compared with American wages, these are very low, but living expenses are also lower here, and another point to be considered is that the working man is here insured for sickness, and an old age pension is provided, the premiums for which are paid partly by the employer. The regular straight piece-work system seems to be favored in all the shops visited here.

World's Fair in Turin, 1911.

It is, as yet, entirely too early to say anything regarding the contemplated World's Fair in Turin in 1911. The leading men of the industries in Italy, who were interviewed on this subject, did not seem to be very optimistic about the enterprise, but rather the opposite. Their view was, that as far as Italy is concerned, not much could be gained by an exposition, but a great deal of money would be required for the arrangements, and Italy can hardly afford to spend the money for purposes of this kind at the present time. Aside from this, the exhibiting machine manufacturers have to go to a large expense, and are doubtful about whether they afterwards will be amply repaid for this in increased trade.

Trade Conditions in Switzerland.

The industrial conditions which have been noted as existing in the eastern part of Germany and in Italy can also be observed in Switzerland. The manufacturers of machine tools, as well as of other kinds of machinery, have apparently a fair amount of work on hand and are working with full or nearly full force, while the dealers in machine tools complain that business is very dull, and that no improvement in the conditions worth mentioning has taken place. The watch industry in the eastern part of Switzerland, which is of great importance, is at present very dull, largely owing to the fact that on account of the financial depression in the United States no export of watches takes place to this country. In fact, dealers in machinery in Switzerland seem to be more pessimistic about the future than are those in Germany and Italy.

After having visited Germany, Austria, and Italy, the differences in conditions in Switzerland are striking. It appears that the republican form of government has here had an influence on the general spirit even in the machine shops. The pay is somewhat, although not much higher here than in the neighboring southern Germany. Skilled machinists receive on an average 7 francs ($1.37) a day; but more than in the matter of pay does it here appear that the democratic form of government has influenced the ideals of the shop in regard to the relation between the foreman and the men under him. When talking to his foreman, the employe neither is required to, nor does he, assume that attitude of subordination created by the military spirit of discipline which is so commonly observed in Germany. More of the democratic equality is in evidence, and the same spirit is exhibited as is found in most American shops. The visitor realizes this as soon as he is inside the shop, and it becomes still more apparent to him as he is walking around, inspecting the machinery, and watching the men at their work.

* * *

According to a note in *Mercator*, a brick-yard is at the present time being established at Skutskär in Sweden for making "brick" from the refuse from sulphite mills. It is stated that the "brick" thus manufactured possesses all the qualities of ordinary brick.

MISCELLANEOUS FOREIGN NOTES.

German Imports and Exports of Machine Tools.—According to statistical tables published in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, issue of March 25, 1908, the exports of German machine tools in 1907 amounted to 58,051 metric tons, as compared with 22,743 metric tons five years ago. The increase over the previous year amounted to 12,743 tons. The imports in 1907 amounted to 8,175 tons, being a decrease of 5,974 tons, as compared with 1906. Of the imports, nearly 70 per cent came from the United States, and about 11 per cent from Great Britain. The decrease in the imports from the United States, as compared with the previous year, amounted to about 4 per cent. As regards exports, Italy is the largest customer of Germany in the machine tool line. Austria-Hungary, France, Switzerland, and Belgium come next, in the order mentioned. The exports to Italy alone amounted to 12,580 tons, or more than one-fifth of the total exports.

Growth of Russian Industries.—Russia, which until lately imported nearly all her supplies of machinery and other iron products, has of late become an exporting country, the industries of Russia having, during the last years, developed on a large scale. The iron industry has begun to play an important part in the country's exports. Rails and railroad cars, particularly freight cars, have been exported; rails to Servia, Roumania and Argentina, particularly, and railroad cars to Italy. Russia has immense possibilities for industrial extension, having unlimited resources in nearly all directions. Fresh naphtha and coal deposits are constantly being discovered, and mining and manufacture are steadily becoming better organized, and made rational. The primitive methods of the Russians so often referred to, excepting perhaps in agriculture, will soon be a thing of the past. Immigration from European Russia to Siberia is increasing tremendously, and the vast resources of northern Asia are likely to be greatly developed during the next decade.

The Neville Machine & Tool Co., Ltd., 7 James St., Liverpool, England, has brought out an interesting portable radial drilling machine. The base of the machine is mounted on four small wheels, and is also provided with four resting blocks, secured to screws passing through brackets in the base. When the machine is in use, the screws and resting blocks are so adjusted that the base rests on these, instead of on the wheels, and the weight of the machine provides enough stability for any ordinary drilling operation. When the machine is to be moved, the screws securing the resting blocks are turned, thereby lifting the blocks so that the base will rest on the wheels. The radial arm is so mounted that it can be turned through an angle of 360 degrees. The maximum length of the arm is 3 feet 7 inches, having a vertical adjustment over the base plate of 4 feet 11 inches. The base plate is 6 feet 6 inches by 2 feet, and the traverse adjustment of the tool-carrying head is 2 feet.

Trade Conditions in Belgium.—It is reported from Belgium that the iron, steel, and machinery industries are not as crowded with orders as they have been for some time past, and that prices, which have been for some time rather abnormally high, have a tendency to return to a more normal level. Foreign competition, particularly from Germany and Great Britain, is becoming more keen, since in these countries there has been a somewhat smaller demand placed on the industries by the home market during the last few months. It is also likely that before long American competition in Belgium will also influence local conditions, since American manufacturers are likely to have an opportunity for some time to come to devote themselves to foreign trade. The keen competition at home, however, has caused Belgian exporters to make efforts to form a syndicate for promoting their foreign trade. This syndicate is intended to have representatives and selling agents in all the important centers all over the world. Being only a selling syndicate, the proposed capital of $5,000,000 is rather a large one, and the combination may have some future ahead of it. The organization is well systematized, and intends to do banking business and take care of transportation for its members, as well. In general, it might be said that the outlook for the Belgian machinery industry is satisfactory.

MACHINERY AND SUPPLY CONVENTION.

The joint convention of the Southern Supply and Machinery Dealers' Association, the National Supply and Machinery Dealers' Association, and the American Supply and Machinery Manufacturers' Association, met in Richmond, Va., May 13, 14, and 15. Manufacturers and merchants from all parts of the country, engaged in the manufacture of machinery and supplies, and in its distribution, were represented. The three organizations went on record as opposing any reduction of prices at this time. Action was taken looking toward influencing the United States Government in requiring that all goods purchased by the Government should be marked with the name of the manufacturer. Resolutions were passed opposing legislative action in behalf of so-called "anti-trust" and "anti-injunction" measures, and requesting legislation sanctioning the combination of manufacturers and merchants, where such cooperation proves beneficial to the industries and trades, and is not harmful to the public.

A number of addresses were made, among which may be mentioned one by Mr. F. A. Hall, of the Yale & Towne Mfg. Co., New York, who spoke on the subject of "Resale Prices." In connection with this, it may be mentioned that the associations reaffirmed their endorsement of the minimum resale price system. The dealers' organizations pledged themselves to assist the manufacturers in the rigid enforcement of this system wherever adopted. Other addresses of interest were: "Salesmanship," by Mr. W. E. Gerow, of the Atlantic Supply Co., Jacksonville, Fla., and "Commercial Fraternity," by Mr. C. A. Moore, president Manning, Maxwell & Moore, New York City. Mr. D. K. Swartwout, of the Ohio Blower Co., Cleveland, Ohio, gave a "Plain Talk to Jobbers," and Mr. W. M. Pattison, of the W. M. Pattison Supply Co., Cleveland, Ohio, spoke on the "Advantages of Cooperation in Machinery and Supply Business." Finally, Mr. Robert Wuest, commissioner of the National Metal Trades Association, Cincinnati, Ohio, spoke on the "Benefits Derived from Trade Organization," and Secretary Wm. H. Taft, who was invited to address the joint convention, delivered an address on "The Value of Trade Organization." The committee in charge of the convention had arranged for several entertainments, including a smoker and vaudeville performance, at the Jefferson Auditorium, and a banquet.

Mr. J. C. Miller, of Huntington, W. Va., was elected president of the Southern Supply and Machinery Dealers' Association, and Mr. Alvin M. Smith, of Richmond, Va., secretary and treasurer. Mr. George Puchta, of Cincinnati, Ohio, was elected president of the National Supply and Machinery Dealers' Association, and Mr. A. T. Anderson, of Cleveland, Ohio, secretary and treasurer. Mr. Chas. F. Aaron, of New York City, was elected president of the American Supply and Machinery Manufacturers' Association.

* * *

OPENING OF THE MACHINERY CLUB OF NEW YORK.

The Machinery Club of New York, the movement for the organization of which was commenced over a year ago, opened its quarters on the 21st and 22d floors of the Fulton Terminal Building, corner of Fulton and Church streets, on May 21. The purpose of the club is to bring into closer contact the great number of men who are engaged in the machinery business in New York City, and those otherwise interested in the machine industry. The club is also intended to be the headquarters for out-of-town members, and while it will be primarily a lunching club, it is expected that the convenient location and the excellent and pleasant quarters will make it a general meeting place for the machinery trade in New York, and a home-like stopping place for those residing elsewhere, whose business takes them to New York at intervals.

The main feature of the opening was an address by Mr. George A. Post, president of the Standard Coupler Co., who, in some well-chosen remarks, explained the purpose of the club and the intentions of its organizers. A luncheon was also served. The number of people present at this occasion, and the general appreciation expressed of the efforts of those who have been most active in the organization of the club, seemed to indicate the complete success of the undertaking.

The movement for the organization of the Machinery Club was begun on April 1, 1907, when Mr. F. H. Stillman, president of the Watson-Stillman Co., called a meeting of the trade at the rooms of the Board of Trade and Transportation. At this meeting more than two hundred men engaged in the machinery and metal trades and allied industries were present, and a committee was appointed to form an organization. The efforts of the organizers have been well rewarded, 1,100 members having been enrolled before the opening of the new quarters, and there are now more than 500 resident members.

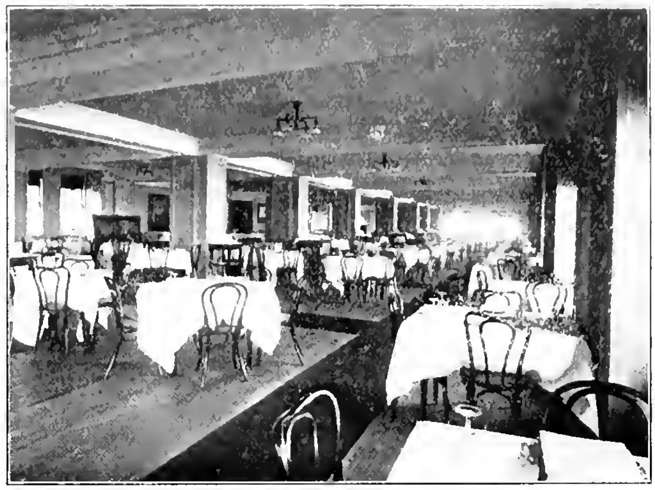


Fig. 1. Main Dining Room, 50 x 150 feet.

The club occupies the entire 21st and 22d floors of the Fulton Building. The main dining room is located on the 21st floor and its dimensions are 50 x 150 feet. Besides this, there is, on the same floor, a large furnished lobby, a grill room, 38 x 54 feet, and a reception room, 26 x 63 feet. A unique feature of the grill room, and one which undoubtedly will be appreciated by out-of-town members, is a large round table placed in a conspicuous place, which is called the club's "open table." The out-of-town members, and others who have but a limited acquaintance in New York, will there find members who will join in conversation with them, as it is an established rule that diners at this table may engage each other in conversation without the formality of an introduction.

Fig. 2. Reception and Reading Room.

On the 22d floor are located an unusually attractive smoking room, an equally attractive ladies' dining room, and several private dining rooms. The 22d floor is the top floor of the building, and a spacious roof-garden will be one of the prominent features of the club arrangements. Much credit is due to the house committee, to which has fallen the task of furnishing the club rooms, and supervising and arranging for the purchase of furniture, etc. The foremost idea of this committee seems to have been to furnish the place in a manner so that it would be comfortable, at the same time avoiding unnecessary luxury or mere useless ornamentation. The

club rooms have the general appearance of being in harmony with the business for which they will become a common gathering place.

A feature that makes the location unusually attractive, aside from its very central position in the machinery district, is the unequaled transportation facilities for reaching the uptown hotel district of New York and the outlying manufacturing districts of Newark, Jersey City, and Brooklyn. The Hudson & Manhattan R. R. connecting with the Subway and joining New York with New Jersey by a great tunnel system, will have its principal station in the sub-basement of the

Fig. 3. Smoking Room.

twin Fulton and Cortlandt Terminal structures. The Cortlandt Terminal Building is also the home of a large club, the rooms of the Railroad Club being on the 21st and 22d floors.

The officers of the Machinery Club are F. H. Stillman, president; R. C. McKinney, vice-president; Walter L. Pierce, treasurer; W. Seton Henry, acting secretary.

* * *

SPRING MEETING OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

The spring meeting of the National Machine Tool Builders' Association was held at the Hotel Chalfonte, Atlantic City, N. J., May 19-20, and was conducted by President Fred L. Eberhardt of Gould & Eberhardt, and Secretary P. E.

Group of Machine Tool Builders and Guests at Atlantic City, May 19, 1908.

Montanus of the Springfield Machine Tool Co. Forty-nine of the ninety-one concerns having membership in the association were registered. Five new members were enrolled, these being the T. C. Dill Machine Co., Philadelphia, Pa.; Edwin Harrington Son & Co., Inc., Philadelphia, Pa.; Ingersoll Milling Machine Co., Rockford, Ill.; International Machine Tool Co., Indianapolis, Ind.; and the Sibley Machine Tool Co., South Bend, Ind.

The more important matters discussed, of general interest, were uniform cost accounting, machine tool prices, cancelation of orders, uniform sale contracts, apprenticeship and readjustment of railway rates. The report of the committee on uniform cost accounting, presented by Mr. C. Wood Walter of the Cincinnati Milling Machine Co. in the absence of Mr. F. A. Geier, the chairman, was accompanied by a pamphlet prepared for the association by the Miller & Franklin Co., Boston, Mass., which explains the system in detail.

It was unanimously agreed that there was no good reason for changing the present prices of machine tools. The cost of materials has undergone little or no reduction, pig iron being almost the only exception, and wages are practically unchanged. With the resumption of business, machine tools will actually cost more than before the panic because of the inefficiency of new help that must be taken on and trained to replace the men laid off. The association placed itself on record in favor of arbitration among its members, it being recommended that the parties in dispute each choose a representative and these choose a third to act as a board of three to settle the matter. It was the sense of the association that differences in patent matters could be adjusted in this way very much more satisfactorily and cheaply than by recourse to the courts.

The cancelation of orders by buyers of machine tools is a particularly sore subject just now, and much warmth of feeling was displayed in this discussion. The injustice of the present custom which permits an intending purchaser to cancel any or all orders for machine tools at will was pointed out, and resolutions were adopted to discourage the practice. Other lines of manufacture do not countenance cancelation of orders, the purchaser being unable to break contracts without the consent of the manufacturer or without forfeiting a certain part of the purchase money deposited when the contract was made. In the report by Mr. C. A. Johnson of the Gisholt Machine Co., a uniform contract was recommended that should cover cancelation and provide that title to all machinery sold should not pass to the purchaser until the full purchase money had been paid. The defective business practice of jobbing foundries which supply machine tool castings was caustically referred to by Mr. C. H. Norton of the Norton Grinding Co. in a minority report, and American practice was compared with European practice, much to the advantage of the latter.

Mr. J. H. Cone, of the National Metal Trades Association, of Cincinnati, addressed the meeting just before adjournment on cooperative engineering education, and noted the remarkably good results that have come from the innovation in the Cincinnati University. Not only have the students who took the coöperative engineering course been able to keep abreast of their classes, although in school but half time, but their examinations were higher in average rating than those taking the full time course. More remarkable has been the effect on the system of teaching. The practical knowledge obtained by the boys alternately working one week in the Cincinnati shops and one week in the university shows the weaknesses of much mechanical engineering instruction. It is believed that this system of mechanical education will spread, as its practical benefits become known.

* * *

PERSONAL.

John E. Willard has been made manager of the Union Gas Engine Co., San Francisco, Cal.

Norman G. Meade, electrical expert and occasional contributor to MACHINERY, is now with the New York Edison Co. in charge of the editorial work on the *Edison Bulletin*.

G. O. Gridley, manager of the Windsor Machine Co., Windsor, Vermont, will sail for England the first week in June. Mr. Gridley expects to be gone about six weeks.

Herbert C. Petty has been elected a director of the Crocker-Wheeler Co. Mr. Petty entered the service of the company in 1903, and advanced rapidly to the position of contract manager.

Edward B. Busby, formerly with the Midvale Steel Co., is now employed in the selling department of the Electric Welding Products Co., Cleveland, Ohio, formerly the Cleveland Cap Screw Co.

J. E. Merrill, foreman pattern-maker of the Waterbury Mfg. Co., Waterbury, Conn., has left that concern to take charge of the pattern shop of the Bridgeport Foundry and Machine Co., Bridgeport, Conn.

Russell A. Stinson, vice-president of the Canadian Crocker-Wheeler Co., Ltd., Montreal, recently organized, has been identified with the manufacture, construction and sales end of the electrical trade in Canada for the past fifteen years.

T. W. Meachem, president of the New Process Raw Hide Co., has been elected president of the Chamber of Commerce of Syracuse, N. Y., which is a merited recognition of business ability from a community where Mr. Meachem is well known.

F. E. Lovell, president of the Canadian Crocker-Wheeler Co., Ltd., Montreal, is a member of the old-established lumbering firm of H. Lovell & Sons, Coaticocke, Quebec, which has extensive interests in mills and timber lands throughout the province of Quebec.

F. John Bell, secretary-treasurer of the Canadian Crocker-Wheeler Co., Ltd., has been identified with the electrical trade in Canada for the past fifteen years, and is well-known in Montreal, where the head office of the company has recently been opened.

Dr. Schuyler Skaats Wheeler, past president of the American Institute of Electrical Engineers, and president of the Society of Engineers, addressed the engineering society of Columbia University, May 4, on the subject of engineering honor. Dr. Wheeler mentioned the three great duties of the engineer in the order of their importance: First, the engineer's attitude to his client; second, to the public; and third, to his engineering society. He strongly condemned the publication of all fake scientific and engineering statements, and insisted that discoveries and inventions should be announced not in the daily papers, but through technical societies or through the technical press.

The many friends and admirers of Prof. William Kent, dean of the College of Applied Science, Syracuse, N. Y., and compiler of Kent's "Mechanical Engineer's Pocket Book," are much interested in the controversy raging between him and Chancellor James R. Day, of the university, over the former's action in regard to the alleged perilous condition of certain of the university buildings. Following the terrible school building fire in Collinwood, Ohio, March 4, in which 165 children died, Dean Kent called attention to the lack of fire escapes and fire protective construction in the College of Applied Science building, claiming that the conditions were extremely hazardous, but was ridiculed for his pains. He applied to the public authorities of Syracuse for an investigation, the result being that his claims were sustained. As a result of going over the chancellor's head, Dean Kent's resignation has been demanded. This he has refused to give because his actions were dictated by motives of public policy, being what any citizen had a right to do. No reflection has been cast on his ability as an educator or engineer, the demand for resignation being made because of disregarding the opinion of the chancellor on a matter of safeguarding human lives.

* * *

OBITUARY.

Arthur Koppel, head of the Arthur Koppel Co., New York, died suddenly of heart disease at Baden-Baden, Germany, May 13. Mr. Koppel was fifty-six years old. He leaves a wife, three sons, and a daughter.

We announce with deep regret the sudden death of our Paris representative, Mr. Eloi Delmouly, who was asphyxiated by the gas from a stove set up for heating purposes. Mr. Delmouly was well known as an engineer in his special field. He was a bachelor with no relatives in Paris, and will be buried at his native place, Agen, in the southern part of France.

Francis B. Stevens died at his home at Castle Point, Hoboken, N. J., May 23, at the age of nearly ninety-four years. Mr. Stevens was born at Trenton, N. J., October 16, 1814. He was educated in the New York University and became a civil engineer. He made a number of inventions, the best known of which is the Stevens cut-off, first applied to the steamboat *Albany* in 1840. His uncle, Edwin A. Stevens, was the founder of Stevens Institute.

William Dana Ewart.

WILLIAM DANA EWART.

The death at Rome, Italy, on Sunday, May 3, of William Dana Ewart, will be noted with more than ordinary regret by those whom his genial disposition had made his friends and by the many others to whom his most prominent invention has made his name familiar. Mr. Ewart was born in Ohio about fifty-six years ago, and at a comparatively early age gave evidence of an inventive mind and rare mechanical ability. He was the inventor of the malleable-iron detachable drive chain, first known under his name and in later years as link-belt, which has formed an important part of agricultural and other interchangeable machinery, and has, to possibly a greater extent than any other single invention, helped the wonderful progress in the development of elevating and conveying machinery during the past thirty years. This drive chain has been continuously manufactured by the Ewart Manufacturing Company and exploited by the Link-Belt Machinery and Link-Belt Engineering Companies till, in 1906, all three companies were consolidated into the Link-Belt Company, a corporation in which he was largely interested, and whose fortunes are still largely directed by his former associates. Mr. Ewart, whose abilities brought their proper reward, was not only an inventor, but a man of executive capacity, possessing a rare gift for harmonizing differences and securing cooperation. His health becoming impaired, he retired in his early prime from the activities of business and sought renewal of physical strength under more favorable climatic conditions abroad.

* * *

From time to time we have mentioned in these columns some experiments that have been carried on in Europe to perfect the process for the production of alcohol from peat, initiated nearly forty years ago. It is now stated that important progress has been made in the last two years by a Frenchman, Raynaud, and that the results obtained are so encouraging that a plant for manufacturing alcohol from peat on a commercial scale will be erected in northern Germany. According to statements made by Professor Ramsay, one ton of dry peat will furnish 42½ gallons of pure spirits, giving as a by-product about 66 per cent of sulphate of ammonia. Owing to the fact that the only obstacle to the more extended use of alcohol at the present time is its price, this process, if successful, will tend to solve an important power problem of the future, it being asserted that the manufacturing cost of one gallon of 97 per cent alcohol will be only about ten cents.

A WARNING TO MACHINERY DEALERS AND MANUFACTURERS.

Iron and steel companies, machine manufacturers, hardware dealers, etc., are cautioned against transacting business with a party who is at the present time floating worthless checks. His methods of operating are first to write to a certain concern for a catalogue, etc., from an address in almost any part of the country. Later he calls upon such firm with said catalogue and certain articles marked, asking to see these goods and places an order for same, giving a fictitious address. He then asks if a deposit is desired on the transaction and fills out a blank check in sums ranging from $200 to $1,500. Sometimes he gives a large check in part payment and asks for a certain amount, probably one-third or less, to be given him in cash for necessary expenses as he has no one in the vicinity who can identify him in order to have a check cashed.

He may use almost any name, but is known to have operated under names of: K. S. Miller, H. B. Miller, P. P. Hilliard. He is described as being an American, 28 years of age, 5 feet 7 inches tall, 160 pounds in weight, good build, dark hair, smooth shaven and has a large burn scar on the left side of his face. Any information relative to the operations of this party that will be referred to the American Bankers' Association or their agents, Pinkerton's National Detective Agency, New York, will receive prompt attention.

* * *

THE TWO-JAWED LATHE CHUCK PATENTED.

An article was published in the May issue by Mr. Ethan Viall describing a two-jawed lathe chuck used by the H. Mueller Mfg. Co., Decatur, Ill., with the statement that the chuck was patented in 1889 and, therefore, that the patent had expired. We are informed by the patentee, Mr. Edward Marcille, Peoria, Ill., that this statement is an error, the chuck having been patented January 3, 1899, instead of in 1889. Consequently our readers will know that this interesting and valuable chuck construction is not open to the public.

* * *

Beginning with the issue of June 5, the *Railroad Gazette* of New York and the *Railway Age* of Chicago, will be issued as a single combined weekly periodical, under the name of the *Railroad Age Gazette*, with the publication office in New York. Both papers have been long established, the *Railroad Gazette* for more than fifty-two years, and the *Railway Age* for thirty-two years. The changed conditions in railway business have made the advertising support inadequate for two expensively conducted journals in the field.

* * *

NEW BOOKS AND PAMPHLETS.

HANDBOOK OF MATHEMATICS FOR ENGINEERS. By L. A. Waterbury. 91 pages, 2¾ x 5½ inches. Published by John Wiley & Sons, New York. Price $1.00.

This little work is intended to be a vest-pocket handbook of mathematics for engineers. It treats of algebra, trigonometry, analytical geometry, differential calculus, integral calculus, theoretical mechanics, mechanics of materials. A thumb index is provided for convenient reference and a special index makes the work very convenient for reference.

STRENGTH OF CHAIN LINKS. By G. A. Goodenough and L. E. Moore. 73 pages, 6 x 9 inches, illustrated. Published by the University of Illinois, Urbana, Ill.

This bulletin, No. 18, records results of a series of tests to determine the strength of chain links, and to verify the laws and formulas for the strength of chains. The appendix gives at length the theory of stresses in curved bars, analysis of the open link, derivation of theoretical formulas for the change of length in the axis of the link, and analysis of stud link. The pamphlet is one of much practical value to designers and engineers having use for chains in machinery or for handling materials.

AUTOGENOUS WELDING OF METALS. By L. L. Bernier. 45 pages, 4½ x 6½ inches. Published by the *Boilermaker*, 17 Battery Place, New York City. Price $1.00.

This pamphlet is a description of the application of autogenous welding to the manufacture of tanks and other receptacles made of plate metal. The autogenous process is essentially a welding process, the heat of the oxy-acetylene flame being so great that the metal at the joint is fused and joined together into a perfect weld. The flame may be made oxidizing or non-oxidizing to suit the requirements of the case. In welding it is of course made non-oxidizing and when used for cutting metals apart it is preferably oxidizing. The importance of the process for tank making is obvious.

THERMODYNAMICS OF TECHNICAL GAS REACTIONS. By F. Haber. 356 pages, 6 x 9 inches. Published by Longmans, Green & Co., New York. Price $3.00, net.

This book is made up of seven lectures on chemical reaction and its relation to reaction energy; entropy and its consequence in gas reactions; derivation of formula, and its effect on reactions of solids; examples of reactions which proceed without change in the number of molecules; examples of reactions involving a change in the number of molecules; the determination of the specific heats of gases; and the determination of gas equilibria, with the theoretical and technical discussion of related questions. The work is technical and of interest to those only concerned with the chemical and technical problems of thermodynamics.

TABLES AND OTHER DATA FOR ENGINEERS AND BUSINESS MEN. Compiled by Chas. E. Ferris, Professor of Mechanical Engineering, University of Tennessee. 160 pages, 2½ x 5½ inches. Published by the University Press, Knoxville, Tenn. Price 50 cents.

This little vest-pocket manual for engineers was issued primarily to advertise the University of Tennessee. The large demand for it shows that it meets a common want, the present issue being of the tenth edition. It contains metric conversion table, tables of areas and circumferences of circles, tables of squares, cubes and reciprocals, weights of rivets and round head bolts; weights and areas of square and round bars; weights of sheet or wrought iron, steel, copper and brass; tables of sines, tangents and secants, hyperbolic logarithms, and many other tables of common use among engineers.

THE STEAM TURBINE. By Robert M. Neilson. 604 pages, 6 x 9 inches, 387 illustrations. Published by Longmans, Green & Co., New York. Price $4.20, net.

The first edition of Mr. Neilson's work was issued in 1902. This book is of the second edition, in which the descriptions of Parsons and De Laval steam turbines have been considerably enlarged, as well as the chapter on marine propulsion. A new chapter has been added, in which the Parsons, Stumpf, Schulz, Curtis and Seger turbines are described. The book treats of the fundamental notes and definitions of the steam turbine, the conversion of heat energy and steam into kinetic energy, types of steam turbines, losses and efficiency, steam turbines of five classes, low pressure steam turbines, effects of steam pressure, superheat and vacuum on efficiency, etc. An appendix contains a list of British patents on steam turbines from the earliest records up to the end of 1905. The work will be found a very satisfactory treatise on the subject and can be recommended to those interested in mechanical construction and theoretical treatment.

BETTERMENT BRIEFS. By H. W. Jacobs. 240 pages, 6 x 9 inches, 132 illustrations. Published by the author, Topeka, Kansas.

The work is a collection of some contributions on railroad betterment that have been published from time to time, and are now brought together and bound in book form. The author is assistant superintendent of motive power of the Atchison, Topeka & Santa Fe Railway System, Topeka, Kansas, and has had an unusual opportunity of studying the organization and efficiency of the railway machine shop. It illustrates many time-saving devices that are in daily use and gives particular attention to the use of high-speed steel on the lathe, planer, milling machine and other machine tools. An example of motion pictures is given on page 158, which were taken for the instruction and the entertainment of the men. These pictures show examples of machine work, firing locomotives, etc., and help to enlist their interest and co-operation in the promotion of more efficient methods. The work as a whole is one that can be most highly recommended to railway shop master mechanics, superintendents of motive power and all concerned in the increase of the efficiency of railway repair shops.

MACHINE DESIGN, CONSTRUCTION AND DRAWING. By Henry J. Spooner. 691 pages, 6 x 9 inches. About 1,500 figure numbers and 4 folding plates. Published by Longmans, Green & Co., New York. Price $3.50.

Sixty-five pages of the work are devoted to the subject of drawing, being on drawing instruments, materials, scales, and drawing to scale; how to draw straight lines and simple figures; circular arcs and lines, and how to commence a working drawing. Then follow chapters on machine details, including leather collars, shafting, crankshafts, cranks, journals, couplings, clutches, key and keyway, riveted joints, bolts, nuts, screws, pipe and pipe connection, cotters and cottered joints, bearings, journals, hangers, roller and ball bearings, toothed gearing, friction gearing, wire rope gearing, chains, crane hooks, steel and iron cranks, pistons and piston rods cross-heads, guides, connecting-rods, engine eccentrics, machine handles, materials used in construction of machines, strength of beams, hints on designing machines and machine parts, springs, miscellaneous. The work is voluminous, and certainly covers a large amount of engineering matter. It should be of general value to students, draftsmen, engineers and others concerned in machine construction and detail.

BRENNAN'S HAND BOOK. A compendium of useful legal information for business men. By B. A. Brennan, contract manager of the Westinghouse Machine Co. 571 pages, 4 x 6½ inches. Published by *The Electric Journal*, 422 Sixth Ave., Pittsburg, Pa. Price $6.00.

This book was compiled to meet the wants of the author, who is the contract manager of the Westinghouse Machine Co., and contains a synopsis of the statutes bearing on the collection laws of the different states and useful legal forms. The work by sections is: I. Contracts in general; II. Sale Contracts; III. Property, Deeds, Mortgages, Liens, Interest; IV. Acknowledgments, Power of Attorney, Licenses, Guarantees, etc.; V. Notes, Checks, Interest; VI. Negotiable Instruments; VII. Synopsis of Statutes on Conditional Sales, Chattel Mortgages, Bills, Notes, Forms of Acknowledgments; VIII. Collection Laws Tabulated; IX. Legal Forms. It is obvious that this publication of legal lore, presented in everyday language, is of the greatest value to manufacturers, shop managers, merchants, dealers, and others doing business in various states. The book is well printed and bound in flexible leather, with gilt-edged pages, being suitable for the library, desk or traveling purposes.

POWER AND POWER TRANSMISSION. By E. W. Kerr. 366 pages, 6 x 9 inches. 263 illustrations. Published by John Wiley & Sons, New York. Price $2.00.

This book is made up largely of the subject matter of lectures delivered by the author, who is professor of mechanical engineering, Louisiana State University. The present issue is of the second edition, in which the chapters on steam turbines and valve diagrams have been rearranged and added to. A valuable feature is practical problems; 175 problems and 10 pages more of matter have been added. The work defines the terms used in machinery and mechanics, and treats of shafting, bearings, frictional lubrication of bearings, friction wheels, pulleys, bevel gearing, screws, cams, the lathe, pipe fittings, heat, steam, simple steam engines, automatic cut-off engines, indicators, compound engines, valves, valve gearing, valve diagrams, rotary engines, steam turbines, pumping machinery, gas engines, compressed air and hot air engines. The book has one fault common to many otherwise excellent American technical books, and that is the liberal use of manufacturers' electrotypes of a style and size totally unsuitable to the general character of the work. The book is well suited to the needs of students in mechanical and engineering courses.

ELEVATOR SERVICE. By Reginald Pelham Bolton. 69 pages, 7½ x 10¾ inches. Published by the author, 527 Fifth Ave., New York. Price $5.00.

This work treats of the conditions and proportions of elevators, and gives diagrams, formulas and tables for passenger travel, relation of the elevators to the building, and proportions and loads of cars. Its contents by chapters are: I. Problem of Vertical Transportation; II. Conditions; III. Passengers and Operators; IV. Rating the Work of the Elevator; V. Computing the Average Work; VI. Shape and Size of the Car; VII. Load and Speed Conditions; VIII. Building Its Prearranged Surface; IX. Examples of the Use of Large Chart Giving the Relation of Elevators to Area of Floors; X. Definitions of Some Terms Used in Connection with the Elevators. The problem of vertical transportation has become one of the most serious that the constructing engineer has to deal with in the modern office

MACHINERY.

July, 1908.

CAM APPLICATIONS.*

MECHANISMS EMPLOYED IN CONNECTION WITH CAMS.

GEORGE W. ARMSTRONG.†

George W. Armstrong.‡

Cams and their attendant levers, considered merely as simple machine elements, are without doubt the most versatile of mechanisms; and, when subjected to the designer's consideration, may be developed along such diverse lines, and made to exhibit such limitless possibilities, as are shared in no comparable degree by any other elementary mechanical principles at his command. Even with all their inherent adaptabilities, however, their field may be greatly extended by conjunctive appliances devised to control or modify their motions and applications in various ways. It is the purpose of this article to illustrate several such devices designed by the writer. Some of these performed their functions very satisfactorily, and appear as features in patented machines, while others never reached the stage of practical application, although this need not detract from their interest as theoretical mechanical movements.

Cam Combination Movement No. 1.

Figs. 1, 2, and 3 represent the solution of three inter-dependent problems. The requirements of the one illustrated by Fig. 1 were that two bell crank levers, working oppositely,

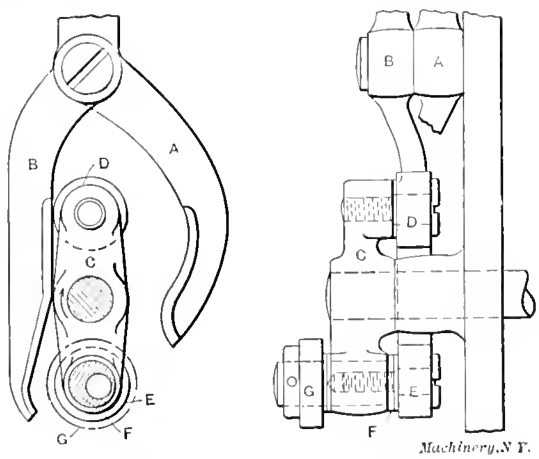


Fig. 1. Cam Combination Movement No. 1.

should transmit to other machine elements a variable motion, differing in each lever (the kind of motion, length, or time not being pertinent to this discussion). Every other vibration of each lever must be through a certain angle a; the alternate vibrations of each lever must have the angle a varied through a cycle of twelve vibrations from a maximum to a minimum, and vice versa, in harmonic ratio, a being the mean.

Levers *A* and *B*, with properly shaped cam arms, are operated by the rolls on arm *C*, which alternately engage the lever cam surfaces. The roll *D* gives the angle a. Roll *E* is eccentrically fastened to the bushing *F*, which is rotated in its seat by the star wheel *G* one-twelfth of a revolution per revolution of arm *C*, thereby carrying the roll to and from the center to vary the angle of vibration according to the imposed conditions.

Cam Combination Movement No. 2.

Another mechanism, acting with the above, presents to a certain extent somewhat similar conditions. An irregular vertical line *G*, Fig. 2, is desired reproduced by the upper end of a lever as follows: For one vibration the line must be re-

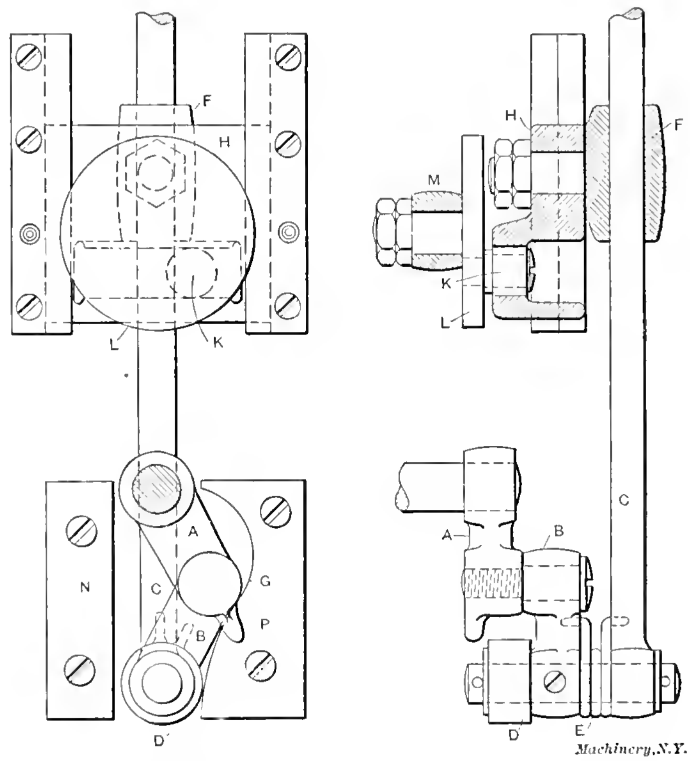


Fig. 2. Cam Combination Movement No. 2.

produced exactly; this is the mean vibration of a cycle of twelve, in each of which the line is reproduced to an increased or diminished scale, to the maximum or minimum, or vice versa. The amplitude of variation of the reproduced line per vibration must be by harmonic ratio. Further, the lever must return in a straight line.

Crank *A* and connection *B* reciprocate the lever *C* and the roll *D* which is kept in contact with *G* by spring *E*. The lever *C* is fulcrumed and slides in the oscillating bearing *F*, which is supported by the slotted cross-head *H*. This is operated by roll *K*, fastened off center on a twelve-tooth ratchet *L*, supported by a bridge-bearing *M*, over the cross-head ways.

In action, the crank throws the connection *B* out of line with the lever *C*, which results in the spring *E*, by reason of the introduced tension, forcing roll *D* to follow the outline of *G* till the highest point is reached, whereupon the connection becomes out of line on the opposite side, and constrains the spring to hold the roll against the straight return guide *N*. During every revolution, the pawl *P* turns the wheel *L* one tooth, raising and lowering *H* and *F*, thereby assuring the proper magnification and diminution of *G*.

Cam Combination Movement No. 3.

Fig. 3 represents the third problem. A horizontal lever must be given a transverse movement along a bar, upon

* For additional information on this subject see "Laying Out Cams for Rapid Motions," February, 1908, and other articles there referred to.

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‡ George W. Armstrong was born in 1876 in Norwich, Conn., and was educated at the Norwich Free Academy. He took a post-graduate course in science, and was assistant instructor in manual training. He studied the International Correspondence School Course in mechanical engineering, and has had experience as machinist, pattern-maker, tool-maker and draftsman in various shops. His specialty is designing special machinery.

which it is fulcrumed, during the 90-degree dwell of its operating cam; the speed of the movement must decrease by harmonic ratio as it approaches the middle of its travel from each end, and increase as it recedes; while the lever must be vibrated through smaller angles as it approaches the middle, and greater angles as it recedes.

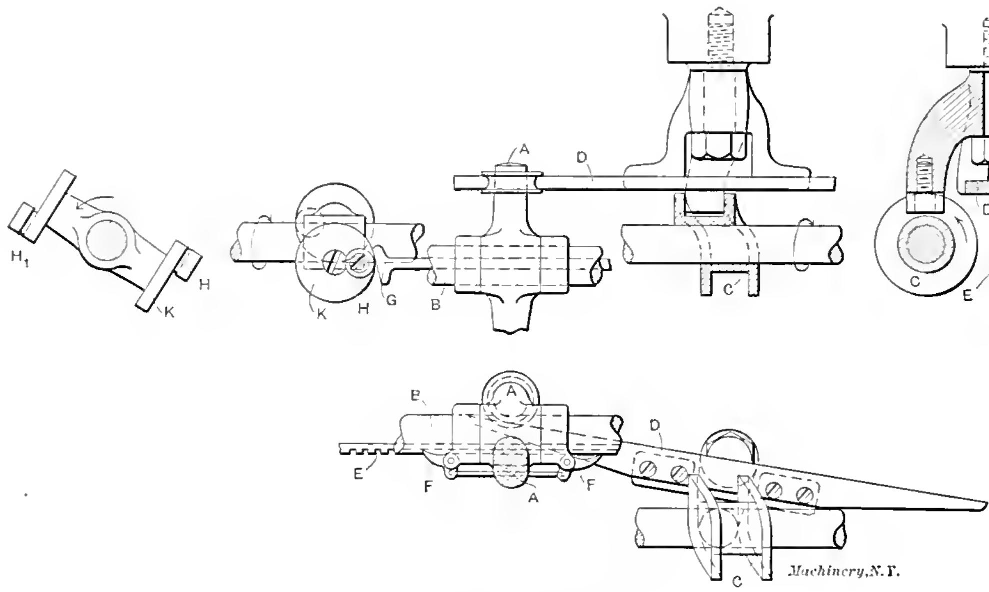


Fig. 3. Cam Combination Movement No. 3.

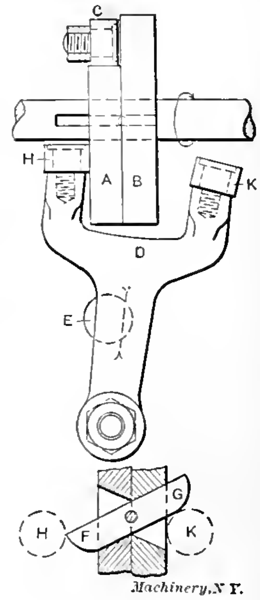


Fig. 4. Cam Combination Movement No. 4.

Lever A, pivoted upon B, is vibrated by means of cam C and rocking bar D. Bar B is splined to accommodate a ratchet E, with which one of the pawls F engages. At each end of the travel, the pawls strike, change positions, and automatically reverse the feed. The ends G of the ratchet are reciprocated by roll H, which is mounted eccentrically upon a twelve-tooth star wheel K. At each revolution, as the star wheel comes opposite the ratchet, a stationary pin turns it one tooth, throwing the roll out from center and moving lever A along. When the lever is farthest to the left, the roll H is in line with the ratchet and star center, and between them. This position gives the maximum movement to the ratchet. The roll is thereafter thrown further out of line, decreasing the feed until the lever reaches the middle distance, after which the roll H_1, on the opposite end, comes into action to complete the movement in an increasing ratio. Another set of star wheels and rolls on the other end of the shaft, gives positive motion and return to the ratchet in both directions.

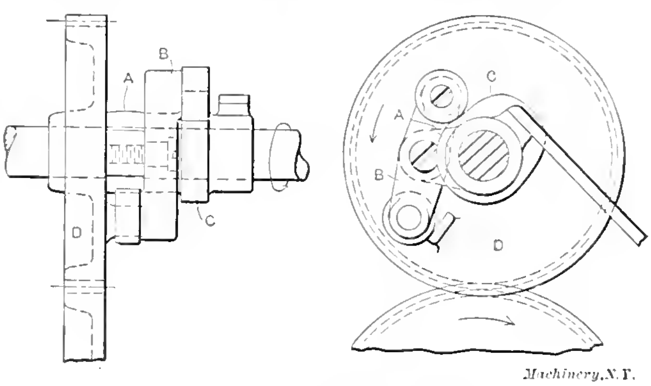


Fig. 5. Cam Combination Movement No. 5.

Cam Combination Movement No. 4.

Fig. 4 shows an arrangement where two revolutions of a cam are necessary to give the required movement to the lever. The rise and the dwell require one revolution each. Two cams A and B, fastened together, can slide upon the shaft a distance equal to the face of one, by reason of a spline and a key. The motion is taken off by roll C, which is shown in the engraving resting on spiral cam A. Cam B is an entire circular disk. The shifting lever D is operated on the "load-and-fire" principle, E being a spring plunger. In the cams, and pivoted between them, above the key, is a double-ended cam F and G, omitted for clearness from the large figure. This swings until it rests against the sides of the opening.

In operation, the cam A lifts the roll to its highest point, when lever D slides the cam along, leaving the roll C upon cam B for the dwell of one revolution, when the cam is immediately shifted in the opposite direction for an instantaneous drop. With the lever and cams as shown, F engages roll H and forces it to the left until E acts to throw the lever and the cam the full distance over. If F and G were stationary, they would interfere with the rolls H and K, and be inoperative, but being pivoted, the end out of engagement is swung forward to clear its roll before the other end throws the roll on this side over.

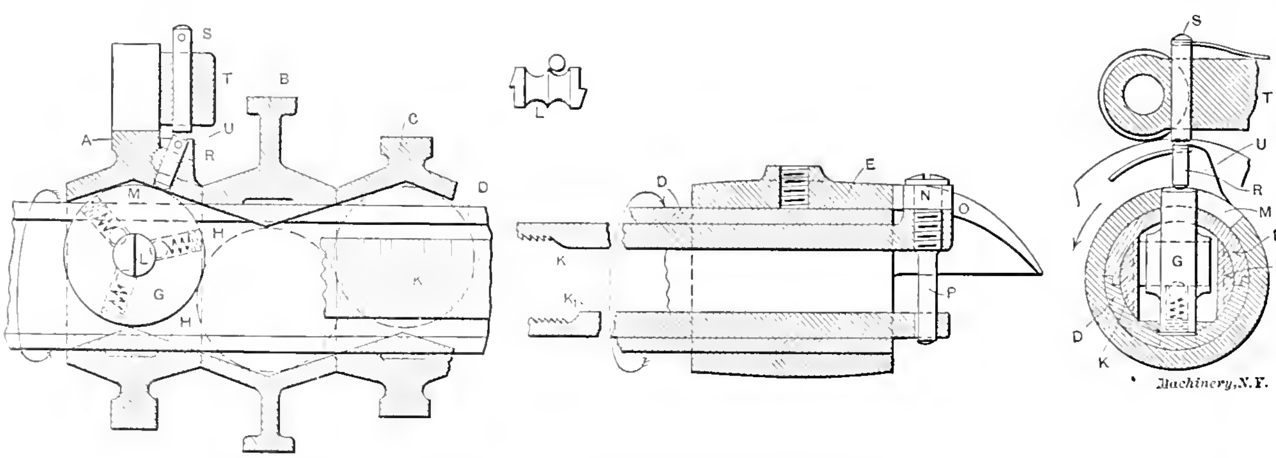


Fig. 6. Cam Combination Movement No. 6.

Cam Combination Movement No. 5.

Fig. 5 shows a method whereby a shaft, making the same number of revolutions as its driver, is rotated at variable

speeds. The driving shaft carries the casting *A* to which is fulcrumed the lever *B*, which in turn has a roll on each end. One roll engages a cam *C*, supported upon the shaft, but not revolving with it. The other roll bears upon a lug on the side of gear *D*, which is also free upon the shaft, but is constrained to revolve with it either faster or slower, according to the relative positions of lever *B* and cam *C*.

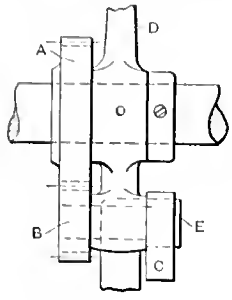


Fig. 7. Cam Combination Movement No. 7.

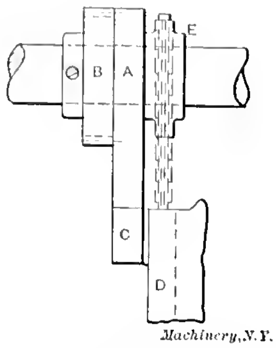


Fig. 8. Cam Combination Movement No. 8.

Cam Combination Movement No. 6.

A problem entailing a group of five dissimilar cams upon one shaft presented these requirements: The cams must operate their respective levers successively back and forth from end to end of the group; that is, while any one operates its lever, all the others must remain stationary with their lever-rolls on a 90-degree low dwell. It requires eight revolutions of the shaft to complete one cycle.

The design adopted to carry out these provisions is shown in Fig. 6, in which the hollow shaft *D*, carried in bearings *E*, supports the cams *A*, *B*, *C*, etc. A roll key *G* is caused to move inside of the shaft from end to end. The roll is constrained to follow the inclines *H*, and is drawn along its sinuous course by ratchets *K* and K_1, and a pawl *L*, it being obvious that *G* will key each cam in succession to the shaft as it enters its respective keyway *M*. Within *G* a double-ended pawl *L* is held in engagement with either ratchet *K* or K_1 by balls and springs. The ratchets are cut oppositely and are reciprocated by roll *N* and cam *O*. Roll screw *P* constrains both ratchets to reciprocate together, and a similar equipment on the opposite end makes the motion positive. When the roll has keyed the last cam, the return of the ratchet causes the pawl to rise onto a higher surface, thereby throwing it into mesh with the other ratchet, and effecting the reversal. It will be noticed that, in the engraving, the part of the longitudinal section to the right is turned around 90 degrees in relation to the portion at the left. This was done to show more clearly the construction.

To hold the cams positively while they wait their turn, knock-out pin *R* is resorted to in connection with the catch-pin *S* in lever *T*. Just as roll *G* starts to drive the cam, it pushes out *R* and raises *S* above the lug *U*, freeing the cam from the lever.

Cam Combination Movement No. 7.

A lever is to be vibrated twice per revolution of a shaft, which shaft is to be the fulcrum of the lever. A gear *A*, Fig. 7, upon the shaft drives the pinion *B* and cam *C* which have a bearing in the end of lever *D*. The cam runs over a stationary roll *E*, and vibrates the lever about the shaft as a center.

Cam Combination Movement No. 8.

Fig. 8 shows how a shaft may be rocked by a cam which is located upon itself. The cam *A*, fast to gear *B*, is driven from an outside source, and reciprocates the roll *C* and the radial slide *D*. A chain passes over a sprocket *E* which is fast on the shaft. One end of the chain is fastened to the slide *D*, the other is fastened to a tension spring beneath the slide.

Cam Combination Movement No. 9.

Referring to Fig. 9, it was desired that lever *A* should have an angular displacement of 45 degrees, but it was found that a cam to accomplish this with the given center distances would not swing inside the rods *B*. The idler lever *C* was resorted to, and, as first designed, was connected to the lower arm of *A* by a link. As made, however, the roll *D* on *C* ran between the cam *E* and the lever roll *F*, allowing a much smaller cam and giving a very smooth movement.

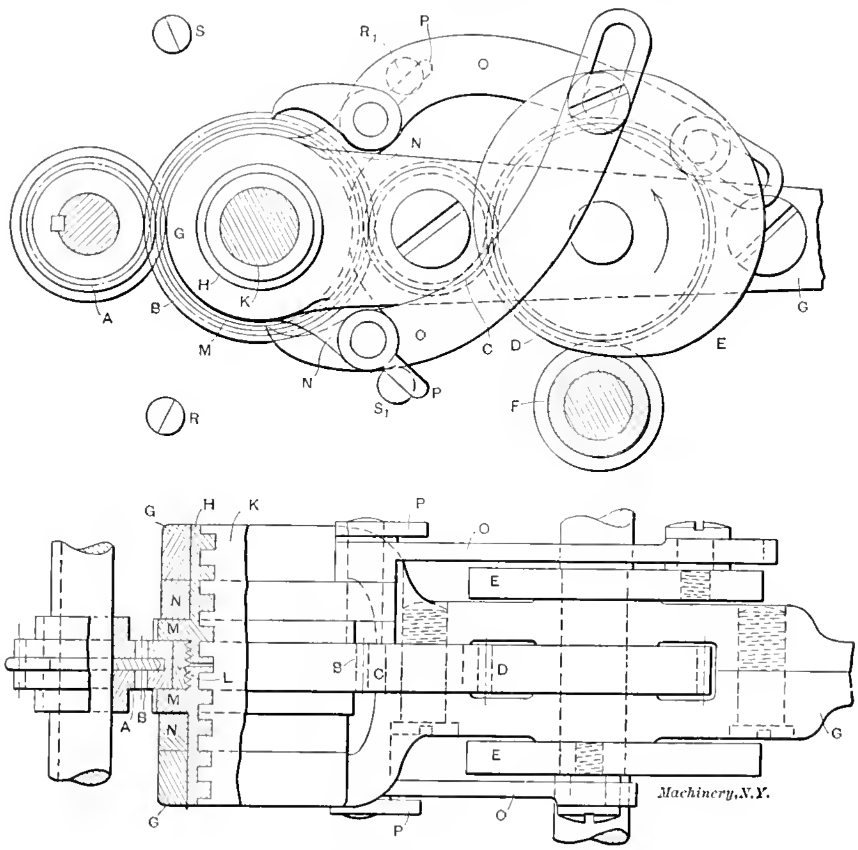


Fig. 11. Cam Combination Movement No. 11.

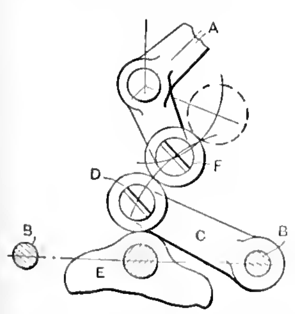


Fig. 9. Cam Combination Movement No. 9.

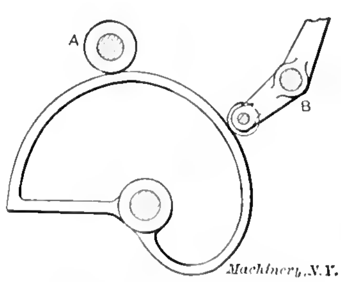


Fig. 10. Cam Combination Movement No. 10.

Cam Combination Movement No. 10.

How one cam was made to operate two machine elements is shown in Fig. 10, where the cam was designed to reciprocate the roll *A* and its slide, giving it a 90-degree dwell after the rise and while lever *B* was vibrated. By properly positioning the fulcrum and proportioning the arms of lever *B*, the necessary motion for it was taken off the last part of the rise of the cam. Roll *A* is shown at the beginning of dwell and the cam is about to throw lever *B*.

Cam Combination Movement No. 11.

A cam is desired to vibrate a third-class lever, and while at its lowest dwell (100 degrees), the lever must be given a lateral translation of 1/16 inch. The total travel each way is 6 inches, and the feed must be automatically reversed at each end.

The manner of accomplishing this is delineated in Fig. 11, in which pinion A drives idlers B and C and cam gear D. The pinion is keyed on the shaft, and is built up with a flange which engages a groove in gear B, causing it to follow the gear. Two like cams E are driven by D, and bear against flanged roll F. The lever G swings about its fulcrum H which is a two-part nut upon the stationary screw K. The nut is divided, the halves being united by sleeve L. The flanges M on each nut are provided with oppositely cut ratchets. Rockers N carry the pawls being actuated by the connections O. In order that the required translation may be imparted to the lever by the four pitch nut, the pawls must swing through an arc of 90 degrees. The engraving shows the parts in position to do this.

The reversal is accomplished by the projections P on the pawls and two pair of spring plungers; R and R_1, being on one side of the frame, and S and S_1 being on the other side. As the lever travels away from us, the pawls approach R and R_1. At the last 1/16 feed, R recedes to let its pawl pass, but throws it into the ratchet on its return. Plunger R_1 recedes to allow the pawl to pass by, but immediately lifts it out of its ratchet.

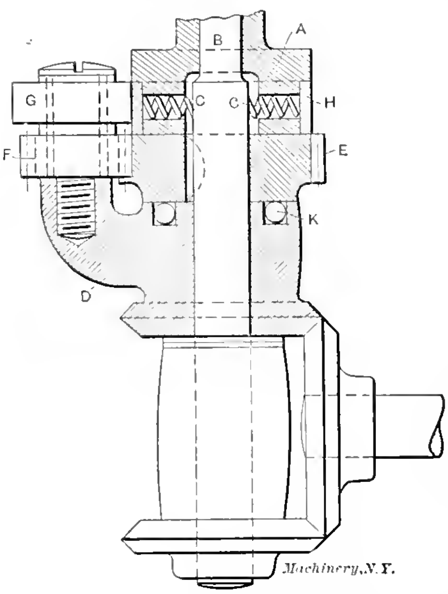


Fig. 12. Cam Combination Movement No. 12.

Cam Combination Movement No. 12.

The accompanying Fig. 12 shows how a circular part making thirty revolutions per minute clockwise, in a horizontal plane, was vibrated from and to its center twice per second, the vibrations being applied progressively counter clockwise around its center, and the part being vibrated vertically sixty times per minute. The part A to be vibrated is revolved by shaft B,

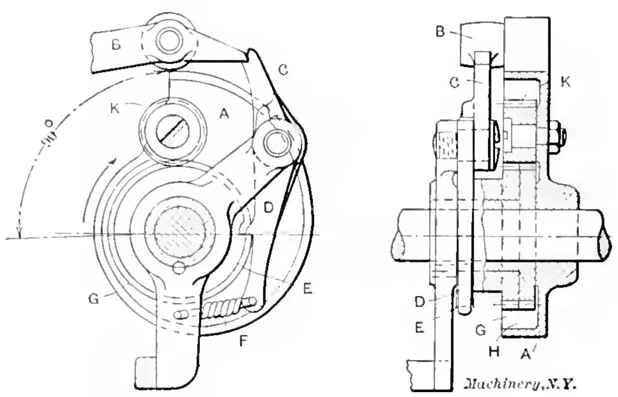


Fig. 13. Cam Combination Movement No. 13.

and centered about it by three springs C. The arm D revolves in the opposite direction to A and the gear E of twenty teeth, which results in the pinion F revolving four times per revolution of arm and part A. The pinion carries a cam G which is made of rubber. It presses against the slip ring H and vibrates the part A. The ring is provided to prevent any drag by reason of the opposite directions of rotation. The balls shown at K serve to reciprocate the part A vertically by reason of the annular groove having two barriers against which the balls stop, and part E having two cam projections which enter the groove and roll up over the balls.

Cam Combination Movement No. 13.

The cam A in Fig. 13, elevates lever B during three-quarters of a revolution. The latch C holds it up during 90 degrees dwell. This latch is controlled by the pawl D, cam E, and spring F. Cam E has ratchet-like notches in its edge, and is made in one piece with a 24-tooth gear G. The pair is rotated upon the hub of a 25-tooth stationary gear H by the planetary pinion K, once every twenty-four revolutions of cam A.

It is desired that the lever B should have 90 degrees dwell the first revolution; thereafter the dwell should increase 360 degrees after each rise to the fourth period (which gives 1,530 degrees dwell), when the dwell should decrease till it is 90 degrees again; that is, during the fourth period the rise is three-quarters of a revolution, and the dwell is $\frac{1}{4} + 4$ revolutions.

This requires 24 revolutions per cycle, and cam E should be indexed for 24 divisions, but only cut at these divisions: 1—2—4—7—11—16—20—23. When pawl D drops into a notch, latch C is thrown out, giving a sudden drop to lever B.

Cam Combination Movement No. 14.

Five levers equally spaced are fulcrumed upon one bar. Four different positive motion side cams operate the four outside levers. The fifth or middle lever is to have the resultant motion of the others at all times; that is, the forces acting on the other four are to be automatically resolved, and their resultant in magnitude and direction is to be transmitted positively to the fifth lever.

As it is not necessary to show the cams or levers to illustrate the principles involved, a horizontal section, merely, of the resolving apparatus will be shown. The four levers are suitably connected by knuckle-joints, one to each of the racks L, M, N and O, Fig. 14. These racks are free to slide up and down independently, and are arranged in two pairs. One pair meshes with pinion A_1, the other with A_2. As the arrangement is symmetrical, the description of one side will suffice. Any movement of levers L and M will be transmitted to pinions A_1 and B_1, which are constrained to travel together by reason of a stud through both. A stationary rack C_1 and a sliding rack

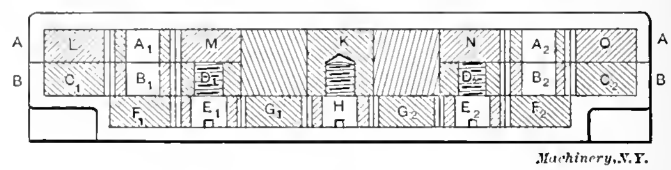


Fig. 14. Cam Combination Movement No. 14.

D_1 engage pinion B_1. Sliding rack D_1 carries a pinion E_1, which in turn engages stationary rack F_1 and sliding rack G_1. The last, and also rack G_2, engage pinion H upon sliding bar K, to which is attached the fifth lever.

To illustrate the action, we will assume that lever L lifts one inch, lever M drops ½ inch, lever N is stationary, and lever O lifts ¼ inch. The resultant is a ¾-inch rise. We know that a pinion moved along a stationary rack will cause a movable rack on the opposite side to travel with twice the velocity of the pinion's periphery. This fact and its converse is here applied.

Lever racks L and M acting upon pinion A_1 will cause it to rise $\frac{1}{2}(1 - \frac{1}{2}) = \frac{1}{4}$ inch. This travel is doubled in sliding rack D_1, producing a movement of ½ inch, and doubled again in sliding rack G_1, throwing the latter 1 inch. As G_1 has teeth on both sides, it, in turn, moves pinion H, and the fifth lever slide K, ½ inch. Lever racks N and O traced out as above give a movement of ½ inch to G_2 and ¼ inch to H and K, which totals ¾ inch rise for the fifth lever. When all cams drop 1 inch together, the resultant is 4 inches drop for the middle lever.

* * *

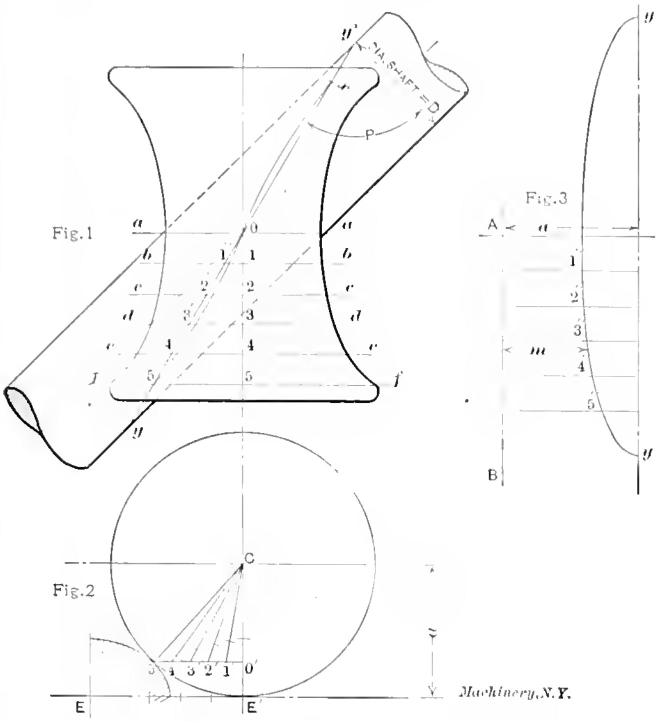
It is mentioned in the *Times Engineering Supplement* that a new steam turbine of novel design has been brought out by Mr. John Ogg, Aberdeen, Scotland. The turbine consists of a metal wheel or disk mounted on a hollow shaft perforated by holes passing from the center to the inside of the wheel, radially. The holes are tapered from the center outward and form expanding nozzles for the steam, which is supplied through the hollow shaft. The steam, on issuing from the nozzles, strikes against blades fixed to the rim of the wheel at a suitable angle. Several wheels may be mounted on the same shafts and the blades on some of the wheels may be set for the forward motion and others for reverse motion.

GRAPHICAL SOLUTION OF CROSS-ROLL CURVE PROBLEM.*

SIDNEY C. CARPENTER †

In the present article the writer offers a method of constructing the cross-roll curve. This method will be found fully as accurate, and far easier to handle, than the more complicated formulas which have been suggested for the same problem.

After laying out the shaft and the center line of the roll, as in Fig. 1, the first step is to determine the line of contact between the roll and shaft. Taking a section on the line *ff*,



Graphical Solution of the Cross-roll Curve.

at the end of the roll, draw the ellipse forming the section of the shaft on this plane, as shown in Fig. 2. From C, the center of the roll, draw a circle tangent to the ellipse, and locate the point of tangency 5′, as closely as possible. This point is the point of contact between the roll and the shaft on the plane *ff*. Projecting 5′ to Fig. 1 we obtain the point 5″. The straight line from 5″ to 0 represents the average direction of the line of contact. Produce 5″ 0 in both directions till it cuts the sides of the shaft at y and y', and draw the ellipse which represents the section of the shaft on yy', as shown in Fig. 3. This ellipse should be constructed as accurately as possible. The minor axis, of course, equals the diameter of the shaft, and the major axis equals $\frac{D}{\cos a}$.

At a distance a from the major axis of the ellipse, equal to the vertical distance between the center lines of the roll and shaft, draw AB parallel to the major axis. In Fig. 1 divide 05 into a number of equal parts, and through these points draw *bb*, *cc*, etc., cutting yy' in 1″, 2″, etc. These are the points of contact on the sections *bb*, *cc*, etc., assuming the contact line to be straight. Now revolve the ellipse yy' into the plane of the roll axis. Points 1″, 2″, etc., will take the positions shown in Fig. 3, and AB will be the center line of the roll. Erect ordinates on yy' passing through 1″, 2″, etc., and produce them to AB. Under the conditions assumed it is evident that the distance m, on any ordinate, from AB to the curve of the ellipse, is equal to the radius of the roll section at that point. Revolving the ellipse back to its real position, point 5″ will assume position 5′ in Fig. 2; the real radius of the section will be $C5'$, and the distance between 5″ and AB, Fig. 3, will equal $C0'$. But $C5'$ equals $\frac{C0'}{\cos 5'C0'}$. Therefore, denoting the distance from AB to the curve of the ellipse by m, angle $5'C0'$, $1'C0'$, etc., by F, and the radius of the roll section by R,

$$R = \frac{m}{\cos F}$$

Angle F can be obtained by dividing $5'C0'$ into angles corresponding with the other points of division, and m must be measured from Fig. 3. The formula, however, is not exact, though it is very close. The method of obtaining F gives the correct angle, but m is slightly too small, for the real point of contact, instead of being on the straight line 5″0, is on the curved line 5″0. A little consideration will show that the real line of contact is an arc over the surface of the shaft, as represented by the curve 5″0x, while the straight line 5″0x represents the chord *through* the shaft.

If the construction is very carefully done, the following method gives very close results. After obtaining 5′, Fig. 2, the point of contact on the section *ff*, draw 5′0′ perpendicular to $C0'$ and divide it into equal parts, corresponding to the divisions on 05. Draw $C1'$, $C2'$, etc. Now divide EE' into the same number of parts. The division points represent the center of the shaft section on the planes *aa*, *bb*, *cc*, etc. For each position, draw that portion of the ellipse which is normal to the corresponding line from C. The point of intersection will be the point of contact for the corresponding plane in Fig. 1, and the radius can be measured directly, or transferred to Fig. 1, and the curve for the outline of the cross-roll drawn. The accuracy of the result depends upon the care with which the ellipse is constructed for the different positions.

* For additional information on this subject, see the article in the December, 1907, issue, on the "Derivation of the Cross-roll Curve," and other articles there referred to.
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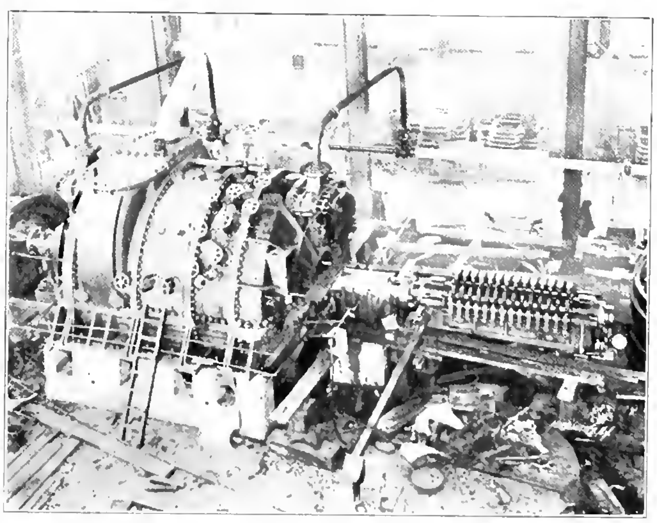
* * *

GIANT TURBINES FOR JAPANESE CRUISER.

There have just been completed at the Fore River Works, Quincy, Mass., a pair of giant turbines, destined for the new Japanese cruiser *Ibuki*, now building in a Japanese yard. These turbines will develop on aggregate of 27,000 horsepower, and the cruiser will have a speed of 23 knots, with 14,500 tons displacement. The turbines are 144 inches in diameter, with seven ahead and two reverse stages, contained in one casing. The reverse wheels will develop about 60 per cent of the full-ahead power, and reversing can be accomplished in eight to ten seconds from the time signals are given. These will be the first turbines ever installed in a Japanese ship, and are to be followed by two more of similar



One of the Turbines built at the Fore River Works, Quincy, Mass., for a Japanese Cruiser.

design for the battleship *Aki*, now under construction. The boxed weight of the turbines just finished was 150 tons. Each separate part was securely boxed, marked and numbered, so that the parts can be readily fitted together when Japan is reached. A diagram was made of the vessel which carried the parts of the turbines before the crates were hoisted aboard, in order that there might be no movement in the hold that would cause damage to any of the parts in rough weather. Several workmen from the Fore River Works are going to Japan to assist in setting up the turbines. The building and shipping of the turbines were under the direction of Commanders Yushida and Kamimura of the Japanese navy

ADAMS-FARWELL AERONAUTIC GASOLINE MOTOR.

The flying-machine inventor is not so much ridiculed nowadays as of yore, for attempting to accomplish mechanical flight. The Darius Green type of flying machine inventor, among whom was the ill-fated German, Otto Lilienthal, laid a foundation of practical knowledge of air resistance, air currents and the laws affecting the action of gliders and aeroplanes; and to-day the possibility of navigating the air looms before us. Lilienthal began his experiments in 1891, and was killed by an accident to his glider in 1896. Although his work was generally regarded with contempt at the time, Lilienthal's investigations were the start of work along the same lines that is of much interest and value now. It is with the advantage of the principles established by such men as Lilienthal that the present experimenters are enabled to attack the problem of "heavier-than-air" flying machines, intelligently. They are generally men of expert engineering and mechanical knowledge, such as the Wright brothers, Henri Farman and Leon Delagrange, and their work is regarded with respect, because we are beginning to understand what the requirements are and how they are to be met. The successful solution of flying, which is believed to be not far distant, will mean a tremendous change in light transportation and sport. The engineer is interested in the practical side. He knows that birds fly because of possessing great muscular power and wing surface, as compared with their weight. It does not necessarily follow, however, that a flying bird continually exerts great power; in fact, we have very good proof that it does not, but it must always have large reserve power to enable it to rise quickly from the ground and to suddenly change its course when the air currents do not favor progress. So it must be with the mechanical flyer; hence the need for powerful and light motors.

The accompanying half-tones, Figs. 1 to 4, show a new aeronautic motor developed for an Eastern inventor who is making secret tests of a new type of aeroplane. The motor is the design of F. O. Farwell, inventor and patentee of the revolving cylinder motor first used on the Adams-Farwell automobile. (See MACHINERY, November, 1904, for description.) The automobile engine described had three cylinders revolving around a stationary crank-shaft, and a 20-H.P. engine weighed 190 pounds, or $9\frac{1}{2}$ pounds per H.P. This design was afterwards changed to five cylinders, and the aeronautic motor shown herewith is built from the same patterns with the exception that the bore is $4\frac{1}{4}$ inches, instead of 4 inches. It is lightened by making some other changes also. The engine illustrated has five cylinders, $4\frac{1}{4}$ inches bore, $3\frac{1}{2}$ inches stroke, and runs at 1,800 R.P.M. Its weight is only $97\frac{1}{4}$ pounds, and figured by the Association of Licensed Automobile Manufacturers' rule, $\text{H.P.} = \frac{D^2}{2.5} \times N$, its rating is 36 H.P., or only 2.7 pounds per H.P. This weight includes everything necessary for operation, with timer, float-feed carbureter, automatic force-feed oil-pump and lubricating oil tank. With the spider shown in the half-tones, Figs. 2, 3, and 4, which secures the motor to four tubes, the motor and base weigh 104 pounds. The parts not included in this weight are the battery, coil and gasoline tank, which cannot be considered as parts of the motor.

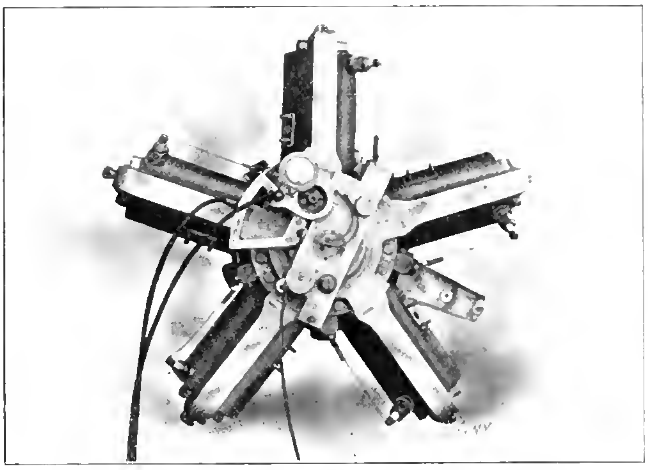


Fig. 1. Top View of Adams-Farwell Five-cylinder Motor for Air Ships and Aeroplanes.

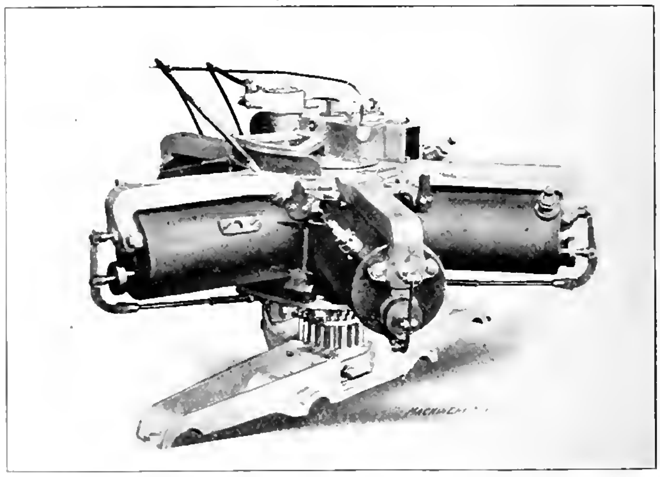


Fig. 2. Side View of Five-cylinder Motor, showing Spider for Attaching to Frame.

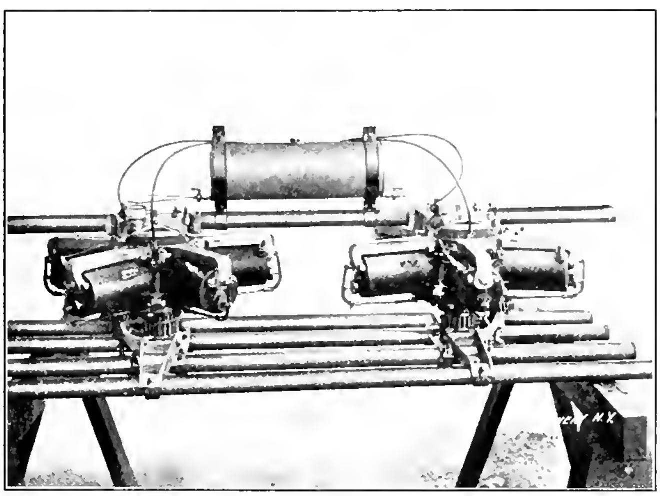


Fig. 3. Two Motors attached to a Frame of Tubes, with Complete Equipment

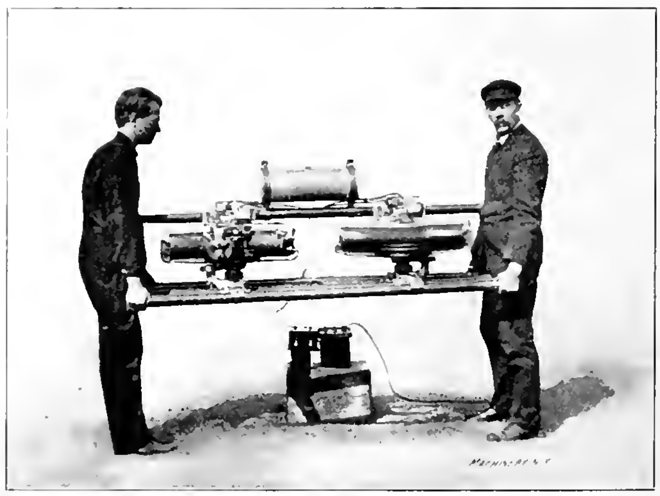


Fig. 4. Two Motors supported by Two Men. One Motor is shown running at High Speed, Illustrating Freedom from Vibration.

The above weight per H.P. developed is believed to be the lightest of any motor so far built in which practical utility was not sacrificed. The nearest approach is the Antionette eight-cylinder motor, made by the Adams Mfg. Co., Ltd., London, England. The weight of this engine for 31.71 H.P., by the A. L. A. M. rule, is 88 pounds or 2.77 pounds per H.P. The larger sizes are heavier per H.P. This motor is water-cooled, and requires considerable additional weight for the water, water pump, piping and radiator. Another very light motor, built by the G. H. Curtis Mfg. Co., Hammondsport, N. Y., weighs 150 pounds for 40 H.P. or 3.57 pounds per H.P.

The construction of the Farwell motor is peculiarly advantageous for aeronautic purposes. The cylinders form the fly-wheel, and this fact alone means a big saving in weight. Inasmuch as the cylinders revolve rapidly in the air, they are air-cooled, and no other air-cooling machinery is required. The cylinders act as their own fan, and the cooling effect has been found to be perfectly satisfactory. In the automobile motors, as first developed, longitudinal ribs were cast on the cylinders, but in 1907 these were discarded, it having been found that smooth cylinders as large as 5 inches bore and 5 inches stroke cooled perfectly working in this way. Another saving of weight comes from the fact that all five cylinders work on a common crank-pin, and all ten valves are operated by one cam.

Not the least difficult part of the design was the attachment of five connecting-rods to a crank-pin 1⅜x4 inches, so that the working pressure per unit of bearing surface would not greatly exceed the limits imposed by lubrication and durability. A longitudinal section of a cylinder, connecting-rod and the crank-shaft is shown in Fig. 5. Four of the connecting-rods have narrow forked bearings encircling the crank-pin, while the fifth rod has a single bearing double the width of one fork and, of course, equaling the width of two. The exterior of these bearings or forked parts is machined truly circular, and each connecting-rod is made with an extended part each side of the forked bearings which is machined to fit the exterior of the other connecting-rod forks. Inasmuch as the maximum pressures transmitted to the connecting-rod act to compress it against the crank-pin, the working bearing of each connecting-rod on the power stroke is the full length of the pin and about 60 degrees of its circumference.

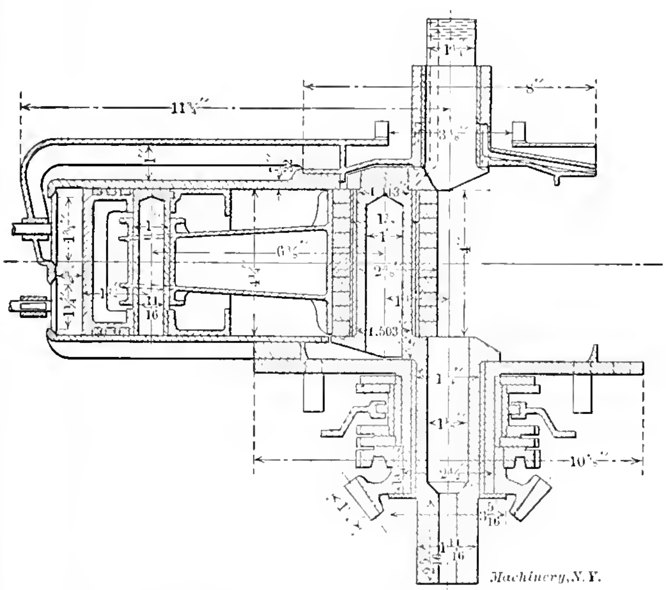


Fig. 5. Vertical Section through a Cylinder and the Crank-shaft, showing Method of attaching Connecting-rods to the Crank-pin.

Each cylinder is cast with the head and a part of the central crank case in one piece of steel of high tensile strength, each weighing only 7½ pounds. The five cylinders are bolted together and are bolted to a top aluminum flange, weighing 3 pounds, which forms the gas manifold. At the bottom the cylinders are bolted to a steel flange, which supports the valve cam and the transmission gear. These flanges have long bronze bushings, and form bearings around the vertical stationary crank-pin. The pistons are made of cast iron and weigh 2½ pounds each. The connecting-rods are made of bronze.

As before stated, the valves, ten in number, are operated by one cam. These valves have no springs to close them, but being in the heads of the cylinders and closing outwardly, they are closed by centrifugal force. The higher the speed of the motor, the greater the centrifugal force, and the greater the necessity for a strong force to close the valves quickly. Centrifugal force also puts the gas in each cylinder under pressure, which is an advantage in a high speed engine. The engine operates under the variable compression system, used for several years on the Adams-Farwell automobile motors. It consists in mechanically holding the inlet valve open for a part of the compression stroke, and closing it after a part of the gas has been blown back, and taken in by another cylinder, which at that time is under the suction stroke. The compression is relieved and the motor runs with little compression resistance when starting or running slowly. It may be gradually increased until maximum speed and power is obtained, and may be as gradually reduced when stopping the motor. Therefore, there is not the abruptness in starting or stopping, which characterizes the ordinary gasoline motor, and this is another feature of considerable importance in aeronautical work.

The wiring for the ignition system is as simple for this five-cylinder motor, as it could be for a single-cylinder motor. There is but one spark coil, one timer and contact, one primary, and one secondary current. Fig. 1, showing the top view of the motor, makes the arrangement clear. The wire is attached to a flat steel spring. This is insulated for the remainder of the timer by a fiber block. A hardened steel wheel is mounted freely on the concentric or crank end of a short shaft, which is geared to the motor, and which makes one revolution to each two-fifths revolution of the motor. A distributor for the secondary current is formed by a strip of brass on the lower edge of a fiber segment, supported by a bracket shown. A short, bare wire leads from the spark plug, on each cylinder, to a fiber insulator, near the crank case. In the top of this insulator is a screw, which, when the motor turns, passes under the distributor, but does not touch it. When the cylinder, which is to be fired passes under the distributor, the timer wheel makes contact with the springs and the secondary current passes to the spark plug of that cylinder. Each alternate cylinder is on the power stroke as it passes the dead center of the crank. There being five cylinders, the power strokes are in perfect rhythm. After the motor is started, the timer case is swung around to the left, which advances the spark to its maximum.

The same shaft that turns the timer wheel revolves the force-feed oil pump by means of a worm gear. The rectangular block shown at the top, which is clamped to the upper tube, not only forms a support to the upper end of the crank-shaft, but makes an oil tank holding one-half pint of lubricating oil. It supports the timer and oil pump, and in one end is formed a carbureter with float-feed chamber. The complete device weighs only 2½ pounds. To recapitulate the advantages claimed for the Farwell motor, for aeronautic purposes are:

Gyroscopic force, utilized to steady aeroplanes in flight; the entire motor revolves around the stationary crank-shaft, giving maximum fly-wheel effect for given total weight; the lightest motor of this power that has ever been constructed (97¼ pounds, rated at 36 H.P.); motor has no fly-wheel, no muffler, and no cooling device, other than that made by the revolving cylinders; valves close by centrifugal force, instead of springs; ten valves actuated by a single cam; simple ignition system identical with that used on single-cylinder motors of ordinary design; gas injected into the cylinder under pressure by centrifugal force; absolute freedom from unbalanced forces and vibration. The motor is built by the Adams Co., Dubuque, Iowa.

* * *

Electric welding enables certain manufacturing operations to be accomplished easily, simply, and, therefore, cheaply, which, if conventional old-time methods were used, would be very costly and difficult. Take for example the case of multiple-throw automobile crank-shafts. Every one knows how hard it is to drop forge such work satisfactorily beyond two throws in one piece, following common practice. It is made comparatively easy if electrical welding is employed as an assembling process. Four-throw and six-throw shafts are now built up by electrical welding in the rough, using single-throw or double-throw units until sufficient throws have been united. The advantage of the method has been recognized as making possible a still further advancement. If the single-throw drop forgings are rough-turned and rough planed before being electrically welded together, the finishing operations of the assembled shaft are greatly simplified and cheapened.

MAGNALIUM.

VALUABLE CHARACTERISTICS OF AN ALUMINUM ALLOY.

Magnalium is an aluminum and magnesium alloy which promises to fulfill the expectations based in the past on aluminum, but never realized on account of its softness and other unfavorable qualities, which have been overcome by the development of magnalium. For the following interesting notes on its characteristics we are indebted to Mr. Morris R. Machol, 32 Park Place, New York, who is the American agent of the Magnalium Syndicate of Berlin, Germany.

Magnalium like pure aluminum can be cast in a liquid condition. The castings can be machined about the same as brass. The machined surfaces are of a mirror-like smoothness and silvery color. Perfect screw threads can easily be cut in the metal, and bored holes can be made smooth and true. Filing it results in fine, regular, clean-cut surfaces without tearing up the metal or clogging up the file as does aluminum, and the action is accompanied by the usual typical sound which is heard when filing. Only rough or medium fine files can be used on aluminum, preventing, of course, any exact work, while magnalium will allow the use of even the finest kind of files.

Magnalium can be cast by any ordinary foundryman, the only precaution necessary being the use of *clean* graphite crucibles, and care must be taken not to increase the temperature too far above the melting point (1185 to 1250 degrees F.) as this weakens the metal. If cast in an iron chill the tensile strength is greatly increased and is at a maximum if the chill is water-cooled. Cast in dry sand, the usual quality of magnalium has a tensile strength of 18,000 to 21,000 pounds per square inch, and shows reduction of area of 3¾ per cent; cast in iron chills, 22,000 to 25,000 pounds per square inch; reduction of area, 5 to 8 per cent. The tensile strength of a quality containing a somewhat smaller percentage of aluminum equals about 34,000 pounds per square inch, but can be increased to about 42,500 pounds per square inch by proper treatment. By drawing, rolling, pressing, etc., the tensile strength obtained by quick cooling is still further increased. Wire drawn from one quality of the alloy has a tensile strength of 41,000 pounds and 10 per cent reduction of area, while it will stand 53,000 pounds if the raw material has been forged before drawing. Soft rolled sheets of alloy "Z" have a tensile strength of 42,000 pounds and 15 per cent reduction of area; hard rolled sheets, about 52,000 pounds and 3 per cent reduction of area.

Magnalium containing less than a certain percentage of aluminum cannot be rolled but can readily be drawn. The tensile strength of a drawn bar tested was 60,000 pounds, and that of a tube, 74,000 pounds per square inch.

Another advantage of magnalium is that it is extremely close grained, so that the polishing can be done without previous treatment. Furthermore, in lathe work the tool speed can be twice as great as with aluminum, thus making a saving in labor. Transparent or colored lacquers can be readily applied; polishing, etching, engraving, etc., can be easily done.

Pure aluminum being soft, can be cut with a knife like zinc or lead, while magnalium is hard. Some magnalium alloys, however, are very ductile and can be forged, rolled, drawn, etc., as intimated in the foregoing, sharing all advantages of aluminum in this direction. Annealed magnalium "Z" is so ductile that it can be rolled or beaten like silver. The elasticity of cast or annealed magnalium is small, but in the forged, hard-rolled or drawn material it is much greater. It attains and maintains a high polish and shows excellent resistance to atmospheric conditions. The color of magnalium is silvery white in contrast to the grayish aluminum. Besides all this, magnalium has the advantage that its specific gravity is less than that of aluminum. While the specific gravity of pure aluminum is 2.64, magnalium shows 2.4 to 2.57, according to the percentage of alloy. Other aluminum alloys have a greater specific gravity than aluminum, the most of them being between 3 and 4.

Magnalium has no odor. It resists oxidation better than aluminum or any other light metals and is almost unaffected by dry or damp air, water, gaseous ammonia, carbonic acid, sulphureted hydrogen and most organic acids. It is very slowly affected by saltpeter or sulphuric acid and more rapidly by alkalies or strong alkaline solutions. Salt water attacks magnalium slightly, and where exposed to sea water the metal should be lacquered, which will protect it so that it will give excellent satisfaction.

Magnalium shows almost no magnetic influences, but its electric and thermal conductivity is about 56 per cent of that of pure copper. The specific heat of magnalium is 0.2185.

Magnalium, especially alloys "X" and "Y," can be forged with good results most easily by heating the metal and then working about the same as Swedish steel. The metal must not glow red, but must be hot enough to char a piece of wood. Of course, the casting should be clean before forging to avoid cracks in the metal.

The great ductility of magnalium, especially alloy "Z," makes it possible to produce plates of any thickness. The ingot is first heated to between 570 and 660 degrees F. and rolled so that the reduction at the first pass is about 20 per cent. Then the plate is again heated. After the first two passes the plate is turned 90 degrees and passed through the finishing rolls until it reaches the required thickness. As magnalium rapidly loses its ductility in rolling, it has to be annealed repeatedly.

Magnalium should be annealed in a muffled furnace in order to keep the flame and gases away from the metal. The annealing furnace must be kept at an even heat. The metal must appear dark red and char a pine wood stick so that carbon particles separate from it. To anneal plates does not require as high a temperature. If plates are chilled in cold water, they will be very tough and ductile. The thinner the plates, the lower should be the temperature of the annealing furnace. Plates of less than 0.01 inch thickness can be heated in boiling oil or water and allowed to cool slowly. If the magnalium is gradually heated to a temperature of less than 750 degrees F. and slowly cooled, the metal gets so hard and elastic that it can be worked into springs.

Magnalium is a very ductile metal and in this respect is only surpassed by gold, silver, platinum and copper. When drawing, the diameter of the cast ingot should be reduced very slowly at first. Best results are obtained if the ingot is forged before drawing. Perfectly smooth wire as fine as silk threads has been made with astonishing tensile strength. Tubes made from plates or from cast hollow pieces are treated in exactly the same way as rods, namely annealed repeatedly, chilled and afterwards drawn cold over a mandrel.

Magnalium is remarkable inasmuch as that it can be tooled at high speed, about like steel. Screw threads of length can be easily and cleanly cut. The tools have to be very sharp and the surfaces (both metal and tools) must be kept lubricated with either kerosene, turpentine, paraffin, benzine, vaseline, soap-water or even clear cold water. Excellent surfaces will result and perfect screw threads or holes will be obtained. To cut magnalium, a fine-toothed saw, lubricated with kerosene, is recommended. Magnalium can be punched, drop-forged and pressed without any difficulty—about the same as silver, brass or steel plate—provided that it has been well annealed.

Weight for weight, magnalium is stronger than Siemens-Martin steel with 2 per cent aluminum alloy. This steel has an ultimate tensile strength of about 114,000 pounds per square inch. Magnalium "Z" is rated at 52,200 pounds per square inch. Dividing each by its specific gravity yields 14,400 and 20,800, or nearly 50 per cent advantage of strength for the same weight in favor of magnalium. The value of the new alloy for aeroplanes, automobiles, army equipment and many other uses in which cost is not so important as lightness, is quite apparent. The price per pound is about two times that of aluminum.

* * *

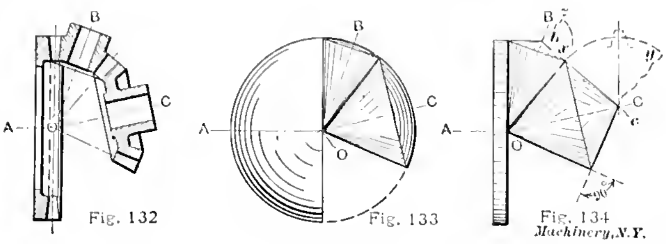
An advantageous system for lighting at the milling machines is in use in the Kearney & Trecker Co.'s shops, Milwaukee, Wisconsin. A small bracket of cast iron is screwed to the top of the milling machine at the front end, over the bearing for the overhanging arm, and into this is screwed a piece of ordinary Almond tubing, through which the wire is carried. This gives a very satisfactory flexible arrangement, and permits the light to be brought into the best position.

GEAR-CUTTING MACHINERY 7.

RALPH E. FLANDERS.*

MACHINES FOR FORMING THE TEETH OF BEVEL GEARS.

In studying methods and machines for cutting the teeth of bevel gears, we come to the most fascinating branch of the whole subject which we have been considering. It will be impossible in the comparatively short space we are able to devote to the subject to do more than give the bare outlines of the ingenious mechanisms which have been devised for this work. Almost any one of the machines we describe, operating on the templet or the molding-generating principles, would



Figs. 132, 133, 134. Illustrating the Spherical Basis of the Bevel Gear, and Tredgold's Approximation for Developing the Outlines of the Teeth on a Plane Surface.

require several pages and many illustrations to explain the details of its construction. We can, however, in the comparatively short descriptions here given, get an understanding of the principles of operation of each of them. This will best be done by analyzing the various principles of action and methods of operation applicable to the cutting of bevel gear teeth, as was done for spur gears in the introduction of this series of articles, following the same classification there given, but making the necessary changes in the mechanisms shown in Figs. 1 to 10 to fit them for the work of cutting bevel gears instead of spur gears.

The changes required in the spur gear cutting devices to adapt them for cutting bevel gears, made necessary by the difference in the nature of the two forms of gearing, are explained in Figs. 132, 133, and 134. The action of a pair of mating spur gears may be seen and studied on the plane perpendicular to their axes. To be understood correctly, the action of bevel gearing must be observed on a spherical surface. In Fig. 132 are shown three bevel gears with axes OA, OB, and OC. The bevel gear on axis OA is of the form known as the "crown gear." It is practically a rack bent in a circle about center O. Pinion OB and gear OC are familiar types of bevel gears. In Fig 133 are shown the pitch surfaces of the gears in the preceding figure. It will be seen in that figure that the pitch lines of the gear on the axis OC, for instance, converge at the center O. These pitch lines represent a conical pitch surface which is shown cut out from a sphere on axis OC in Fig. 133. In a similar way the cone about axis OB represents the pitch surface of the pinion in Fig. 132, while the plane face of the hemisphere at the left of Fig. 133 is the pitch surface of the crown gear of the preceding figure. If we wish to draw accurate representations of the teeth of the bevel gears in Fig. 132, in order to study their action in the same way that we can when drawing the teeth of spur gears on the plane surface of the drawing board, we would have to draw them on surfaces of the sphere from which the pitch cones in Fig. 133 are cut. The pitch circles, etc., of the various gears would be struck from centers located at the points where the various axes OA, OB and OC break through the surface of the sphere. Except for the different surfaces

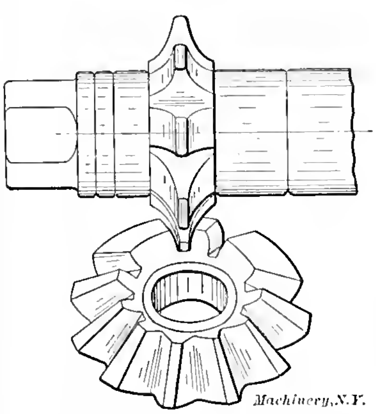


Fig. 135. Shaping the Teeth of a Bevel Gear by the Formed Cutter Process.

on which the drawing would be done, the procedure would be identical with that for spur gears. It should be noted that straight lines on spherical surfaces are represented by great circles—that is to say, by the intersection with the surface of planes passing through the center of the sphere.

Owing to the impracticability of the sphere as a drawing-board, an approximate process, known as "Tredgold's," is usually followed for laying out the teeth of bevel gears approximately. This is shown in Fig. 134 applied to the same case as in the two preceding figures. The conical pitch surfaces vanishing at the center O are identical with those in Fig. 133, as is also the plain circular face of the crown gear. For the bevel gear and pinion, however, the teeth are supposed to be drawn and the action studied on surfaces of cones complementary to the pitch cones—that is, on the cones with apexes at c and b. The surface of these cones can be developed on a flat piece of paper, as shown for that on axis OC in Fig. 134, in which case the pitch line becomes xy, as there illustrated. Teeth drawn on this pitch line, as for a spur gear, may be laid out on the conical surface and used as the outlines of bevel gear teeth. The difference in the shape of teeth obtained under the same system as the two methods shown in Figs. 133 and 134, is so slight as to be negligible, except perhaps, in gears having very few teeth. Whatever the method pursued for laying out or studying the action, all

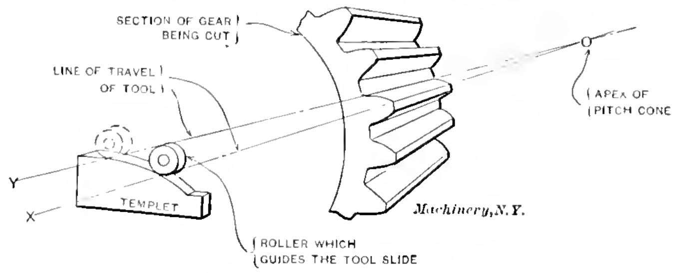


Fig. 136. Diagram illustrating the Templet Principle for Forming the Teeth of Bevel Gears.

the elements of which the teeth are formed consist of straight lines which meet at the center O of the pitch cones; consequently the teeth grow small toward the inner end, vanishing at the center if they are carried that far.

Five Principles of Action.

All of the five principles of action on which spur gear teeth may be formed (the formed tool, the templet, the odontographic, the describing-generating and the molding-generating principles) may be also applied to the cutting of bevel gears, though the describing-generating principle has never been so used, as far as the author's knowledge goes, so we will not give any time to its consideration.

The Formed Tool Principle: The use of this principle is illustrated in Fig. 135, where we have a bevel gear blank set

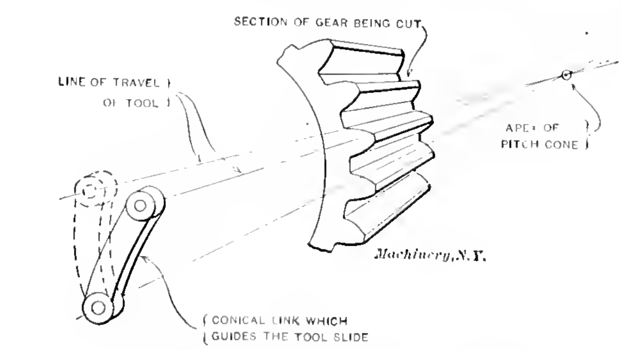


Fig. 137. Diagram illustrating the Odontographic Principle for Forming the Teeth of Bevel Gears.

in position to have the tooth spaces cut by a formed milling cutter. This method, though perhaps the commonest employed of all, is in its nature an approximate one only, it being impossible by it to form the tooth correctly. The reason for this may be seen in Fig. 135, where it is evident that the right-hand side of the cutter is reproducing its own unchanging outline along the whole length of the base of the tooth at the right. This form should not be unchanging, for, as previously explained, the teeth and the spaces between them grow smaller toward the apex of the pitch cone, where they finally vanish;

* Associate Editor of MACHINERY.

so it is evident that the outline of a tooth at the small end should be the same as that at the large end, but on a smaller scale—not a portion of the exact outline at the large end, as produced by the formed tool process and as shown in the figure. To make this error as small as possible, it is customary to use a cutter which gives the proper shape at the large end, and set the blank so that the tooth is cut to the proper thickness at the small end. This leaves the top of the tooth at the

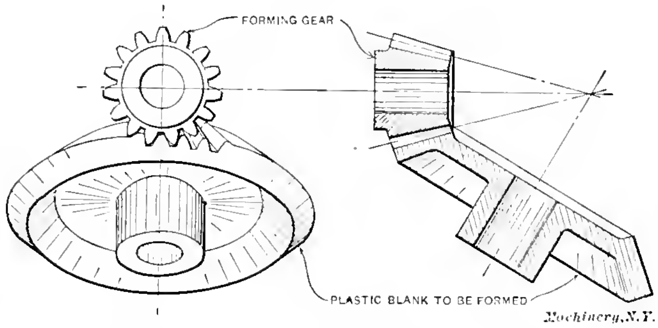


Fig. 138. The Impression Operation, applied to forming the Teeth of a Bevel Gear by the Molding-Generating Process.

small end too thick, an error which is often remedied by filing. Of course, the principle is the same with the formed planer or shaper tool as with the formed milling cutter, and the errors involved in the process are also identical. It is evident that but one side of the tooth space can be cut at a time, so that at least two cuts around will have to be taken.

The Templet Principle: This principle is illustrated in Fig. 136, in skeleton form only. A former is used which has the same outline as would the tooth of the gear being cut, if the latter were extended as far from the apex of the pitch cone as the position in which the former is placed. The tool is carried by a slide which reciprocates it back and forth along the length of the tooth in a line of direction (*OX*, *OY*, etc.) which passes through the apex *O* of the pitch cone. This slide may be swiveled in any direction and in any plane about this apex, and its outer end is supported by the roller on the former. With this arrangement, in the case shown, as the slide is

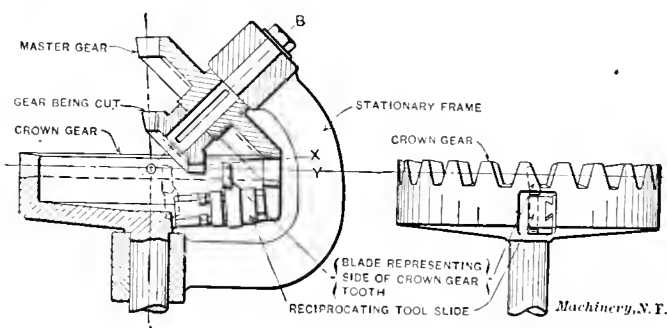


Fig. 139. Model illustrating the Shaping or Planing Operation, applied to the Molding-Generating Principle of forming the Teeth of Bevel Gears.

swiveled inward about the apex, the roll runs up on the former, raising the slide and the tool so as to reproduce on the proper scale the outline of the former on the tooth being cut. Since the movement of the tool is always toward the apex of the pitch cone, the elements of tooth vanish at this point, and the outlines are similar at all sections of the tooth, though with a gradually decreasing scale as the apex is approached—all as required for correct bevel gearing.

The arrangement thus shown diagrammatically is modified in various ways in different machines, but the movement imparted to the tool in relation to the work is the same in all cases where the templet principle is employed no matter what the connection between the former and the tool may be.

The Odontographic Principle: As explained for spur gears in Fig. 3, it is often possible to approximate the exact curves required for the teeth of gears by mechanisms which make use of circular arcs or other easily generated curves. In Fig. 137 is shown in diagrammatic form an arrangement for obtaining, by means of link work, a close approximation to the exact form of an involute outline, such as might be produced by the templet in Fig. 136, for instance. This true involute outline may be very closely approximated by a circle drawn on the surface of a sphere. To give this required circular movement to the point of the tool, the slide on which the tool reciprocates may be constrained by a link as shown, pivoted at the base to the frame of the machine, and at the upper end to the slide. The axes of these pivots should pass through the apex of the pitch cone, as required by the spherical nature of the bevel gear. This link work (which is thus of the "conical" type) if properly proportioned and located, will guide the tool slide and the tool point in very nearly the same way as a properly constructed templet, used as shown in Fig. 136.

The Molding-Generating Principle: The counterpart of the spur gear process shown in Fig 5 is illustrated for the bevel gears in Fig. 138. Here a correctly formed gear is being rotated in the proper position and in the proper ratio with a plastic blank. This operation, as in the case of the spur gear, forms teeth in the plastic blank which are properly

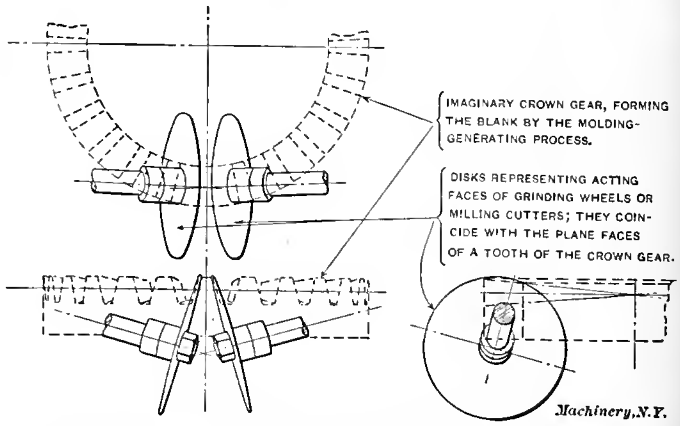


Fig. 140. Diagram suggesting the Arrangement of Milling Cutters or Grinding Wheels for Forming the Teeth of Bevel Gears by the Molding-Generating Process.

shaped to mesh with the forming gear or with any other gear of the same series. Fig. 6 has no possible counterpart in the cutting of bevel gears.

Four Methods of Operation.

By Impression: The same four methods of operation as for spur gears may be applied to the molding-generating principle, and quite generally to the other principles as well. Instead of using for illustration a rack as the generating member, we will have to use its bevel gear counterpart, the crown gear shown in Fig. 132. The impression method would simply

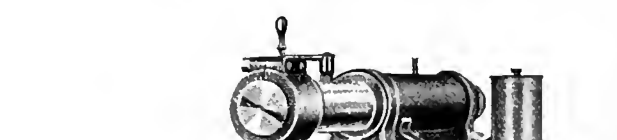


Fig. 141. Cutting Bevel Gear Teeth on a Milling Machine by the Formed Cutter Method.

consist of rolling the crown gear on axis *OA* and the pinion on axis *OB* together, when, if the latter were formed of a plastic material, the teeth of the crown gear would produce in its smaller mate corresponding tooth spaces and teeth of the proper shape.

By Shaping or Planing: There is but one form of tooth to which the planing operation of molding-generating is adapted. This is the form in which the crown gear has teeth with plane sides, which may be cut with a straight-sided tool. If

the drawing of an involute rack were wrapped around the periphery of the disk in Fig. 131, about axis AO, and the tooth outlines thus determined used in teeth vanishing at O, in the plane of the pitch line, the resulting crown gear would be of this type. In other words, it is Tredgold's approximation of the involute system. In Fig. 139 such a crown gear is shown combined with a simple mechanism for making use of the planing or shaping operation in the molding-generating process. The gear being cut is keyed on a loosely revolving spindle, to which is also keyed a master gear, formed on the same pitch cone and having, in this case, the same number of teeth. This spindle is so set in relation to the axis about which the crown gear revolves, that the master gear and

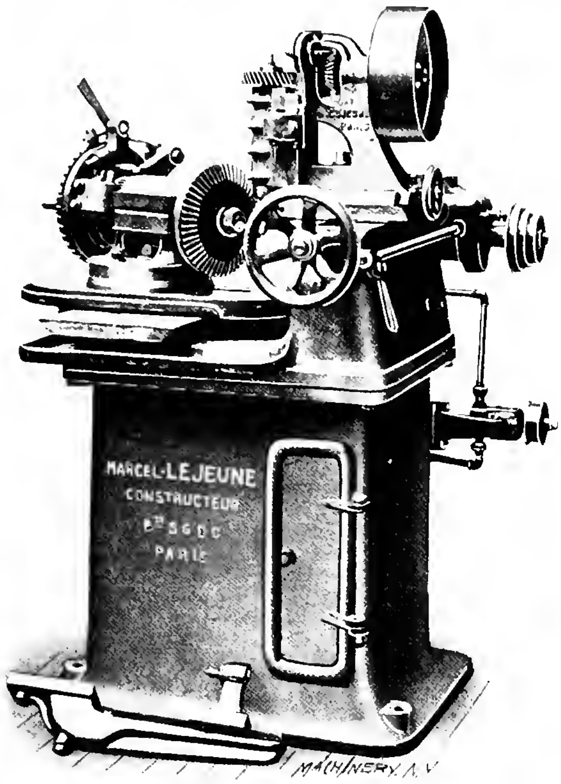


Fig 142. A Special Milling Machine for Cutting Bevel Gear Teeth.

the crown gear mesh together properly, the crown gear being of the required pitch, and having the proper number and shape of teeth for this action. If now the crown gear be rocked about its axis, the master gear will also rock with it, carrying the gear being cut.

The blade is set, as shown in the view at the right, so that its cutting edge coincides with the plane of one of the teeth of the crown gear, and being held in a slide which guides it in such a way that it moves in this plane, and so that its point follows the line OX, radiating from the apex O of the pitch cones. The tool will evidently represent the side of the tooth of an imaginary crown gear, which is adapted to mesh properly with any bevel gear such as that shown being cut, keyed to the master gear and having the same pitch cone shape and number of teeth.

If, with the mechanism so arranged, the crown gear be rotated so as to start the cut at one side of a tooth of the work (which should be first roughly cut to size) the continued rotation of the crown gear will roll the master gear in such a way that the reciprocating blade (representing the side of an imaginary crown tooth meshing with the work) will shape the side of the tooth being cut to the proper form, by the molding-generating process, on the same principle as shown in Fig. 138.

This arrangement, of course, is not a practical working machine as shown, since there is no provision for making it universal for cutting bevel gears of other pitch cone angles and numbers of teeth, or for indexing the work with relation to the master gear to cut the remaining teeth of the work shown in place. Arranged as shown, however, the machine will cut any gear within its range, of the same pitch cone angle and number of teeth as the master gear. To cut a different number of teeth it would only be necessary to alter angle XOY, as required, setting the slide at a greater angle for fewer and larger teeth, or at a less angle for more and smaller teeth.

This principle will be found applied in this and in modified forms in machines we will describe later. One of the modifications which will be seen is equivalent to making the crown gear in Fig. 139 stationary, and swinging the frame around it about axis OA, thus rolling the master gear and the work in the same relation to the tool as when the frame is stationary and the crown gear is revolved, in the way we have just described. Still another possible modification would consist in holding the master gear and work still, while the frame is swung about axis OB. In this case the crown gear would roll on the master gear, rocking the tool slide in such a way as to give the required movement. It is not possible to form a tooth space complete with a single tool, as shown for spur gears, at T_1 in Fig. 8, without cutting the tooth space too deep at the outside end. A separate blade has to be used for each side of the space or of the tooth.

By Milling, and by Grinding or Abrasion: Milling cutters or grinding wheels may be used to represent the space of the tooth, as they represent the rack tooth for spur gears in Figs 9 and 10. In Fig. 140 is shown diagrammatically an arrangement by which two cutters or grinding wheels may be made to represent the two sides of a tooth in such a way that by them a tooth space may be finished complete in the gear to be cut in a mechanism similar to that in Fig. 139, but without requiring the reciprocating movement. The same difficulty arises as in spur gears, of the center of the tooth being cut in deeper than the ends, owing to the circular form of the cutter. This, however, makes no change in the action of the finished gear.

The variety of applications for these various principles and methods of operation is fully as great in bevel gears as in

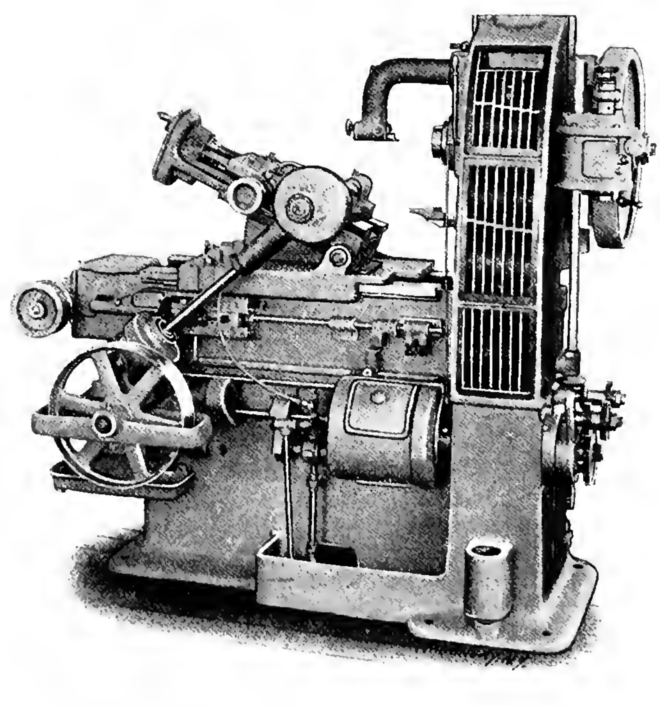


Fig. 143. Brown & Sharpe Automatic Spur and Bevel Gear Cutter, as set up for Cutting Teeth of the latter Form.

spur gears, and the machines in which they are incorporated apply these principles and methods in an even more ingenious fashion.

Machines using Formed Milling Cutters for Shaping the the Teeth of Bevel Gears.

One of the most commonly used machines employing the formed tool process is the ordinary milling machine. An example of the use of the Cincinnati miller for this purpose is shown in Fig. 141. The work is held on an arbor carried by the spindle of the universal head, by which the blank is indexed for the required number of teeth. The head is set to the proper angle to make the bottom of the tooth space horizontal. As explained in the paragraph describing Fig. 135, it

is possible to cut but one side of a tooth space at a time, if teeth of even approximate accuracy are desired. For this reason, and to obtain as nearly a correct form of tooth as possible, the side of the tooth to be cut is moved away from the cutter horizontally and then the work spindle is revolved to bring it up to it again, the amount of "set-over" and "rolling" being adjusted by judgment and by "cut-and-try," to give the best results. Instructions for doing this have recently been published in MACHINERY.*

The automatic attachment built by Ludwig, Loewe & Co., and shown in Fig. 14, is also adapted to the cutting of bevel gears in the milling machine, which it renders automatic, doing the work under the same conditions as the orthodox machine shown in Figs. 143 and 144.

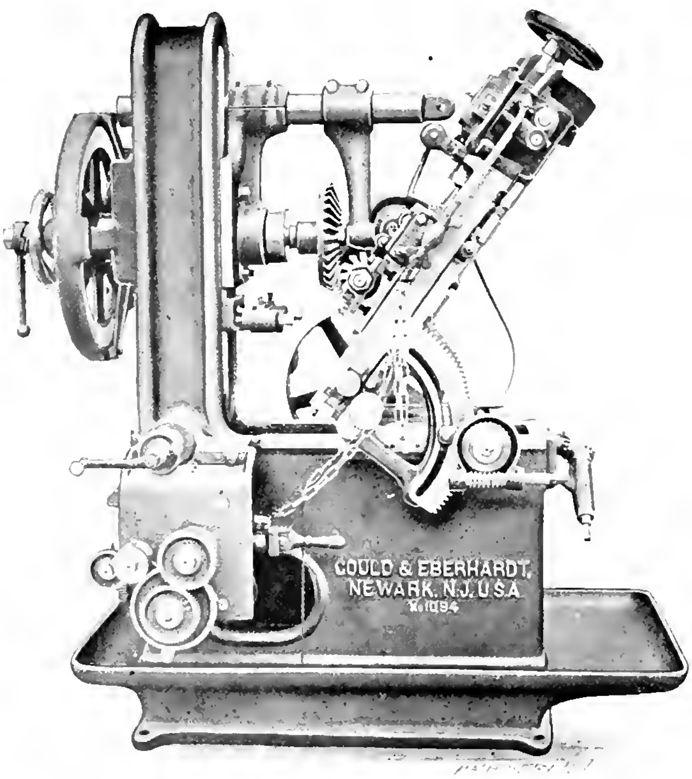


Fig. 144. Cutting a Bevel Gear on the Gould & Eberhardt Automatic Machine of the Orthodox Type.

The dividing head of the milling machine may also be used on the shaper table, for indexing the work and setting it to the proper angle when cutting the teeth with a shaper tool having a blade formed to the proper outline. The necessary set-over and rolling movements required to reproduce an approximation to the correct form are exactly identical with those necessary for the milling machine. The shaping process may be used for odd jobs where no formed cutter is available.

In Fig. 142 is shown a special machine which is identical in operation with the milling machine when used as shown in Fig. 141. Being built, however, especially for the work of cutting bevel gears, it is of simpler construction and less expensive. The bed of the machine carries sliding ways at the right, on which is mounted a knee on the face of which the cutter spindle is vertically adjustable. The latter is driven, through the twisted and bevel gearing shown, from a wide-faced pulley of large diameter. The knee is not mounted directly on the slide but is carried by an intermediate saddle along which it is adjustable in and out for the depth of cut. The feed is provided with an automatic stop, but is returned by hand. The work is mounted on a spindle set in a head, which may be clamped at the proper cutting angle on the base by which it is supported. This base may be adjusted toward or away from the cutter as well as parallel with the movement of the latter, to approximately the position required. The work is indexed by a notched plate operated by hand. The index locking pin is itself carried by an arm which may be swung about the axis of the work by a worm and worm-wheel adjustment to give the required rolling movement, independently of the indexing for correcting the shape of the teeth. What corresponds to the cross movement given the blank in the milling machine is effected here by the vertical adjustment of the cutter spindle on the face of the knee. Provision is made for making both of these adjustments positively and quickly. This machine is built by Etablissements Marcel Lejeune, 93 Rue D'Angouleme, Paris.

Another favorite way of using the formed cutter principle for cutting the teeth of gears employs a modification of the orthodox automatic gear-cutting machine, such as previously shown in Figs. 21 to 28 inclusive. When this is done, one side of the tooth can be finished clear around without attention from the operator, the cutter slide feeding up, returning, and the work indexing, as for spur gears. The cutter has to be set out of center with the blank and the latter rotated, to approximate the correct form, as with the machines previously described. After going around one side of the tooth, this adjustment has to be reversed to complete the other side, so that two operations are necessary. Fig. 143 shows the Brown & Sharpe gear-cutting machine as provided with the angular cutter slide adjustment for bevel gears, and Fig. 144 shows a Gould & Eberhardt machine arranged for the same work. Probably a greater proportion of the bevel gears made are cut on machines of this kind than in any other way. For slow running gears, the approximation, especially if the teeth are afterward filed, may be made close enough to be correct for all practical purposes. For large, high-speed gears to transmit power, one of the planing processes to be described later should be used.

In Fig. 145 is shown still another method of adapting the orthodox gear-cutting machine to the work of cutting bevel gears. The machine shown in this case is that built by the E. J. Flather Mfg. Co., of Nashua, N. H., and illustrated in Fig. 23.* The attachment consists of a supplementary work spindle connected with the main work spindle by bevel gearing in such a way that it may be adjusted to any angle, thus making it unnecessary to complicate the cutter slide and feeding mechanism. The attachment is suitable for work of small diameter, and may be applied to machines not originally designed for cutting bevel gears.

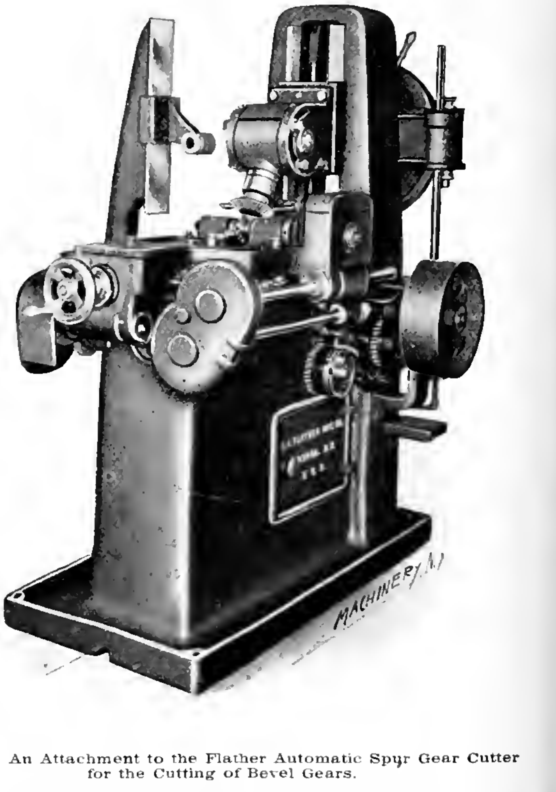


Fig. 145. An Attachment to the Flather Automatic Spur Gear Cutter for the Cutting of Bevel Gears.

The automatic idea has been carried still further in a machine developed a few years ago by the Brown & Sharpe Mfg. Co., of Providence, R. I., for cutting bevel gears for chainless bicycles. These gears were to be made in enormous quantities,

* See article "Cutting Bevel Gears with a Rotary Cutter," in the October, 1907, issue of MACHINERY.

* See "New Machinery and Tools" in the December, 1907, issue of MACHINERY.

so that the time lost in the side adjustment and the rolling of the work to bring the blank and cutter into position for cutting the other side of the teeth, after one side had been completed, consumed sufficient time to make the elimination of the operation profitable. The machine shown in Fig. 146 was therefore devised to first feed the cutter through, with the cutter and work set properly for finishing one side of the tooth;

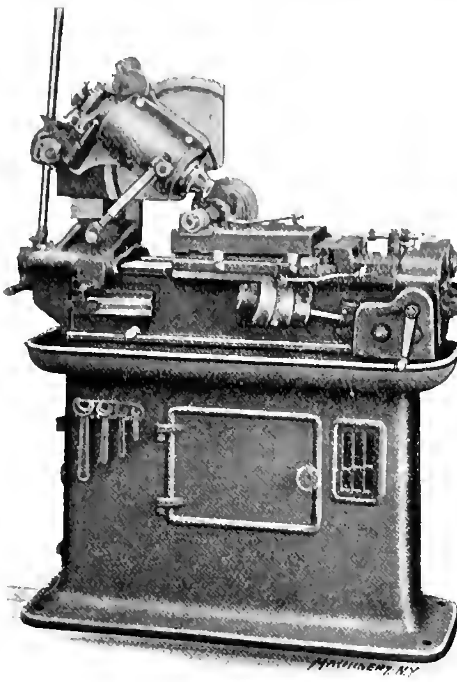


Fig. 146. A Special Bevel Gear Cutting Machine in which provision is made for Shifting the Line of Travel of the Cutter; both Sides of the Teeth are finished automatically.

when the cutter had passed through the work, the slide on which it was mounted was shifted to a different angular location, so that when it was fed backward to its starting position, the return cut operated on the opposite side of the tooth space, under conditions which finished it to the desired form. This change in angular position of the tool slide was so adjusted as to be equivalent to the rolling of the blank and the sidewise movement of the cutter or work, required in cutting bevel gears in the milling machine or automatic gear-cutter.

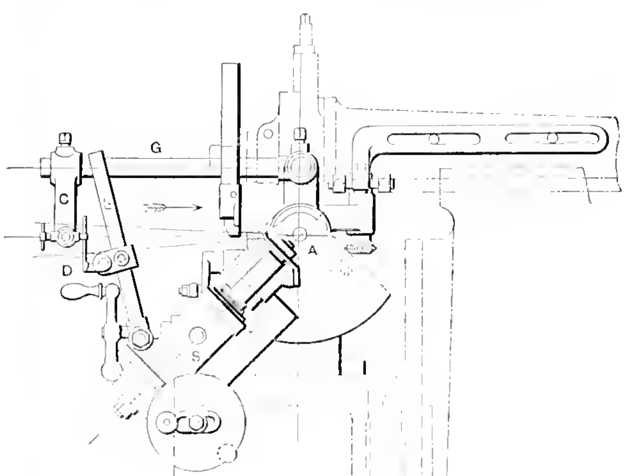


Fig. 147. A German Shaper Attachment for Forming the Teeth of Bevel Gears on the Templet Principle.

This machine indexes the work by a notched plate, stops the feed when the last tooth has been cut, and is in other ways adapted to the rapid manufacturing of gears in large quantities. The gears are afterwards finished by molding-generating process to be described later, in which the inaccuracies inherent in the formed tool principle are smoothed out. Of course, its usefulness is not limited to the bicycle field for which it was first designed.

Attachments for Forming the Teeth of Bevel Gears by the Templet Principle.

The templet principle has found a much wider commercial application for cutting bevel gears than for cutting spur gears. This is due to the fact that the formed tool method, as we have seen, is not suited to producing theoretically accurate teeth in the bevel type of gear as it does in the case of the spur, since it does not give to the teeth an outline at the small end similar to that at the large end. Since the templet process is the least complicated way of forming a tooth similar in outline from one end to the other (in other words, one whose elements vanish at the apex of the pitch cone), a number of very successful commercial machines have been built involving this principle. The first cases we will consider, however, are not complete machines, but attachments to the shaper.

In Fig. 147 is shown an attachment built by the Act.-Ges. für Schmirgel-u. Maschinen-Fabrikation, Bockenheim-Frankfurt am Main.* This is mounted on the shaper table so that the angularly adjustable head which carries the work spindle overhangs the side. The work spindle is indexed with worm and worm-wheel and index plate as in the case of the milling machine dividing head. This indexing mechanism is attached to a quill which is journaled in the work spindle head. It has adjustably mounted on its outer end a bar *B*, to which a holder is attached for supporting the templet *D*. An outer arm *C*, supported from the frame of the attachment by a

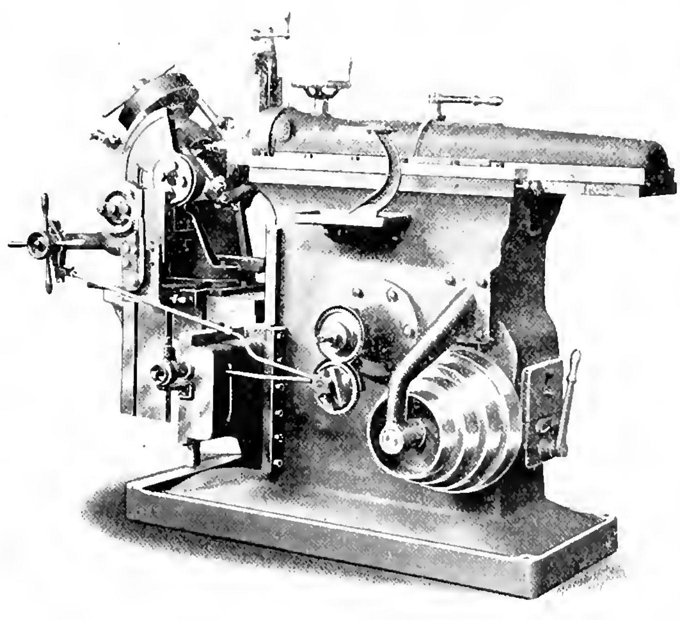


Fig. 148. An American Shaper Attachment employing a Templet for Controlling the Shape of the Bevel Gear Tooth produced.

bar *G*, carries a roll which is adapted to engage with the edges of templet *D*. The blank, in feeding, is swung up into the tool about center *A*. This swinging movement is operated by a worm and worm-wheel sector controlled by a ratchet feed. As the work is thus gradually fed up into the tool, the action of the roll on the templet will rock bar *B*, and the quill and index motion attached to it, thus swinging the work in such a way as to reproduce the outline of the templet on the outside of the tooth. The action is thus identical in its effects with that in Fig. 136, though the templet is used to control the work instead of controlling the tool.

The attachment shown clamped to the shaper table in Fig. 148 is the invention of Mr. Fred Mill, 704 Prytania Ave., Hamilton, Ohio. The design of the attachment will best be understood from the line elevations in Fig. 149. The work spindle is carried in a head *B*, which is swung on horizontal trunnions *A* in housing *C*. This housing is held by semi-circular gibs to the circular base-plate *D*, so that it may be swung about a vertical axis. The feed rod *E*, operated by the regular feed movement of the shaper, is connected through a ratchet and hand-wheel with a worm and worm gear *F*, connected by spur gear segments with the spindle head *B* in

* See article "Two German Bevel Gear Shaping Attachments" in the May, 1907, issue of MACHINERY.

such a way as to swing it about its horizontal trunnions A, and thus feed the blank up into the tool.

On the base-plate D to which the housing is gibbed, is attached a holder G to which the former or templet is fastened. The roll which bears on this templet is held in a roller slide J, which is connected with the segment gears which swing the head in such a way that, as the blank is fed upward into the work, the roller slide is fed downward, carrying the roller along the face of the templet. Since the roll and roller slide are supported by the housing C, the templet moves the housing about its vertical axis, in conjunction with the swinging of the head about its horizontal axis, so as to produce the proper shape of tooth. The roll is held in contact with the head rocks. It is possible, by providing suitable change gears between cam M and worm shaft C in place of the fixed gears shown, to use the same cam or templet M for cutting a large range of gears, it not being necessary in that case to have one for each tooth used. The principle which makes this possible was explained in a description of this attachment, previously published in MACHINERY.*

Machines for Shaping or Planing the Teeth of Bevel Gears by the Templet Principle.

In this country the templet principle is represented commercially by a single machine, that built in various sizes and designs by the Gleason Works, of Rochester, N. Y. This machine is illustrated in Fig. 151. The tool is carried by a

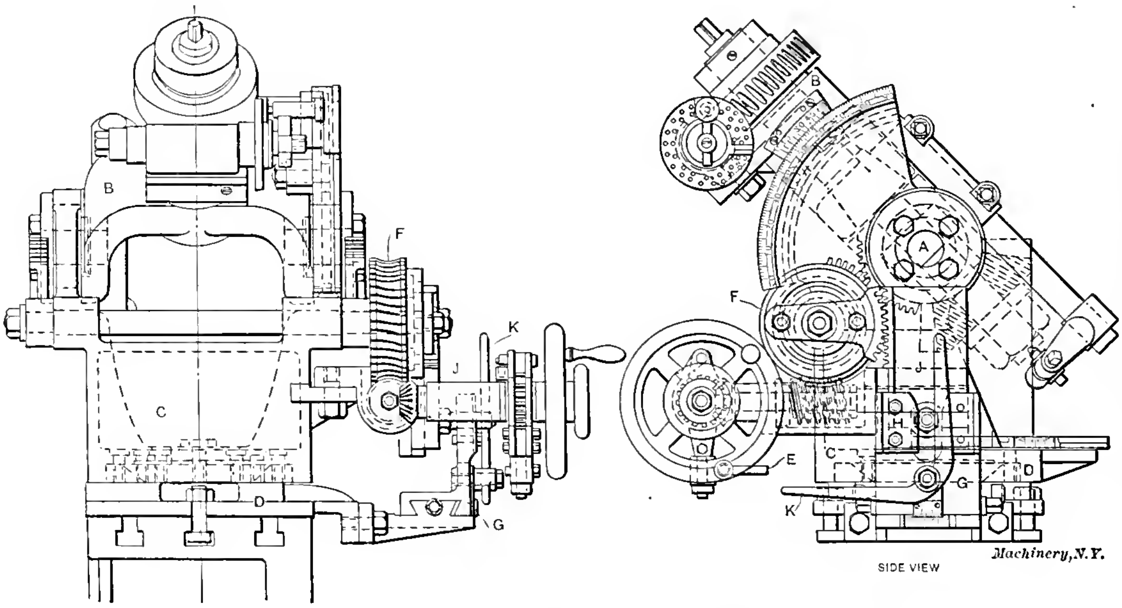


Fig. 149. Rear and Side Elevations of the Bevel Gear Shaper Attachment shown in Fig. 148.

templet by lever K, one end of which carries a weight, while the other bears on the roll stud. For shaping the other sides of the teeth, the templet is fastened on the other side of holder G, and the bent lever K is reversed so as to press the roll against the templet in its new position. A stop is provided which releases the automatic feed and quickly returns the head, so that the tool clears the work, as soon as the cut has been made to the proper depth. We understand that Mr. Mill is designing an automatic machine, operating on the same principle.

In Fig. 150 is shown a German bevel gear shaping attachment, the invention of Prof. Moritz Kroll of the Government Trade School of Pilsen. This device is also designed to be mounted on the shaper table. It has a base-plate to which are attached two standards, F and F_2, having bearings for the trunnions on head B, which may be adjusted about these trunnions to the desired cutting angle, by means of a worm, and worm sector E, fast to F_2. The work is divided by the index plate and adjustable crank shown, operating a worm meshing with the index worm-wheel on the rear end of the work spindle A. This index mechanism is supported on an arm, whose lower forked end is seen at I. The contact points on either side of this arm, as desired, may be made to bear under spring pressure on cam M, which is pinned to gear Q, in mesh with gear D, which is in turn keyed to the shaft C, carrying the worm engaging with sector E. All this mechanism is mounted on swinging head B, excepting E, which is pinned to standard F_2. From this it will be seen that the work may be swung up into the shaper tool about the trunnions on head B by operating shaft C.

As the work is thus swung upward, gear Q is revolved, and with it cam or templet M, which rocks the lower end of lever I, and with it, the work. Templet M is so shaped that this rocking movement, in conjunction with the upward swinging of the blank, causes the point of the tool in the shaper to produce the required outline of tooth. In this, as in the previous cases, the point of the tool is set to travel along a line which, if produced, would meet the intersection of the axis of the work spindle and the axis of the trunnions, about which the holder reciprocated by an adjustable, quick-return crank motion. The slide which carries this tool-holder may be swung in a vertical plane about the horizontal axis on which it is pivoted to the head, which carries the whole mechanism of tool-holder, slide, crank, driving gearing, etc. This head, in turn, may be swung in a vertical axis about a pivot in the bed. The circular ways which guide this movement are easily seen in the illustration. The intersection of the ver-

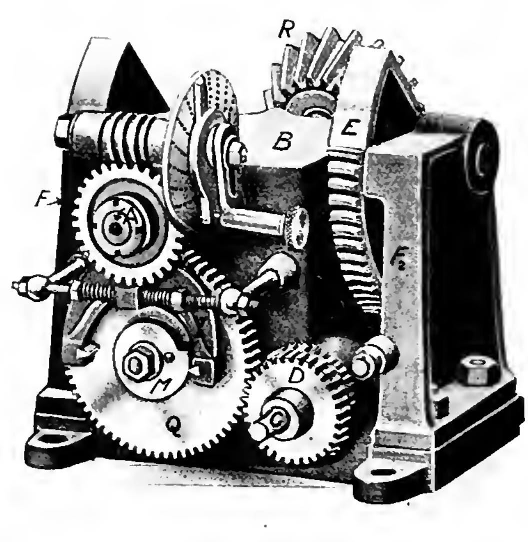


Fig. 150. Shaper Attachment devised by Professor Kroll, in which a Circular Templet is used for Forming the Teeth of Bevel Gears.

tical and horizontal axes of adjustment (which takes place in mid air in front of the tool slide) is the point O in Fig. 136, where the templet principle is shown in diagrammatic form. The apex of the pitch cone of the bevel gear must be brought to this point O. The blank is mounted on a spindle carried by a head which is adjustable in and out on the top of the

* See article "Two German Bevel Gear Shaping Attachments" in the May, 1907, issue of MACHINERY.

bed of the machine so that the apex of the cone of the gear may be brought to this point by means of the gages which are a part of the equipment of the machine. The work spindle is provided with an indexing mechanism, which operates automatically, as do all the other functions of the machine.

Three templets are used, mounted in a holder attached to the front of the bed, on the opposite side from that shown. The first of these templets is for "stocking" or roughing out the tooth spaces. It is simply a horizontal straight-edge on which rests a roller, attached to the outer end of the slide on which the tool-holder reciprocates. With the work and tool set properly, the whole tool-carrying head is swiveled about the vertical axis, feeding in at each stroke of the blade deeper and deeper, until the space has been properly roughed out. After each tooth space has been gashed in this fashion, the templet holder is revolved to bring one of the formed templets into position, and a tool is set in the holder so that its point bears the same relation to the shape of the tooth desired as the cam roll does to the templet. The head is again fed in by swinging it around its vertical axis, during which movement the roll runs up on the stationary templet, swinging the tool about its horizontal axis in such a way as to duplicate the desired form on the tooth of the gear. One side of each tooth being thus shaped entirely around, the holder is again revolved to bring the third templet into position. This has a reverse form from the preceding one adapted to cutting the other side of the tooth. A tool with a cutting point facing the other way being inserted in the holder, each tooth of the gear has its second side formed automatically, as before, completing the gear.

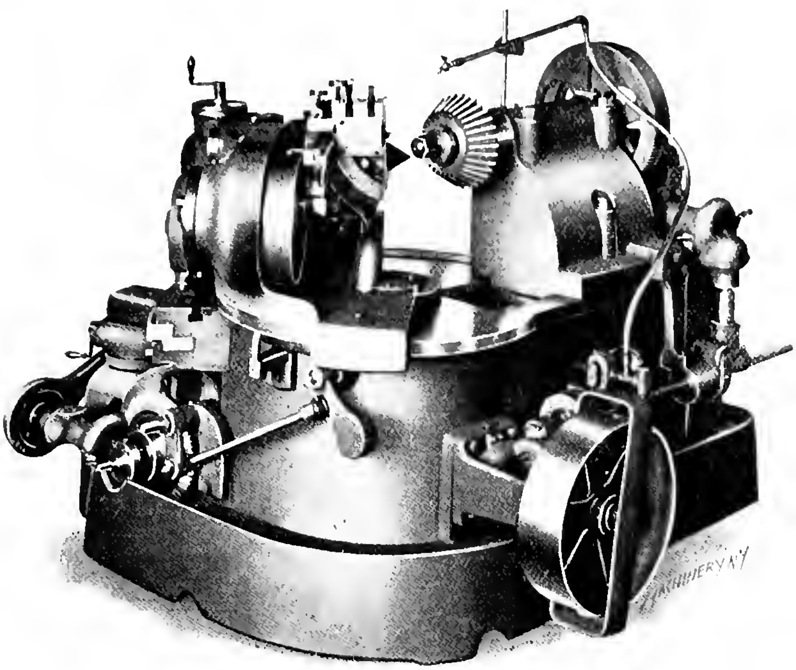


Fig. 151. Gleason Templet-controlled Bevel Gear Planing Machine.

The swinging movement for feeding the tool and the indexing of the work are taken care of by the mechanism of the machine without attention on the part of the operator. The swinging feeding movement about the vertical axis is effected by a cam and slotted link motion which may be adjusted to any degree of angular movement required. The head may be angularly adjusted with respect to its feed to agree with the pitch angle of the gear being cut. This is a more recent design than the last machine of this kind that was illustrated in MACHINERY,* differing from it particularly in the feeding arrangement. That previously shown was fed in to depth by a segment of a worm-wheel operated by a feed motion which could be given a forward movement for any required depth of cut, and a quick return, which was again reversed as soon as the indexing took place.

A French machine, built by Usines Bouhey, 43 Avenue Daumesnil, Paris, is shown in Fig. 152. While it operates on the templet principle, the movement for producing the desired outline is somewhat different from that employed in the Gleason machine, previously described. Instead of applying the movement derived from the templet to the tool, it is applied to the work, in a manner which will be evident from the illustration and the following description:

The cutting tool is carried by an overhanging arm, at the top of the frame, operated by the slotted crank shown. The work spindle carrying the wheel to be cut, the indexing worm-wheel, automatic dividing apparatus, etc., are carried on brackets attached to a swinging sector. The work spindle is so arranged that it may be adjusted longitudinally, to bring it into coincidence with the axis about which the sector is adjusted. The indexing mechanism is attached to a frame which is free to swing under the influence of the templet, which is attached to the upper end of an adjustable arm carried by this frame, and is located in a position to bear on a fixed guiding plate supported by the bed of the machine. It is held in contact with it by a weight and cord.

The action is as follows: The wheel, properly mounted on its arbor, is swung upward toward the reciprocating tool by a worm feed movement, applied to worm-wheel teeth cut in the periphery of the sector. While this angular feeding movement is in progress, a variable rocking is imparted to the entire indexing mechanism, work spindle and work, through the action of the templet on the stationary guide plate. It is this variable motion, controlled by the templet, which produces the desired outline on the tooth. When the correct depth of tooth has been reached, the feed is automatically tripped and the sector returned to its original position. The work is then indexed, the forward feed automatically re-engaged, and the cycle of operations continued until all the teeth are finished on that side, and the machine is stopped by the operator, and reversed for completing the teeth.

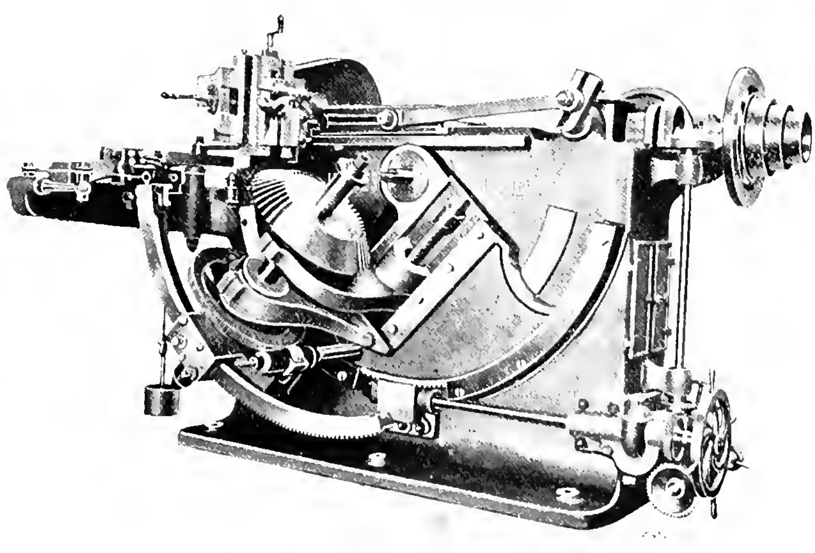


Fig. 152. The Bouhey Templet Planing Machine, in which Provision is made for the Cutting of Twisted Teeth.

A unique provision of this machine is that made for cutting bevel gears with twisted teeth, as shown in Fig. 152. It consists simply in providing for a positive connection between the indexing mechanism and the crank-shaft driving the tool slide, through the medium of change gears, so that the work and crank rotate in unison at the proper ratio to give the

* See article "Cutting Bevel Gears with Correct Teeth" in the June, 1898, issue of MACHINERY.

number of teeth desired in the work. Since the stroke then takes place while the work is rotating, a twisted form of tooth is produced. This tooth has the same shape (when seen at the ends) as when a straight tooth is being cut by the usual method. For cutting another gear of any angle to mesh with a gear cut this way—such, for instance, as the one shown in the engraving—it is only necessary to reverse the connection between the crank and the work so that rotation takes places in the opposite direction, and to set the slide and the templet for the new angle and the new tooth. This being done and the length of the stroke being the same, the teeth cut will exactly correspond in curvature with those previously cut in the mating gear.

Twisted tooth bevel gears are almost unknown in America, but have found considerable favor in Europe, where twisted tooth gearing of various kinds is in much greater favor than here. The teeth of gears thus made are not made to a true conical helix, since the motion is modified by the crank movement. All that is required, however, is that the curves of the gear and pinion should be such that the teeth of each will bear evenly on the other. This requirement is met in this machine.

An English machine, built by Greenwood & Batley, Ltd., Albion Works, Leeds, is shown in Fig. 153. The action and general arrangement of the machine are almost identical with that of the previous machine, excepting that no provision is here made for cutting twisted teeth. A comparison of the two tools serves well to show the wide variation in details resulting when two designers, independently work out the same idea. Aside from the difference in details, there are two salient changes in the mechanism. One of these relates to the feed, which is of the ratchet type, driven from a slotted disk. The other change relates to the mounting of the head, which is carried on two superimposed swiveling sectors, which pivot on a common center whose axis meets the line of travel

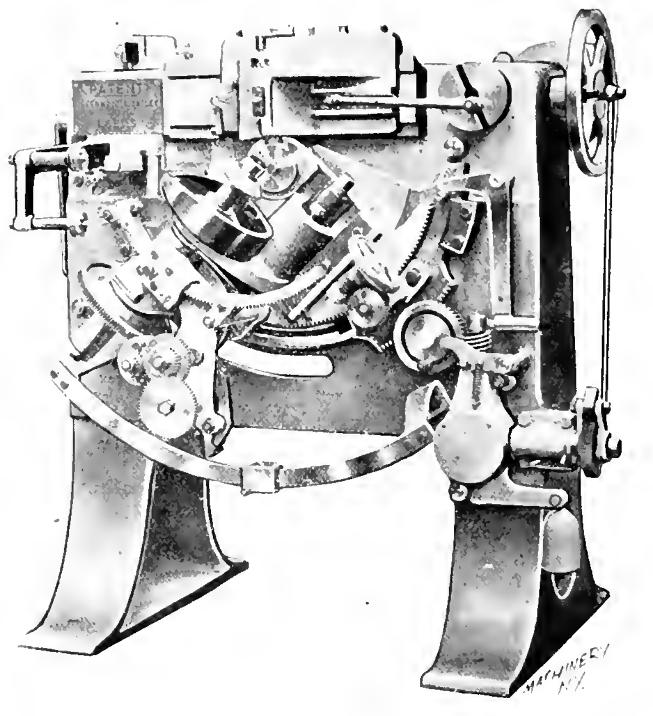


Fig 153 The Greenwood & Batley Templet Bevel Gear Shaping Machine.

of the cutting tool. The outer sector is adjustable on the face of the inner one to suit the angle of the wheel being cut, while the feed movement is applied to the latter. Except for the particulars enumerated, the action is identical with that of the Bouhey machine.

In Fig. 154 is shown still another machine with the same relations between the tool, the work and the templet. As may be seen, however, the design is so different that there is no resemblance between it and those shown in Figs. 152 and 153. The tool is carried by a ram reciprocated by a mechanism similar to that used in a crank-driven shaper; the whole arrangement of the machine, in fact, resembles that of a shaper and is structurally derived from it. The work is carried on a spindle mounted in a frame hung about a horizontal axis from pivots seated in the arms shown projecting from either side of the head of the machine. The work is adjusted on the arbor to bring the apex of the pitch cone into the horizontal axis through the trunnions. A rigid outboard support for the work arbor is furnished, as shown.

The frame carrying the work is swung upward for feeding about the horizontal trunnions by a feed movement operated by the tooth sectors shown on each side, which are engaged by pinions on a horizontal shaft, connected, in turn, by gearing with a ratchet disk seen at the side of the head. From this

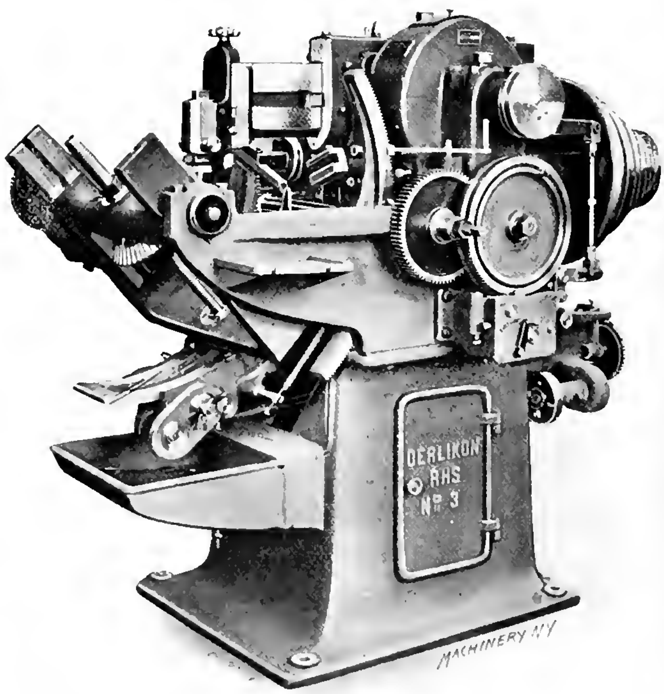


Fig. 154. The Oerlikon Single-tool Templet Bevel Gear Shaper.

the feed movement is obtained. Stops are provided on the face of the disk which limit the swinging feed movement, and actuate mechanism for returning the work rapidly when the cut has been completed, so that the tool is clear for indexing the blank. When the indexing has taken place, the upward feed is again automatically thrown in. As in the Greenwood & Batley machine, the entire dividing mechanism is attached to a bracket carrying an adjustable arm to the upper end of which the templet is attached. By means of springs this templet may be caused to bear on adjustable contact surfaces at either side, depending on which side of the tooth is being cut. The templet, bearing on the guide attached to the head of the machine on the side farthest from the observer, is somewhat imperfectly shown in the engraving.

We think it will be agreed that this tool gives evidences of careful design and construction. It has a decidedly rugged and business-like look. It is built by the Societe Suisse pour la Construction de Machines-Outils Oerlikon, Oerlikon près Zurich, Switzerland.

* * *

The United States Navy Department has decided to install oil-burning apparatus on two of the five torpedo-boat destroyers which are now being constructed by Cramp & Sons, the Bath Iron Works, and the New York Ship Building Company. Some weeks ago, Secretary Metcalf decided that it would be advantageous to have these boats equipped for burning oil instead of coal. The practicability of extending this system to torpedo-boat destroyers already in service has been talked of, and such a change carefully considered by experts, who have come to the conclusion that it would be impracticable to convert into oil-burning craft torpedo-boat destroyers already completed. Aside from the expense which such a change would entail, it was found that the installation of such apparatus would involve much work in the way of alterations, and this could only be done under great difficulty.

SPECIAL MACHINES AND TOOLS USED IN UPRIGHT DRILL MANUFACTURE.

One of the thriving cities of the Middle West—Rockford, Ill. —has acquired considerable distinction within the past few years as a machine tool manufacturing town. Six concerns building lathes, planers, drilling machines, milling machines and shapers are now located there; but machine tool building is by no means a new development in Rockford. One of the oldest concerns in the United States is the W. F. & John Barnes Co., builder of foot-power lathes, foot-power wood-working machinery and upright drilling machines. From this concern three other machine tool companies in Rockford have developed, these being the Rockford Drilling Machine Co. (formerly B. F. Barnes Co.), the Barnes Drill Co, and the Mechanics Machine Co.

The lively competition existing in the manufacture of upright drilling machines has led to the development of many interesting time- and labor-saving devices in the Rockford shops, which are largely used on drill presses. The following article relates to the shop practice of the Rockford Drilling Machine Co., and the special tools illustrated and described are to a large extent the result of the ingenuity and resourcefulness of Mr. R. Milne, the superintendent. The devices which are adapted to the drill press make good object lessons to the intending purchasers, showing them to what extent this humble machine can be used for manufacturing parts that are commonly done on much more costly tools.

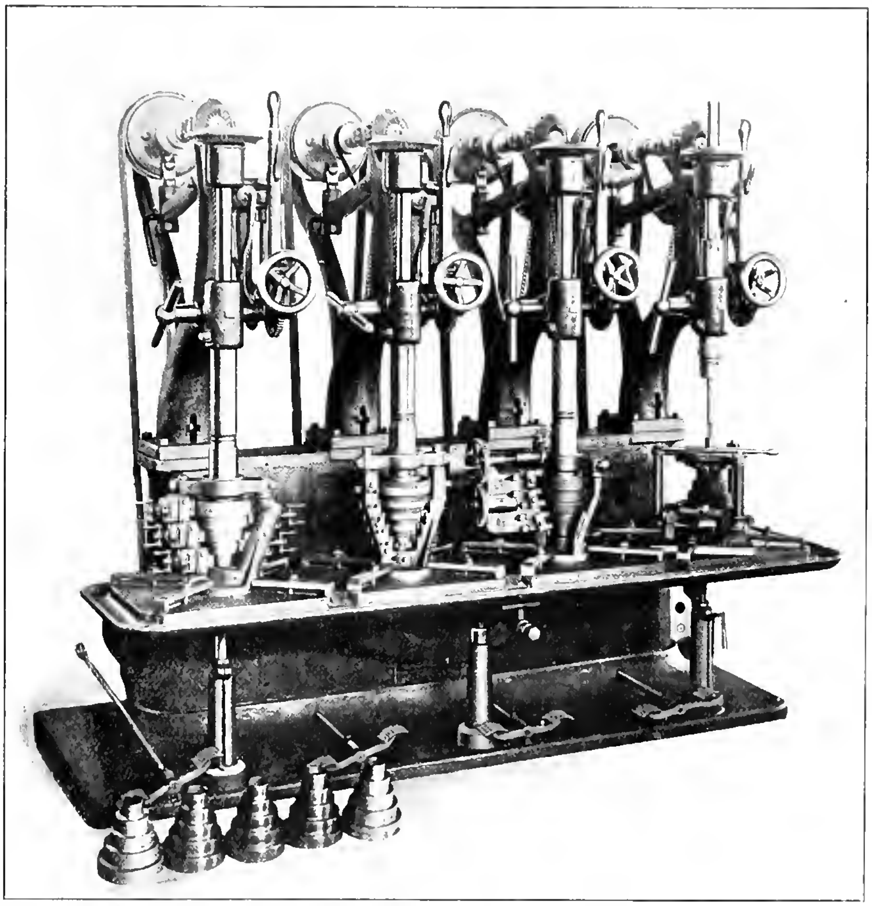


Fig. 1. Set of Tools used on Gang Drill for Boring and Turning Cone Pulleys.

Figs. 1, 2, 3, 4, and 5 are examples in point. Fig. 2 illustrates a cam-cutting attachment for cutting a special cam used in a certain style of drill press. This cam operates the feed motion of the drill spindle through ratchets. The construction of the rig for cutting the cam A is quite plainly shown in the engraving. A small gear is mounted on the lower part of the drill spindle, which drives a train of gears and worm-wheels. The first worm B and worm-wheel gives the rotary motion to the mandrel on which the cam is mounted, and the second worm-wheel driven by gear C operates the crank-shaft D, to which the slide mounted on the base E is attached by the connecting-rod shown in front. This slide reciprocates the cam underneath the end mill mounted in the drill spindle, and thus generates the required curve. The machine operates automatically, the regular feed of the drill press moving the end mill downward until the required depth is reached, when an automatic throw-out stops the feed.

Fig. 1 is another illustration of unusual drilling machine work, a set of special tools being provided for finishing small cone pulleys. The rough casting is mounted in a jig, as shown at the right, and the spindle hole is bored out, the boring tool being supported by a bushing in the top of the jig. The casting is then reversed and placed in the next jig at the left, on which is mounted a set of turning tools. As the casting is revolved, these tools face the edges of the cone steps, the feed being automatically effected by the mechanism. The next step is turning the faces of the pulleys. This jig is simpler in construction. The casting is fed downward past the turning tools held in the sides of the yoke. When this operation is finished, the steps have been turned straight. The jig at the extreme left is for coning the steps, the tools being forming tools, which are fed by hand.

Fig. 3 illustrates a drill press jig for boring pulleys. It consists of a base in which are vertically mounted three square-thread screws which act as the supports for the top plate carrying the guide bushing. The movable part of the jig is operated by three hand-wheels connected by a bicycle chain running on sprockets and held closely in contact with the sprocket by adjustable idlers. A novel feature of the jig is the jaws clamping the edges of the pulley rim. These jaws are notched in vee shape, and grasp the pulley rim internally at the top and externally at the bottom in the example shown, but a larger or smaller size would be grasped in reverse manner by the upper and lower jaws. The jig is adapted to pulleys of all sizes within its capacity, the notched jaws holding any size pulley within these limits concentric with the central hole.

Fig. 5 is a simple rig applied to a 26-inch drill for boring drill spindles. The drill is held stationary, being mounted on the table, and is of the oil tube variety. The lips are ground to cut left-handed in order to accommodate the drill to the left-hand rotation of the work. A gear is mounted on the lower end of the drill spindle, which drives a gear mounted on a sleeve in which the spindle to be bored is chucked. Lubricant is forced to the point of the drill and chips and oil are forced downward onto the table. The rig is very cheap and effective in operation. It consists essentially of only two castings, and the rotary sleeve, together with the chuck, clamping screws and driving gears.

Fig. 4 shows a set of tools used on a gang drill for boring and finishing collars. The rough casting is first caught in the three-jawed chuck at the right, and reamed and faced. It is then removed to the center fixture, which has an expanding arbor worked by the nut beneath. The arbor is expanded inside the bore and holds the casting firmly for the rough turning operation performed by the tool shown above it. The finishing operation is conducted in the same way, the bushing being held in the same manner and turned by a finishing tool of the same style as the roughing tool.

Figs. 7 and 8 show two views of a novel machine for cutting oil grooves in loose pulleys and cone pulleys. A loose pulley A is shown in place in the chuck B in Fig. 7, and the end of the cutting bar is shown projecting through the bore in the hub. The chuck used for holding loose pulleys consists of two sectors B B turned with concentric grooves to suit the various diameters of pulley rims. The handle H, shown in front in Fig. 8, loosens and tightens the frame holding these sectors.

The pulley is placed in position in the sectors, and by tightening the handle they are made to grip the pulley rim firmly. For small work, a three-jawed chuck G mounted on a plate, shown leaning against the base in Fig. 7, is employed. For

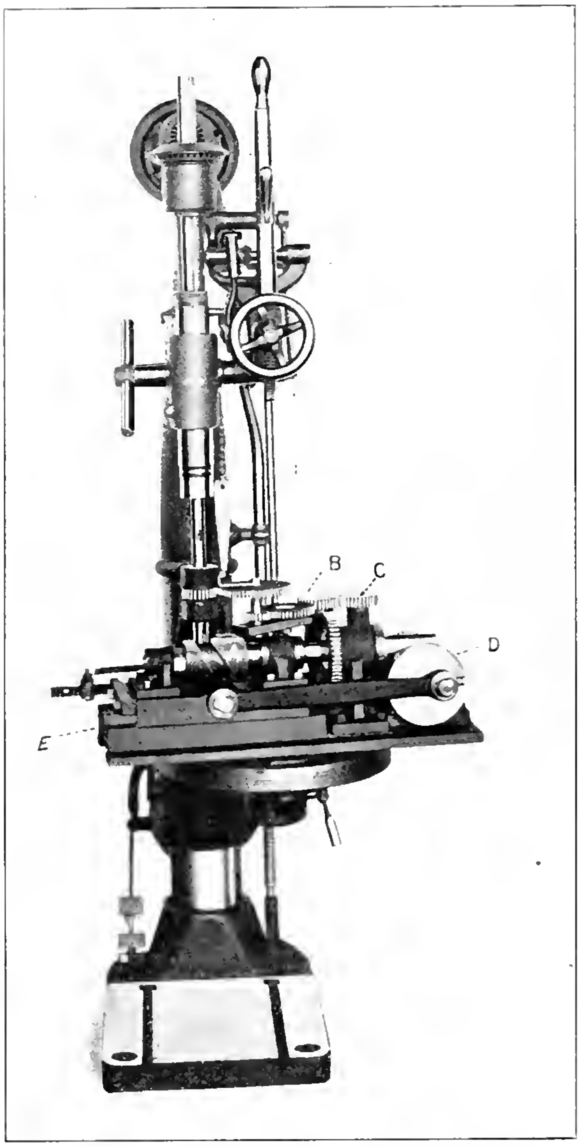


Fig 2. Cam-cutting Machine used on Upright Drill

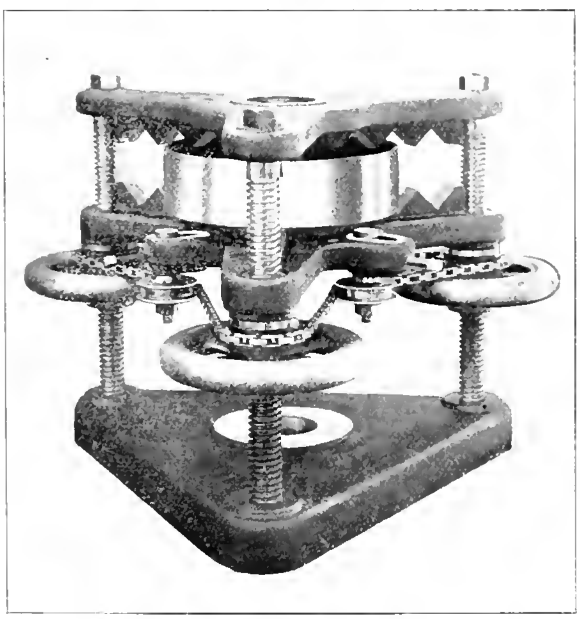


Fig. 3. Jig for Boring Pulleys.

cone pulleys the rig used for cutting loose pulleys is employed, and the adjustable support E, shown underneath, is used to support the outer end of the cone. The action of the cutting tool is a combination of reciprocating and up-and-down movements, as is required for cutting a key-seat deepest in the center. The cutter bar F is mounted on trunnions on a slide, and the rear end C is pivoted to the end of a connecting-rod D, also mounted on trunnions in a second slide. This connect-

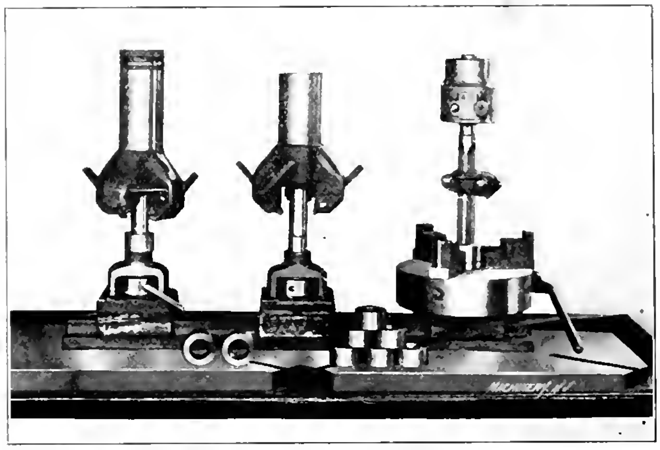


Fig. 4. Jigs for Boring and Turning Collars.

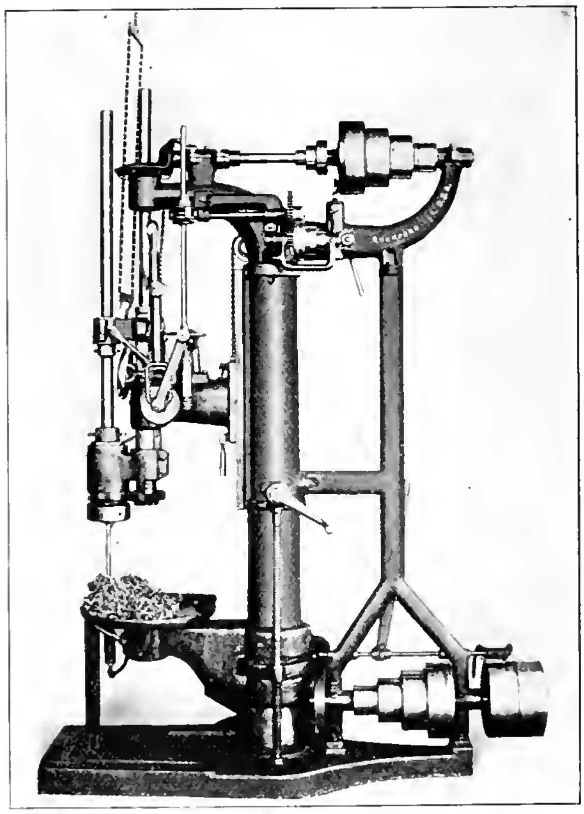


Fig. 5. Attachment for Boring Drill Spindles.

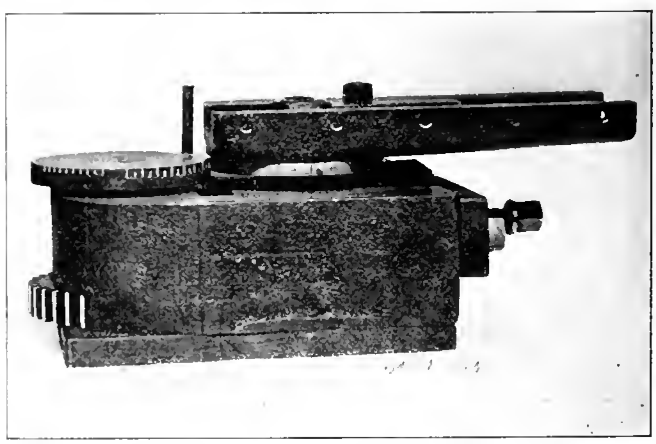


Fig. 6. Jig for Graduating Compound Rests, with Hob.

ing-rod is driven by a slotted crank disk, the stroke thus being made adjustable. The point of connection of the cutter bar to the end of the connecting-rod may be varied by changing the position of the cutter-bar pivot in the connecting-rod

T-slot. Thus the length of the stroke may be adjusted by changing the position of the crank-pin in the slotted crank disk, and the up-and-down movement of the cutter bar is adjusted by changing the location of the pin connecting it to the end of the connecting-rod. The depth of an oil groove is not necessarily a widely varying dimension, but the fact that the depth produced by the mechanism depends on the length of stroke, makes it necessary to change the up-and-down motion whenever the position of the crank-pin is changed on the crank disk. This machine is rapid in operation.

The graduations on the drill sleeves or quills are rolled in by a special device. The lines are raised on the barrel of a hardened rotary die, and this die is geared to a reciprocating table in which the quill is firmly fixed. One pass of the quill underneath the die imprints the graduations. The quill is then transferred to a simple hand jig, and located therein so that ordinary figure dies mounted in square slots will be in position corresponding to the inch graduations. These numbers are successively struck with a hammer, thus sinking the numbers into the quill. A hardened die or hob is also employed for rolling the graduations into the edge of lathe com-

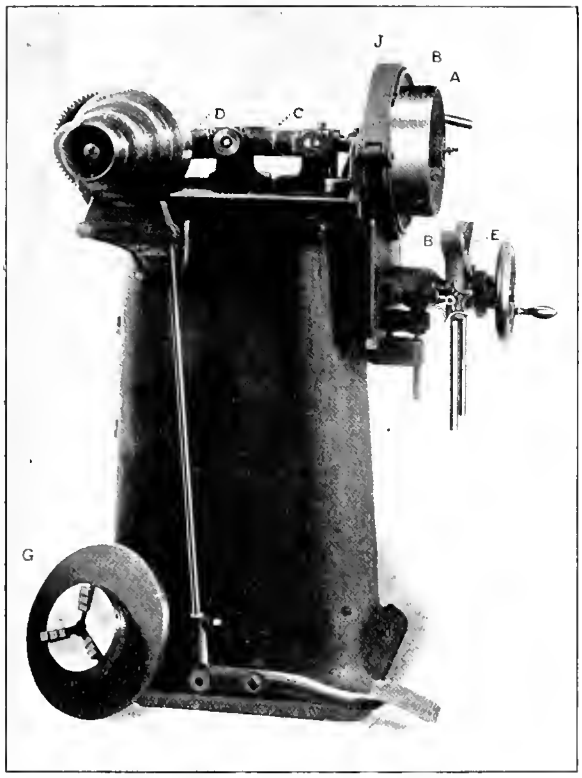


Fig. 7. Keyway-cutting Machine.

pound rests. One rotation does the work. The hob or die is mounted on a spindle which is geared to the face-plate on which the compound rest is mounted, the two thus being made to rotate together positively. See Fig. 6. A variation in diameter of 1/32 inch does not affect the accuracy of the graduations produced, as the gears force the compound rest and the hob to rotate in unison with the rotation of the gears driving them. In other words, the turning of the compound rest is not effected by the hob, but by the gear mounted on the face-plate spindle.

Fig. 9 shows a keyseater which was made from a drilling machine frame, with a few changes in the pattern. The vertical ram which takes the place of the drill spindle in a drilling machine, is operated by a walking-beam having slotted joint connections for the ram and the connecting-rod slide. The crank-shaft is driven by a pinion belted to the cone pulley at the top of the machine. It will be observed that the changes required to convert a drilling machine into a vertical slotter were comparatively small. The machine works very effectively and rapidly. It is employed for keyseating the gears and pulleys, the work being mounted on a table having hand-fed adjustment. The machine works so rapidly that the greater part of the operator's time is taken up in clamping the work in place and removing it from the machine.

The machine shop and foundry buildings are built parallel, along the side of a low bank, the foundry being placed next to the bank and a railroad switch on the bank enables pig iron, sand, coal, coke, etc., to be delivered to the foundry by gravity. The space between the foundry building and the ma-

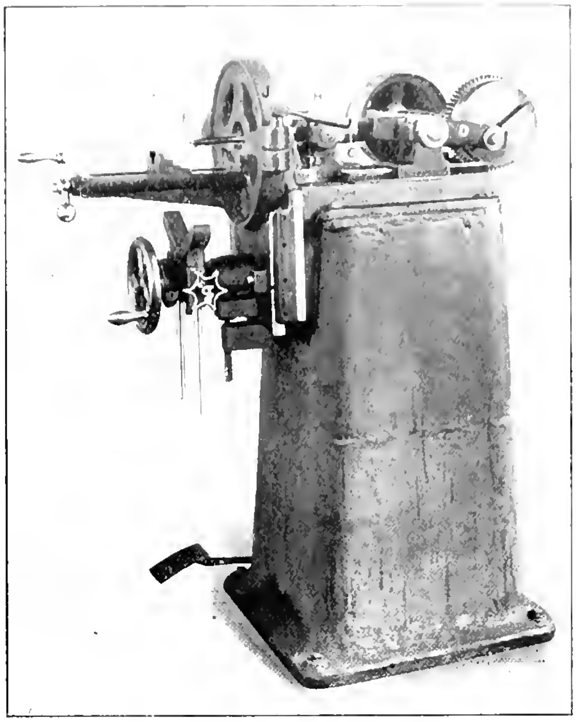


Fig. 8 Keyway-cutting Machine.

chine shop building was lately covered over, converting the space into an ideal castings court. This is illustrated in Fig. 10. A feature of interest is the crane provision made for transferring the castings from the foundry to the castings court. The foundry is provided with a hand traveling crane of the same type as that indicated in Fig. 10, having an I-beam girder for supporting the trolley. At various points in

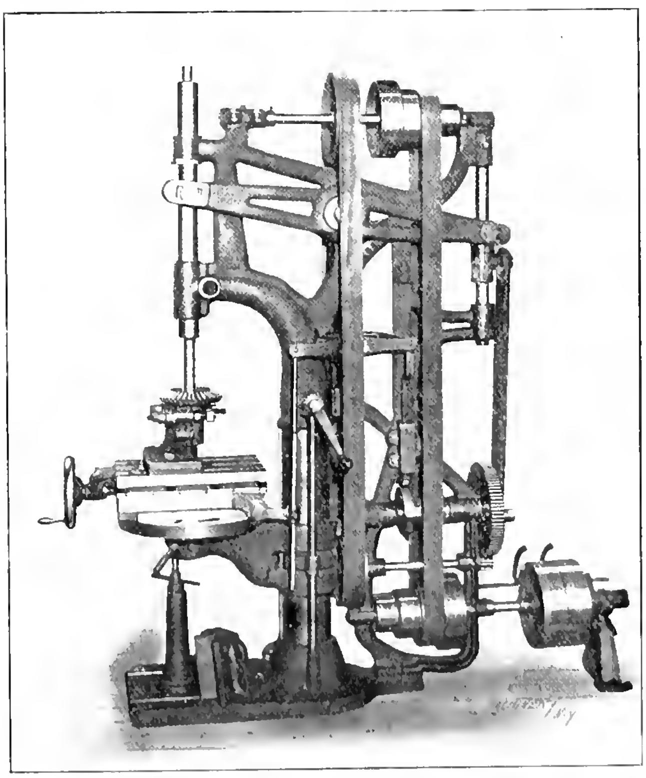


Fig. 9. Keyseater built on Drill Press Frame.

the foundry the I-beam girders are erected at right angles to the crane runway so as to be directly in line with the crane girder. With this arrangement the crane trolley can be run from the traveling crane to the stationary girder tracks and the load deposited or picked up at almost all points in the

foundry. The same arrangement provides connection with the castings court. A casting can be picked up in a far corner of the foundry, transferred to the foundry crane and carried along until opposite the opening leading to the castings court, where it is transferred to the castings court crane and then deposited in the castings court. Automatic safety devices are provided which prevent the trolley running off the end of the crane girder, except when opposite the girder runways, and when the transfer is taking place the crane is locked in position.

The system of keeping stock parts in the erecting shop is a radical departure from the systems in common use in most manufacturing plants. Instead of keeping machine parts in

Fig. 10. Castings Court between Machine Shop and Foundry.

a storeroom under the charge of a storekeeper, they are stored in metallic bins made by the Lyon Metallic Mfg. Co., located under the work benches. These bins extend nearly the whole length of the shop, and are about 1,100 in number. The stock is freely accessible to the men, no requisitions being necessary. The storekeeper takes an inventory of a certain number every day, and in six months has inventoried the whole stock. The loss of parts that cannot be accounted for is stated to be so small as to be practically negligible. Jigs and fixtures are also stored in the machine shop bay, where they are in charge of the sub-foremen. The jigs are kept in metallic lockers having wire screen doors of large mesh. The contents of each locker are plainly visible, and ordinarily the machine men are free to get any jigs that they require. The system of manufacture is such that the men act as their own inspectors of jigs and fixtures, and defects are promptly reported to the toolmaking department for correction.

* * *

The following statements by Mr. Marconi, made at the general meeting of the Marconi Wireless Telegraph Co., in London, this spring are of interest as indicating the progress of wireless transatlantic telegraphy. The seven and one-half months' experience since the transatlantic service was inaugurated, has shown that obstacles which many regarded as insurmountable, such as the interference with other stations, and the difficulty of transmitting messages for long distances during the day-time, have been overcome. For some months past the majority of the messages have been carried across the ocean during the day-time, and no interference whatever has been caused by the operation of the powerful long distance transatlantic stations with the working of the ship-to-shore communications. A speed of as high as 24 words per minute has been achieved. Mr. Marconi also states that with slight modifications of the details of the apparatus, at a very small cost, a speed of at least 30 words per minute can be obtained. Recent developments also make it possible to effect duplex working between wireless stations; that is, each station will be able to send and receive messages simultaneously.

SPECIAL TOOLS IN THE ROCKFORD MACHINE TOOL CO.'S SHOP.

The following illustrations show some special machines designed and built by the Rockford Machine Tool Co., Rockford, Ill., to facilitate the manufacture of shapers and planers, which are its product.

Feeling the need for an efficient and low-priced vertical milling machine, two were improvised from the regular shaping machines built by the company, by making the changes partially shown in Fig. 1. The tool slide on the end of the ram is replaced by the cutter spindle and its driving gear. The ram is adjusted in and out by the crank on the ram stud. This, it will be noted, is the regular arrangement for changing the relative position of the ram in its stroke when used as a shaper. The feed mechanism is belted to the counter-shaft by a separate belt, and thus works independently of the drive. Four changes of feed are provided, with reverse. The sliding pinion on the cross feed screw can be slipped onto the elevating shaft and the table fed up or down, if desired. The machine is driven by two counter-shafts and cone pulleys, giving five spindle speeds. As stated at the beginning, two of these machines are in use, and they have proved to be very satisfactory. They are used for milling T-slots and doing much other milling required in the manufacture of shaper parts. One of the uses that has been profitable is milling dovetail slides, suitable fixtures being provided for chucking the work quickly and accurately so as to preserve the standard angle. The machine will carry a 5-inch face mill and drive it efficiently.

Figs. 2, 3 and 4 show a home-made graduating machine that does good work at a high rate of speed. Fig. 2 shows the

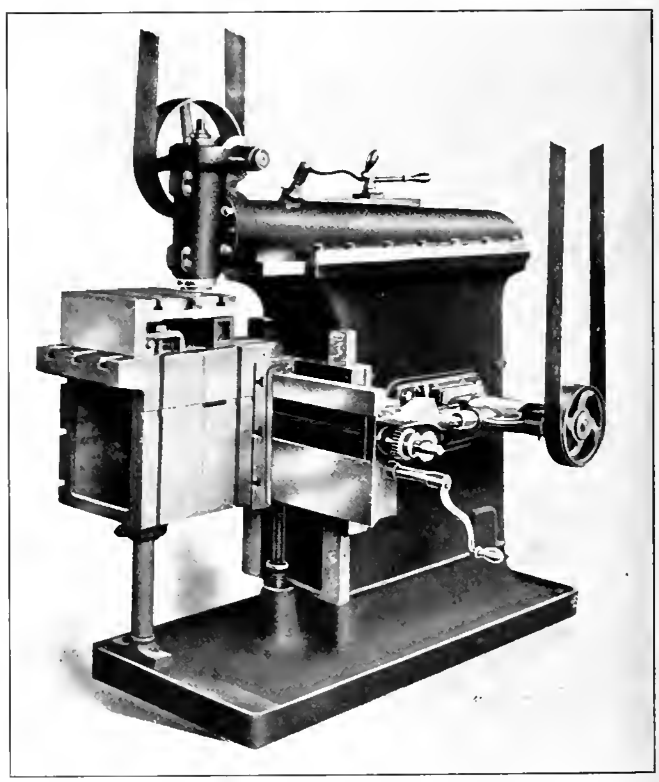


Fig. 1. Shaper converted into a Vertical Milling Machine.

machine set up for graduating the bases of the company's regular swivel base shaper vise, while Fig. 3 shows it in use graduating the saddle of a 28-inch Rockford planer. Figs. 5 and 6 indicate the character of the work done on vise base and planer saddle. It will be understood, of course, that in one case the graduations are made on the cylindrical surface of the swivel base, and in the other case the graduations are radial, being made on the face of the saddle. The machine will graduate along the edge of work ranging from ¾ to 36 inches diameter. The planer saddle shown on the machine in Fig. 4, is graduated all around the circle, and it requires only about 1½ minute's time to complete the work. An automatic trip is provided which stops the work from turning further when the exact number of graduations have been

made for which the machine is set. This feature takes care of such work as shaper vise bases and swivel plates for the head which are graduated from 90 to 180 degrees. The construction of the machine is simple, and as plainly shown, it is operated by hand. The hand-wheel shaft carries a bevel gear driving a bevel pinion operating the ratchet feed. On the end of the hand-wheel shaft is a cam having five projections. This cam operates a plunger, retracted by a coil spring. One of the cam projections is longer than the others,

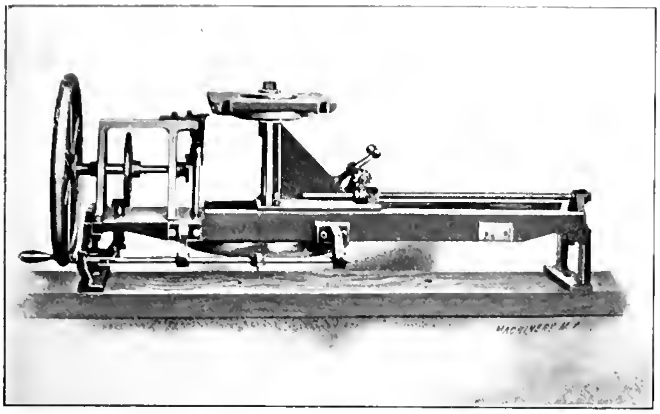


Fig. 2. Home-made Graduating Machine graduating Base of Swivel Vise.

thus making the long graduation mark required to distinguish every fifth degree position. The graduating tool is a sharp pointed piece of steel mounted on top of the plunger, as indicated in Fig. 2, for graduating along the edge of work. The bevel gears operating the indexing mechanism are in the ratio of 5 to 1, and the crank working the indexing lever is adjustable, thus permitting one or more notches to be engaged by the ratchet. This makes it possible to cut graduated collars to suit various pitches of screws, with the same index plate.

When cutting graduations on a flat surface, as indicated in Fig. 3, a different arrangement of the cutting tools is obviously required. In this case it is necessary to provide release for the tool in order to clear the work as it indexes. In the illustration the cutting tool is shown clear of the work,

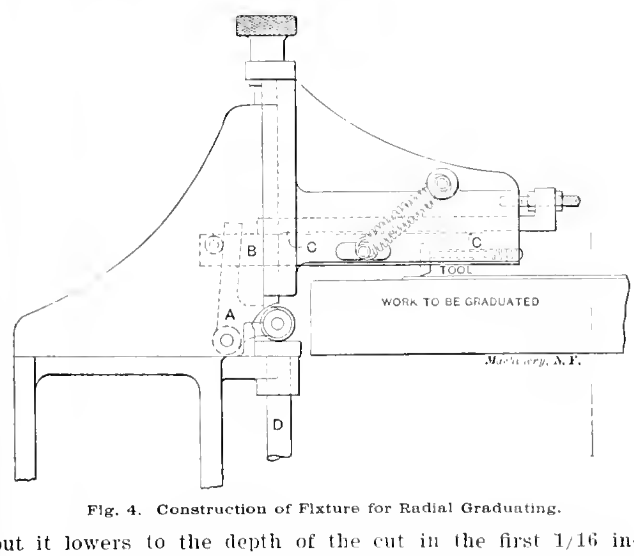


Fig. 4. Construction of Fixture for Radial Graduating.

but it lowers to the depth of the cut in the first 1/16 inch of the movement, and then moves in a parallel line to the end of the cut, when it automatically raises clear of the work and is brought back to the starting point by two springs, one of which is shown in an inclined position on the horizontal part. This release motion is effected by a simple mechanism under the slide.

The construction of the release motion is shown in the line illustration, Fig. 4. The vertical plunger D operates a bell-crank lever A, and this in turn operates a cutter slide B by working against a small roller mounted in the slide. This construction permits the tool to be adjusted vertically to the work by a screw and knurled knob on top of the fixture, and vertical adjustment of about 1 inch is thus provided. The engraving also shows the relief motion for the cutter slide, this being effected by a raised portion C about 1/32 inch high at each end of the slide. The illustration shows the cutter slide at the end of the stroke, with the tool clearing the work. On the first 1/16 inch movement of the cutter slide it moves up onto the incline, forcing the tool into the cut, then travels along to the end of the cut, and then is carried back to its starting point by the springs. The springs thus serve to hold the cutter slide up as well as to bring it back to the starting position.

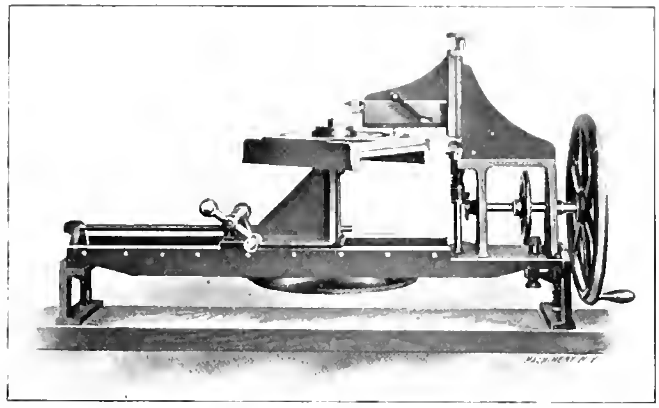


Fig. 3. Machine graduating Planer Saddle.

The index plates have been made accurate, and are 20 inches in diameter. A number have been provided to suit the various divisions required. The adjustment of the machine for circles of varying diameters is simply effected by means of the horizontal slide and screw which is worked by a revolving nut operated by a handle, through spiral gears. The machine, of course, could be arranged to be power driven, but the short time required for graduating a full circle and the small amount of power required to operate it make power unnecessary.

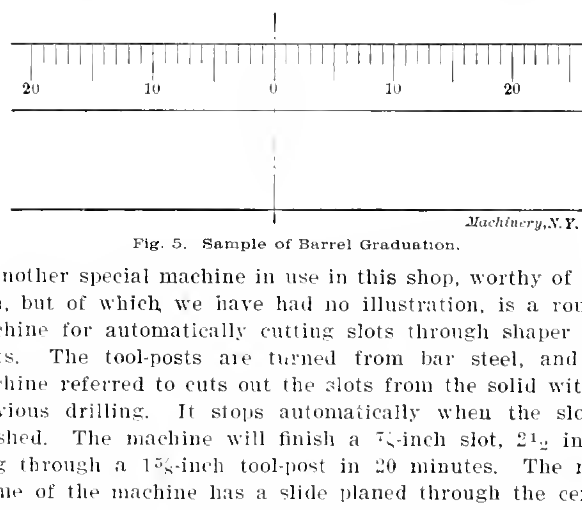


Fig. 5. Sample of Barrel Graduation.

Another special machine in use in this shop, worthy of mention, but of which we have had no illustration, is a routing machine for automatically cutting slots through shaper tool-posts. The tool-posts are turned from bar steel, and the machine referred to cuts out the slots from the solid without previous drilling. It stops automatically when the slot is finished. The machine will finish a 7/8-inch slot, 2 1/2 inches long through a 1 5/8-inch tool-post in 20 minutes. The main frame of the machine has a slide planed through the center, to which a T-slotted work table is gibbed, carrying the fixture

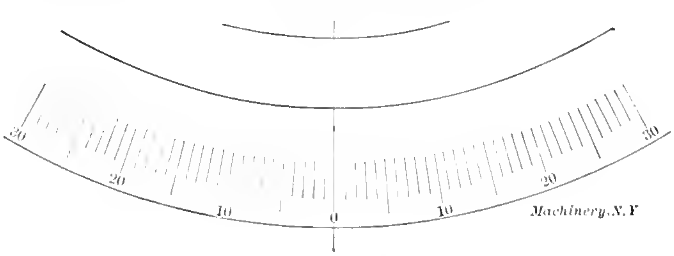


Fig 6. Sample of Radial Graduation.

for holding the work. Two heads carrying the spindles are mounted in right angle slides, one on each side of the table. Cutters are mounted in each spindle and enter the work from opposite sides. The table is moved back and forth by an adjustable crank motion, and the cutters are fed in at each end of the stroke. It stops automatically when the cutters are within 1/32 inch of the center. At this point one cutter is withdrawn and the other cutter is fed through to remove the remaining stock.

The simple boring jigs used for boring the shaft holes in planer beds and shaper frames are worthy of mention because of their simplicity and effectiveness. A jig consists of two cast iron plates, planed on both sides and held together by bolts and distance pieces. It is used on a Detrick & Harvey horizontal boring machine and supports the boring-bars, which are held in bushings in the side plates. The bars are driven by universal joints so that the jig supports the bar entirely independently of the work spindle. The planer casting is mounted on the table between the jig plates, the jig and the casting being located by certain gage points and clamped in position. When the various sizes of jigs were bored, an extra plate was bored simultaneously for each jig, and this is employed as a testing jig for the driving gears, studs being mounted in the holes on which the spur gears are set for testing. Obviously, these studs must have the same center distance for each size machine as the holes bored in the beds.

All these machines and special appliances were designed by Mr. E. D. Westrip, the general manager.

* * *

Some figures which are interesting in view of the present agitation for laws relating to employers' liability for accidents, are quoted by the *Mechanical Engineer*. It is usually considered that with advancing age the liability to accident increases. The figures quoted, which have been compiled by Sir John Brunner, and were first published in the *Times*, London, cover an investigation extending over fifteen years, and tend to disprove the previously mentioned assumption. In fact, these figures indicate that young men, under thirty years of age, are most liable to accidents, as will be seen from the table below.

Age.	Number Employed.	Percentage of Accidents Per Year.
18 to 25	633	8.5
26 to 30	533	6.8
31 to 35	616	4.2
36 to 40	656	3.6
41 to 45	531	2.8
46 to 50	382	3.7
51 to 55	251	2.4
56 and over	246	2.4

It may, of course, be assumed that the marked reduction in the percentage of accidents after the age of fifty is, to a slight extent, due to the fact of putting elderly men on less dangerous work, but it is also indicative of the fact that experience and care will increase with advancing years, and Sir John Brunner draws the conclusion that no employer is justified, not even in his own interest, in refusing to take elderly men in his service, or in dismissing them for the reason that they are more liable to accidents than younger men.

If a man is careful to avoid accidents happening to himself, he is, as a rule, also careful in preventing accidents happening to the machinery on which he is employed, and the figures quoted may therefore be considered as an indication that young men are not necessarily the best investment in a shop, but that men of more advanced years are likely to fill their places equally well, when all factors are considered.

* * *

A maddening and humiliating experience for a manufacturer to undergo is to develop a mechanical feature in an unobtrusive way and wake up some fine morning to find that another fellow had received the credit. It is not an unknown happening for a machine tool builder to work out some little kink or attachment which is good in its place but is of scarcely sufficient importance to pay the cost of taking out a patent to protect his rights. Another concern may adopt the same idea, and it is not an unknown occurrence for the copyist to be awarded credit for its origin. Still worse cases have happened, the copyist having the hardihood to actually patent an idea worked out by another. Of course, it is more charitable to believe that such cases are the result of an independent development, but whether so or not, it does not much help the feelings of the originator. What is his remedy? Show these minor developments in MACHINERY and get the credit that is your due. It helps the trade and it will help you.

MILLING SQUARE THREADS AND TURNING PULLEYS ON A DRILL PRESS.

To cut nicely finished square-thread screws on an ordinary drilling machine seems a most extraordinary operation, quite out of the range of practicability, but a simple attachment designed and used by the Mechanics Machine Co. of Rockford, Ill., does the work satisfactorily, and with a minimum of attention. The attachment, shown in Fig. 1, consists of a plate on which is mounted a master screw (shown in front) and the blank to be threaded. The master screw is splined and is driven with a worm and worm-wheel by a round belt leading to a grooved belt mounted on the regular vertical feed shaft. The master screw is directly connected with the blank shaft work spindle by spur gears without an intermediate gear; consequently the master screw is of opposite lead to the screw produced. In the illustration, a right-hand square-thread screw is being cut, the master screw being a left-hand square-thread screw. In operation, the master screw and the blank travel together to the right, the master screw reacting against a simple nut engagement shown in the front. The threading is a milling operation, as is plainly evident, the cutter being a plain, flat

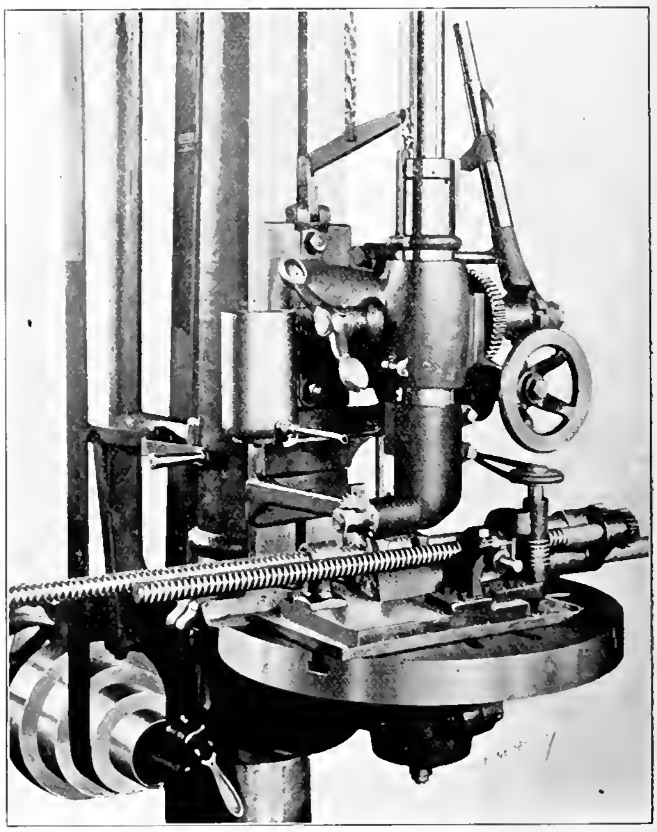


Fig. 1. Milling Square Threads on a Drill Press.

milling cutter on a horizontal shaft mounted in a casting attached to the lower end of the quill. It is driven by the drill spindle through bevel gears.

The screw milling attachment was designed on account of scarcity of help and machinery in the rush of business last year, and it has proved to be a wonderful time and labor saver. It is used for milling the table elevating screws used on upright drill presses manufactured by the company. A screw 27 inches long, 1 inch diameter, can be cut in 1½ hour, the screws produced being smooth and perfect copies of the master screw except in the change of hand or direction of spiral. An intermediate gear would correct this, but for the sake of simplicity it is omitted. The attachment works automatically, the principal attendance required being to put in a new shaft when the previous one is completed. The screw being cut is held by an ordinary spring collet on the work spindle. The attachment is extremely simple in construction, and being capable of producing threaded work of high accuracy because of directly reproducing the master screw, it would seem to have many possible uses.

Another drill press attachment used in the same shop, of almost equally surprising use, is that shown in Fig. 2 for

turning crowned pulleys. The principle of this attachment is not new, pulley milling machines having been used by other machine tool builders for several years, but the development of a drill press attachment for such work, we believe, is new. The attachment is simple, consisting of a base carrying a horizontal spindle, on one end of which the pulley is mounted and on the other end a worm-wheel, engaging a worm. This combination is driven by a second worm and worm-wheel in order to get the required reduction of motion. On the upper end of the second worm shaft is a pulley belted to another pulley mounted on the cutter-head. This cutter-head is fixed in the spindle with a Morse taper shank, fitting the drill socket. Of course the pulleys are bored and keyseated previous to the milling operation.

The milling attachment is located on the drill press table, so that a vertical plane through the work or pulley shaft and coinciding with its axis, stands a short distance to one side of the spindle center line. In the other plane at right angles to the pulley shaft the center line of the spindle coincides with the center plane of the pulley being milled. This position of a milling cutter of sufficient diameter to sweep the entire

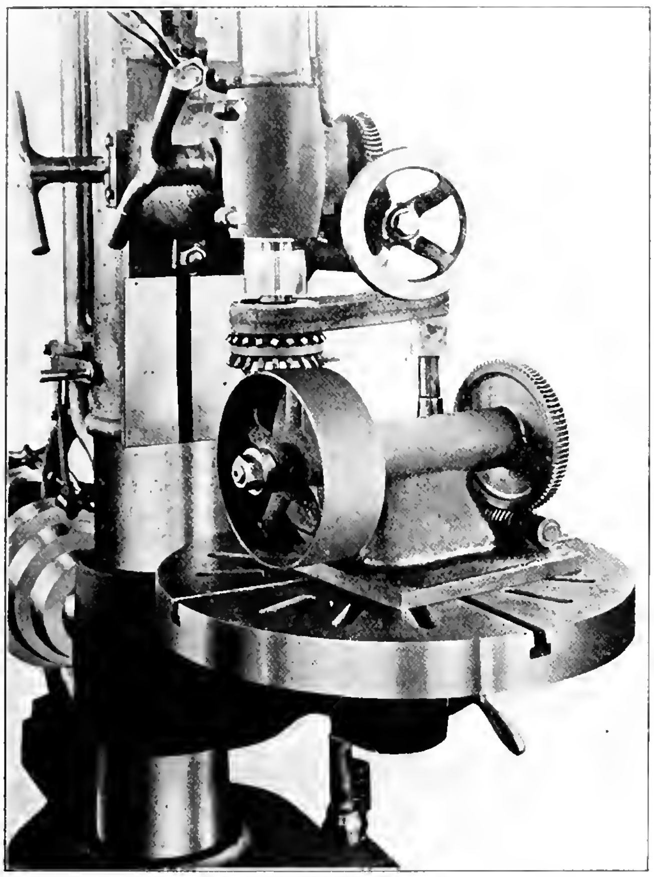


Fig. 2. Milling Crowned Pulley Faces on a Drill Press.

face of the pulley, generates a curved surface that answers the requirements of crowning. The attachment is automatic and requires but one hour to face and crown a 12 x 4-inch pulley. High-speed steel cutters are used, which require regrinding very seldom, so the labor cost of machining the faces of pulleys is reduced to but little more than that of putting the work on the attachment and removing it when finished.

* * *

The importance of well lubricated bearings, as well as the importance of an oil suitable for lubrication purposes, is given in a paper before an English society of engineers, by Mr. T. C. Thomson, some weeks ago. He stated that in a certain machine shop driven by an electric motor, the power needed to drive the shafting and the machine running idle amounted to 37 K. W. when one kind of oil was used, and 25 K. W. when a better quality of oil was substituted. The total rated capacity of the motor was only 65 K. W., so that even with the best oil, it is seen that the frictional losses remain a very substantial fraction of the total energy expended.

JIGS AND FIXTURES—4.

EINAR MORIN.*

CLAMPING DEVICES.

In order to hold the work rigidly in the jig, so that it may be held up against the locating points, while the cutting tools operate upon the work, jigs and fixtures are provided with clamping devices. Sometimes a clamping device serves the purpose of holding the jig to the work, in a case where the

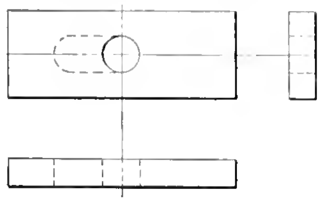


Fig. 37. Form of Clamps used in Jigs and Fixtures.

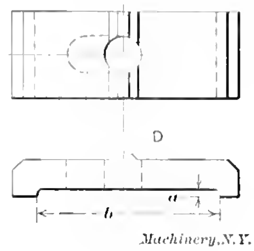


Fig. 38. Improved Form of Clamp.

work is a very large piece and the jig is attached to the work in some suitable way. The purpose of the clamping device, however, remains the same, namely, that of preventing any shifting of the guiding bushings while the operation on the work is being performed. As has been previously mentioned, at the time when the general principles of jig and fixture design were treated in the first installment of this series

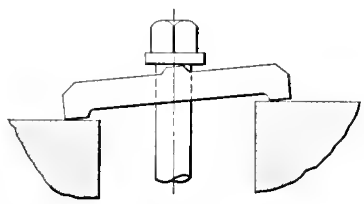


Fig. 39. Action of Clamp shown in Fig. 38 when used to clamp Work which is not Level with the Clamping Surface.

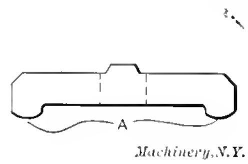
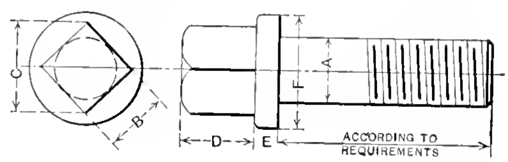


Fig. 40. Clamp shown in Fig. 38, Further Improved.

(April issue), the clamping device should always be an integral part of the jig body in order to prevent its getting lost.

The clamping device may either directly clamp the work to the jig or *vice versa*, but very frequently the clamps simply hold in place a loose or movable part in the jig, which can be swung out of the way to facilitate the removing and the inserting of the work in the jig. The work itself is in

TABLE V. DIMENSIONS OF COLLAR-HEAD SCREWS.



A	B	C	D	E	F	St'd No. of Threads per inch.
$\frac{3}{16}$	$\frac{3}{16}$	0.260	$\frac{1}{4}$	$\frac{3}{32}$	$\frac{3}{8}$	24
$\frac{1}{4}$	$\frac{1}{4}$	0.350	$\frac{5}{16}$	$\frac{1}{8}$	$\frac{1}{2}$	20
$\frac{5}{16}$	$\frac{5}{16}$	0.440	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{9}{16}$	18
$\frac{3}{8}$	$\frac{3}{8}$	0.530	$\frac{7}{16}$	$\frac{5}{32}$	$\frac{11}{16}$	16
$\frac{7}{16}$	$\frac{7}{16}$	0.620	$\frac{1}{2}$	$\frac{5}{32}$	$\frac{3}{4}$	14
$\frac{1}{2}$	$\frac{1}{2}$	0.710	$\frac{9}{16}$	$\frac{3}{16}$	$\frac{7}{8}$	13
$\frac{9}{16}$	$\frac{9}{16}$	0.790	$\frac{5}{8}$	$\frac{3}{16}$	1	12
$\frac{5}{8}$	$\frac{5}{8}$	0.880	$\frac{11}{16}$	$\frac{7}{32}$	$1\frac{1}{16}$	11
$\frac{3}{4}$	$\frac{3}{4}$	1.060	$\frac{13}{16}$	$\frac{1}{4}$	$1\frac{1}{4}$	10

turn clamped by a set-screw or other means passing through the loose part, commonly called leaf. The simplest form of clamping device is the so-called clamp, of which a number of different forms are commonly used. Perhaps the most common and most reliable of all clamps is the one shown in Fig. 37. This kind of clamp is also commonly termed a strap. It is simple, cheap to make, and for most purposes it gives satisfactory service. The clamp shown in Fig. 38 is practically made on the same principle as the one shown in Fig. 37,

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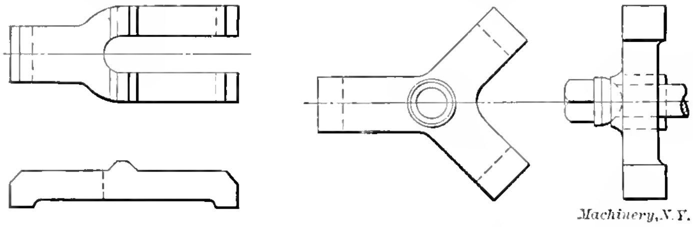
but several improvements have been introduced. The clamp is recessed at the bottom for a distance *b*, to a depth equal to *a*, so as to give a bearing only on the two extreme ends of the clamp. Even if the strap should bend somewhat, on account of the pressure of the screw, it will be certain to bear at the

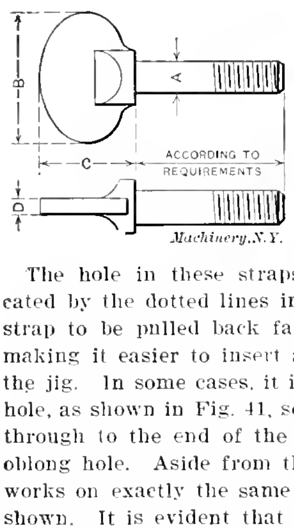


Figs. 41 and 42. Special Forms of Clamps.

ends, and exert the required pressure on the object being clamped. This strap is also provided with a ridge at *D*, located central with the hole for the screw, as shown in Fig. 38. This insures an even bearing of the screw head on the clamp, even if the two bearing points at each end of the clamp should vary in height, as illustrated in Fig. 39. The clamp in Fig. 37 would not bind very securely, under such circumstances, and the collar of the screw would be liable to break off, as the whole strain, when tightening the screw, would be put on one side.

A still further improvement in the construction of this clamp may be had by rounding the under side of the clamping points *A*, as shown in Fig. 40. When a clamp with such rounded clamping points is placed in a position like that indicated in Fig. 39, it will practically bind the object to be held fully as firmly as if the two clamping surfaces were in the same plane.

TABLE VI. DIMENSIONS OF SHOULDER THUMB SCREWS.



A	B	C	D
3/16	9/16	1/2	3/32
1/4	1	11/16	1/8
5/16	1 1/8	3/4	5/32
3/8	1 1/4	13/16	5/32
7/16	1 1/2	15/16	3/16
1/2	1 5/8	1 1/8	3/16

The hole in these straps is very often elongated, as indicated by the dotted lines in Figs. 37 and 38. This allows the strap to be pulled back far enough so as to clear the work, making it easier to insert and remove the piece to be held in the jig. In some cases, it is necessary to extend the elongated hole, as shown in Fig. 41, so that it becomes a slot, going clear through to the end of the clamp, instead of being simply an oblong hole. Aside from this difference, the clamp in Fig. 41 works on exactly the same principle as the clamps previously shown. It is evident that the clamps described may be given a number of different shapes to suit different conditions. The screws used for clamping these straps are either standard hexagonal screws or standard collar head screws, dimensions

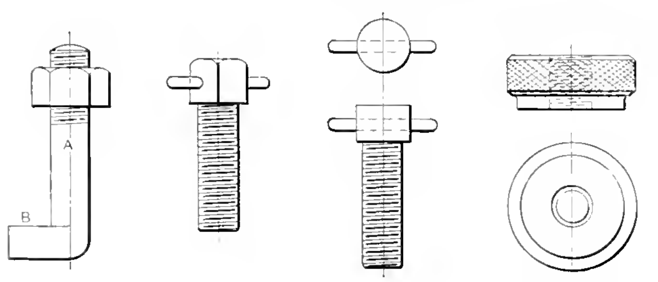


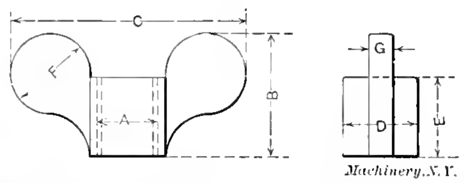
Fig. 43 Fig. 44. Fig. 45. Fig. 46.

of which latter are given in Table V. In a case where it is not necessary to tighten the clamps very much, shoulder thumb screws, as shown in Table VI, may be employed.

Instead of having the strap or clamp bear on only two points, it is sometimes necessary to have it bear on three points, in which case it may be designed similar to the strap shown in Fig. 42. In order to get an equal pressure on all the three points, a special screw, with a half-spherical head like the one shown, may be used to advantage. The half-spherical head of this screw fits into a concave recess of the same shape in the strap. When the bearing for the screw head is made in this manner, the hole through the clamp must have plenty of clearance for the body part of the bolt.

When designing clamps or straps of the types shown, one of the most important things to take into consideration is to provide enough metal around the holes, so that the strap will stand the pressure of the screw without breaking at the weakest place, which naturally is in a line through the center of

TABLE VII. DIMENSIONS OF WING OR THUMB NUTS.

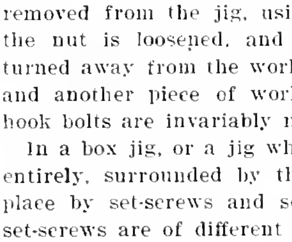


A	B	C	D	E	F	G
3/16	5/8	1 1/8	5/16	3/8	7/16	1/8
1/4	3/4	1 3/8	15/32	1/2	17/32	5/32
5/16	3/4	1 3/8	15/32	1/2	17/32	5/32
3/8	13/16	1 11/16	17/32	9/16	5/8	5/32
7/16	7/8	2	21/32	5/8	11/16	3/16
1/2	1 1/16	2 1/4	3/4	13/16	7/8	3/16

the hole. As a rule, these straps are made of machine steel, although large clamps may sometimes be made from cast iron.

The hook bolt shown in Fig. 43 is better adapted for some classes of work than any other clamping device. At the same time, it is very easy and cheap to make and easily applied. The bolt *A* passes through a hole in the jig, having a good sliding fit in this hole, and is pushed up until the hook or head *B* bears against the work, after which the nut is tightened. When great pressure is not required, the thumb or wing nut, such as shown, together with its dimensions, in Table VII, permits the hook bolt to be applied more readily. The thumb or wing nut is preferable to the knurled nut, shown in Fig. 46, which sometimes is used. It is possible to get a better grip, and to tighten the bolt more firmly by a

TABLE VIII DIMENSIONS OF REGULAR THUMB SCREWS.



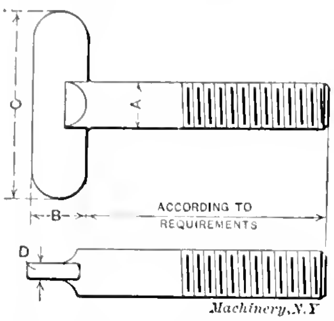
A	B	C	D
3/16	3/4	5/8	3/32
1/4	15/16	3/4	1/8
5/16	1 1/8	7/8	5/32
3/8	1 1/4	15/16	5/32
7/16	1 1/2	1 1/16	3/16
1/2	1 5/8	1 3/16	3/16

wing nut than it is with a knurled nut. When the work is removed from the jig, using the hook bolt clamping device, the nut is loosened, and the head or hook of the bolt is turned away from the work, thus allowing it to be taken out, and another piece of work to be placed in position. The hook bolts are invariably made of machine steel.

In a box jig, or a jig where the work is entirely, or almost entirely, surrounded by the jig, the work is easily held in place by set-screws and sometimes by screw-bushings. The set-screws are of different kinds, the most common being the standard square head set-screw, which is used whenever great clamping pressure is required, the square head allowing the use of the wrench. Sometimes screws of this kind may be tightened enough for the purpose by hand if a pin is put through the head of the screw, as shown in Figs. 44 and 45. This means is used not only when great pressure is not necessary, but also when the work is liable to spring if the screws are tightened too hard. In such a case, if a pin is inserted, it would be obvious that the screw head is not intended for a wrench, but that the pin is intended for getting a good grip by the hand for tightening the screw without

resorting to any additional means. Usually it is not possible to use an ordinary machine wrench on such a screw, as it generally is rather thin, so that if applied to the top of the screw, it would not permit a very good grip. Of course, a monkey-wrench could be applied, but it ought to be stated in this connection that a monkey-wrench ought not to be employed in ordinary manufacturing shop work, as it is intended

TABLE IX. DIMENSIONS OF THUMB SCREWS WITH WIDE GRIP



A	B	C	D
3/16	1/4	7/8	3/32
1/4	5/16	1	1/8
5/16	3/8	1 1/4	5/32
3/8	7/16	1 1/2	5/32
7/16	1/2	1 3/4	3/16
1/2	9/16	2	3/16
9/16	5/8	2 1/4	3/16
5/8	11/16	2 1/2	7/32

primarily for jobbing work. More screws probably have been tightened too hard and twisted off by the injudicious use of a monkey-wrench than in any other way. When a monkey-wrench is used, it should be used with discretion. This, of course, does not mean to imply that the monkey-wrench is not one of the handiest tools that a machinist ever had in his possession, but it is intended to impress the idea that unless the monkey-wrench is used in such a manner that, when it is applied to a small screw head, the power applied at the end of the handle is in proportion to the screw, it is a risky tool to have around.

While a screw with a round head, as shown in Fig. 45, and with a pin put through the head, is undoubtedly better and

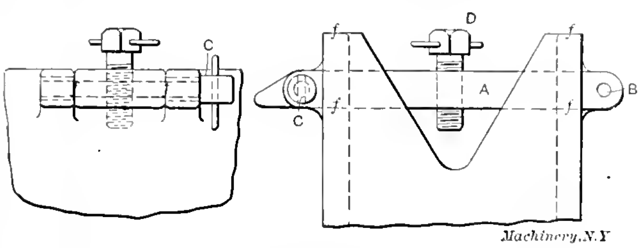


Fig. 47. Common Design of Leaf in Drill Jigs. Screw D Clamps the Work.

more convenient to use than the one shown in Fig. 44, the latter is cheaper to make, because standard screws can be taken right from stock, and a pin hole put through them, after the heads have been annealed. If thumb screws like the ones shown in Tables VIII and IX are available, they are preferable, as they give a good hold to the hand when they are tightened, and, besides, there is very little work required in finishing them. The use of a screw-bushing for clamping work has already been referred to. The clamping screws mentioned so far are generally applied directly onto the work, after having passed through the wall of the jig, or some projecting part serving as a seat for the screw.

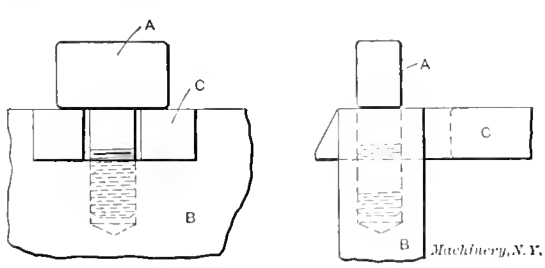


Fig. 48. Clamping Device for Leaf in Drill Jig.

Loose leaves which spring out, in order to permit the work to be inserted and removed, are usually constructed in some manner similar to that shown in Fig. 47, in which *A* represents the leaf, being pivoted at *B* and held by a pin at *C*, which goes through the two lugs on the jig wall and passes through the leaf, thus binding the leaf and allowing the tightening of the set-screw *D*, which bears against the work. The holes in the lugs of the castings are lined with steel bushings in order to prevent the cast iron holes from being worn out too soon by the constant pulling out and putting in of the pin. This kind of leaf, when fitted in nicely, is rather expensive, and is not only used for binding purposes, but also for guiding purposes, making a fitting seat for the bushings. If the leaves are fitted well in place, the bushing will guide the cutting tools firmly.

Another way of holding down the leaf is shown in Fig. 48, in which *A* is a thumb screw, screwed directly into the wall *B* of the jig, and holding the leaf *C* down, as indicated. To swing the leaf out, the thumb screw is turned back about a quarter of the turn, so that the head of the thumb screw stands in line with the slot in the leaf, this slot being made wide and long enough to permit the leaf to clear the head of the thumb screw. This is a very rapid way of clamping,

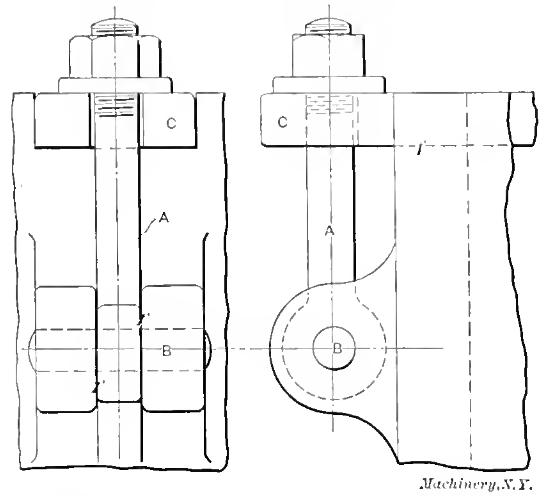


Fig. 49. Eye-bolt used for Clamping Drill Jig Leaf

and is frequently used. The lower side of the head of the screw will wear a long time before the head finally comes in line with the slot when binding. It can then easily be fixed for binding the leaf again when standing in a position where the head of the thumb screw is at right angles to the slot, by turning off a portion of the head on the under side. The size of these thumb screws is made according to the strain on

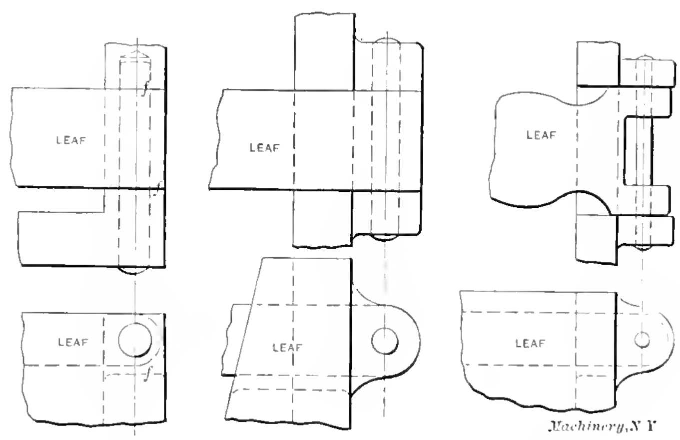


Fig. 50. Detail Designs of Joints between Leaf and Jig.

the leaf and the size and design of the jig. No standard dimensions could be given for this kind of screw.

The hinged bolt, shown in Fig. 49, is also commonly used. Here *A* represents an eye-bolt, which is connected with the jig body by the pin *B*. The leaf or movable part *C* of the jig is provided with a slot in the end for the eye-bolt, this slot being a trifle wider than the diameter of the bolt. The threaded end of the eye-bolt is provided with a standard hexagon nut, a knurled head nut or a wing nut, according to how firmly it is necessary that the nut be tightened.

When the leaf is to be disengaged, the nut is loosened up enough to clear the point at the end of the leaf, and the bolt is swung out around the pin *B*, which is driven directly into lugs projecting out from the jig wall, a slot being pro-

vided between the two lugs, as shown, so that the eye-bolt can swing out with perfect freedom. At the opposite end, the leaves or loose parts of the jig swing around a pin the same as in Fig. 47, the detailed construction of this end being, most commonly, one of the three types shown in Fig. 50. It must be understood that to provide jigs with leaves of this character involves a great deal of work and expense, and they are used almost exclusively when one or more guide bushings can be held in the leaf.

* * *

ADJUSTABLE LEVELING BLOCKS FOR PLANERS.

The adjustable leveling blocks shown in Figs. 1 and 2 are used in the shops of the Pratt & Whitney Co., Hartford, Conn., and the style shown in Fig. 1 is intended, in particular, for the planers made by the company. The design and action of these adjusting blocks are plainly shown in the engravings. The frame *A* is bolted to the concrete foundation by four anchor bolts *B* surrounded by pipes *C*, which prevent the concrete from coming in direct contact with the bolts, and permit a slight adjustment in longitudinal and sideways direction. At each end of the frame *A* are finished surfaces, planed to an angle of 15 degrees. On these surfaces slide the adjusting blocks *D*, also planed on the under side to a 15-degree angle, the upper side being level. These adjusting blocks or wedges are made of cast iron and provided with a long slot *E* permitting a lengthwise as well as a sidewise adjustment, the slot being two inches long and one inch wide, while the bolt, passing through it, is only ⅝ inch in diameter. The blocks are adjusted by set-screws *G*, provided with lock nuts. When properly adjusted, so that the planer table is level, the bolts *F* are tightened down, holding the planer firmly to the frame *A*, which itself is firmly embedded in the concrete foundation, and, as mentioned before, held down by the anchor bolts.

When the lower portion of the planer is of the construction shown in Fig. 1, so that it is possible to place the adjusting screws *G* on the inside, the frame and wedges are made so that the upper surface of the adjusting block will lift the planer table when pushed outward. On many planers, particularly those of larger sizes, it is not possible to have the adjusting screws on the inside, as they would be almost inaccessible. In such cases, the adjusting screw is placed as shown in Fig. 2, the frame and the adjusting block being reversed in their construction. The adjusting block is then pushed inward when it is desired to raise the leg resting upon it. With this exception, the principle of the adjusting block shown in Fig. 2 is exactly the same as that shown in Fig. 1.

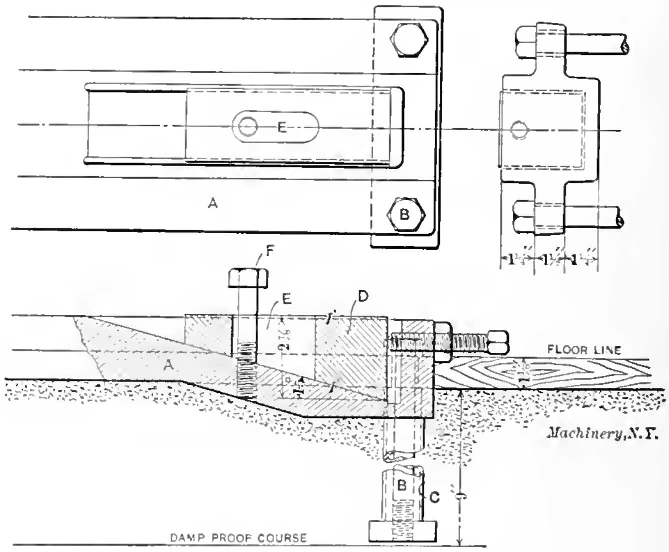


Fig. 2. Leveling Block with the Adjusting Screws on the Outside, instead of on the Inside, as in Fig. 1.

The frame *A* can be made in any length required by the length of the planer, the same pattern being used for all sizes, with the exception of lengthening pieces which are put in to make up for the required length over all. These leveling blocks have been found very convenient and suitable for the purpose for which they are used, and as there is allowance for adjustment in practically all directions, it is comparatively easy to get the desired results with this adjustable arrangement.

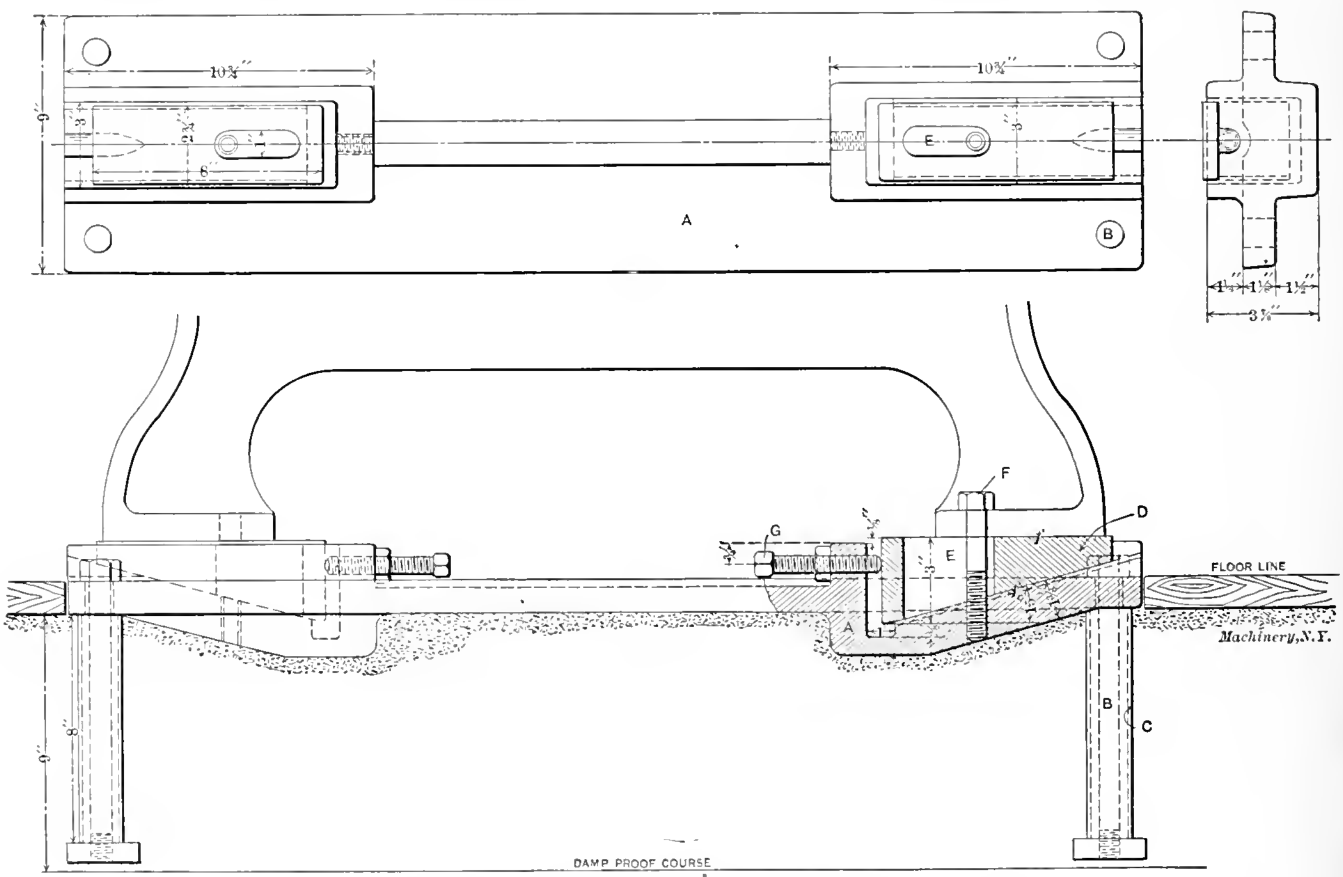


Fig. 1. Leveling Block for Planers, applied to a Pratt & Whitney Co. Planer.

* * *

It is of the utmost importance that plants and machinery be maintained in a high state of efficiency. General recognition, however, is not given to another thing, which is of equal importance, namely, the maintenance of the operatives themselves in a high state of efficiency.—*Practical Engineer.*

SPECIAL AND ADJUSTABLE TAPS.

ERIK OBERG *

STAYBOLT TAPS.

Staybolt taps are extensively used in locomotive boiler work. The ordinary or the radial staybolt tap is shown in Fig. 1; in Fig. 2 is shown the spindle staybolt tap, which has derived its name from the guiding spindle upon which the tap proper revolves.

Radial Staybolt Taps.

If we first give our attention to the radial staybolt tap, as shown in Fig. 1, the length *C* represents the threaded portion. Of this part, the portion *F* is straight or parallel, and the part *G* is chamfered. The part *E* is a taper reamer which reams the hole previous to tapping. The taper of this reamer is usually 3/32 inch per foot. The diameter at *H* is equal to the root diameter of the thread. The diameter of the shank is about 0.005 inch below the root diameter. Staybolt taps are usually made with 12 threads per inch, of the sharp

TABLE I. DIMENSIONS OF REGULAR STAYBOLT TAPS.

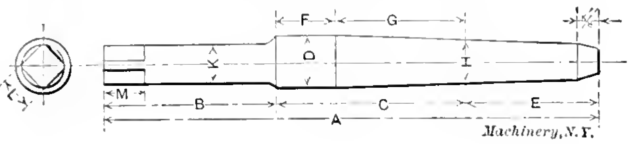


Fig. 1.

Total Length of Tap.	Diameter of Tap.	Length of Shank.	Length of Thread.	Length of Reamer.	Length of Parallel Thread.	Length of Chamfer.	Root Diameter.	Diameter of Shank.	Size of Square.	Length of Square.
A	D	B	C	E	F	G	H	K	L	M
20 inches.	3/4	7	7 1/2	5 1/2	1 1/2	6	0.606	0.601	15/32	3/4
	13/16	7	7 1/2	5 1/2	1 1/2	6	0.668	0.663	1/2	3/4
	7/8	7	7 1/2	5 1/2	1 1/2	6	0.731	0.726	9/16	3/4
	15/16	7	7 1/2	5 1/2	1 1/2	6	0.793	0.788	19/32	3/4
	1	7	7 1/2	5 1/2	1 1/2	6	0.856	0.851	21/32	1
	1 1/16	7	7 1/2	5 1/2	1 1/2	6	0.918	0.913	11/16	1
	1 1/8	7	7 1/2	5 1/2	1 1/2	6	0.981	0.976	3/4	1
	1 3/16	7	7 1/2	5 1/2	1 1/2	6	1.043	1.038	25/32	1
	1 1/4	7	7 1/2	5 1/2	1 1/2	6	1.106	1.101	27/32	1 1/4
	1 5/16	7	7 1/2	5 1/2	1 1/2	6	1.168	1.163	7/8	1 1/4
	1 3/8	7	7 1/2	5 1/2	1 1/2	6	1.231	1.226	15/16	1 1/4
24 inches.	3/4	9	8	7	2	6	0.606	0.601	15/32	3/4
	13/16	9	8	7	2	6	0.668	0.663	1/2	3/4
	7/8	9	8	7	2	6	0.731	0.726	9/16	3/4
	15/16	9	8	7	2	6	0.793	0.788	19/32	3/4
	1	9	8	7	2	6	0.856	0.851	21/32	1
	1 1/16	9	8	7	2	6	0.918	0.913	11/16	1
	1 1/8	9	8	7	2	6	0.981	0.976	3/4	1
	1 3/16	9	8	7	2	6	1.013	1.038	25/32	1
	1 1/4	9	8	7	2	6	1.106	1.101	27/32	1 1/4
	1 5/16	9	8	7	2	6	1.168	1.163	7/8	1 1/4
	1 3/8	9	8	7	2	6	1.231	1.226	15/16	1 1/4

V-form. Although practice has almost universally favored the employment of the sharp V-thread, the main advantage (and perhaps the only real advantage) of a thread of this kind is that it can be made tight in the boiler sheets and kept tight without any great difficulty. On the other hand, the use of the V-thread violates one of the fundamental principles of machine design—the principle, namely, of avoiding all sharp angles, and of filleting every place where such angles tend to occur. This must have occurred many times to engineers and designers, and yet no general movement has been made to discard the V-thread and substitute for it a form that shall not be open to the same objection. The Whitworth thread is receiving considerable attention at the present time, however, for use upon staybolts, and it is regarded with favor by certain builders of large experience, notably by the Baldwin Locomotive Works, which is now using this thread upon locomotive staybolts. If experience shows that staybolts can be made tight and kept so when fitted with this thread, it is probable that its adoption will extend to other builders.

Staybolt taps receive very rough treatment, and are exposed to hard usage, and should therefore be made of an extra good quality of steel. The thread should be relieved both on top and in the angle of the thread on the chamfered portion. The parallel portion of the thread is not relieved. In order to prevent having cutting edges which are too wide toward the smaller end of the chamfered portion, the tap is threaded taper about one-half of the chamfered part. This prevents the tap from reaming instead of cutting. In order to gain the same end, it is advisable never to make the chamfer any longer than, at most, 6 inches. The interrupted thread shown in Fig. 6 in the article on Taper Taps in the April issue, is particularly of value in the case of staybolt taps, and is probably used more on this class of taps than on any other.

TABLE II. DIMENSIONS OF SPINDLE STAYBOLT TAPS.

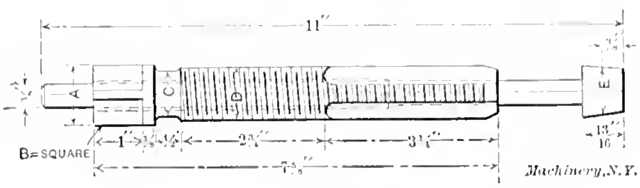


Fig. 2.

Diameter of Tap.	Diameter of Shank.	Size of Square.	Diameter of Neck.	Diameter of Guide.
D	A	B	C	E
3/4	1	3/4	0.601	5/8
13/16	1	3/4	0.663	11/16
7/8	1	3/4	0.726	3/4
15/16	1	3/4	0.788	13/16
1	1 1/16	13/16	0.851	7/8
1 1/16	1 1/8	7/8	0.913	15/16
1 1/8	1 3/16	7/8	0.976	1
1 3/16	1 1/4	15/16	1.038	1 1/16
1 1/4	1 5/16	1	1.101	1 1/8
1 5/16	1 3/8	1 1/16	1.163	1 3/16
1 3/8	1 7/16	1 1/16	1.226	1 1/4

TABLE III. DIMENSIONS OF STRAIGHT BOILER TAPS.

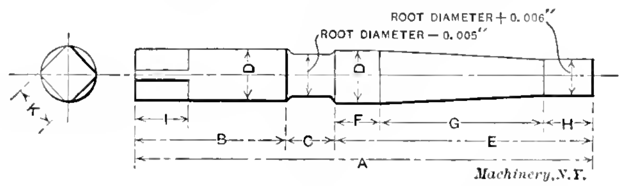


Fig. 3.

Diameter of Tap.	Total Length.	Length of Shank.	Length of Neck.	Length of Thread.	Length of Full Thread.	Length of Chamfer.	Length of Pilot.	Length of Square.	Size of Square.
D	A	B	C	E	F	G	H	I	K
1/2	4 1/4	1 3/4	1/2	2	1/2	1 1/8	3/8	1/2	3/8
9/16	4 7/16	1 13/16	1/2	2 1/8	9/16	1 3/16	3/8	9/16	7/16
5/8	4 5/8	1 13/16	1/2	2 5/16	5/8	1 1/4	7/16	5/8	15/32
11/16	4 13/16	1 13/16	9/16	2 7/16	11/16	1 5/16	7/16	11/16	1/2
3/4	5	1 7/8	9/16	2 9/16	3/4	1 5/16	1/2	3/4	9/16
13/16	5 3/16	1 15/16	9/16	2 11/16	13/16	1 3/8	1/2	13/16	5/8
7/8	5 3/8	2	9/16	2 13/16	7/8	1 7/16	1/2	7/8	11/16
15/16	5 9/16	2	5/8	2 15/16	15/16	1 1/2	1/2	15/16	11/16
1	5 3/4	2	5/8	3 1/8	1	1 9/16	9/16	1	3/4
1 1/16	5 15/16	2 1/16	5/8	3 1/4	1 1/16	1 5/8	9/16	1 1/16	13/16
1 1/8	6 1/8	2 1/16	5/8	3 7/16	1 1/8	1 11/16	5/8	1 1/8	7/8
1 3/16	6 5/16	2 1/16	11/16	3 9/16	1 3/16	1 3/4	5/8	1 3/16	7/8
1 1/4	6 1/2	2 1/8	11/16	3 11/16	1 1/4	1 3/4	11/16	1 1/4	15/16
1 5/16	6 11/16	2 3/16	11/16	3 13/16	1 5/16	1 13/16	11/16	1 5/16	1
1 3/8	6 7/8	2 1/4	11/16	3 15/16	1 3/8	1 7/8	11/16	1 3/8	1 1/16
1 7/16	7 1/16	2 1/4	11/16	4 1/8	1 7/16	1 15/16	3/4	1 7/16	1 1/16
1 1/2	7 1/4	2 1/4	3/4	4 1/4	1 1/2	2	3/4	1 1/2	1 1/8
1 5/8	7 5/8	2 5/16	3/4	4 9/16	1 5/8	2 1/8	13/16	1 1/2	1 1/4
1 3/4	8	2 3/8	13/16	4 13/16	1 3/4	2 3/16	7/8	1 1/2	1 5/16
1 7/8	8 3/8	2 1/2	13/16	5 1/16	1 7/8	2 5/16	7/8	1 1/2	1 7/16
2	8 3/4	2 1/2	7/8	5 3/8	2	2 7/16	15/16	1 1/2	1 1/2

In Table I the dimensions for standard radial staybolt taps, as made by a prominent tap manufacturing firm, are given. However, staybolt taps are made in a variety of sizes and designs for special requirements; but the two kinds given in the table are the most commonly used. All staybolt taps, of the

* Associate Editor of MACHINERY.

sizes given in the table, should have five flutes. The oversize limit of difference in diameter from the correct size of staybolt taps is commonly assumed to be 0.002 inch for taps smaller than 1 inch in diameter, and 0.003 inch for larger sizes. It is evident that it is not permissible for the tap to be *under* the correct size; consequently the diameter is required, after hardening, to be between the standard diameter and a diameter of 0.002 or 0.003 inch, respectively, above the standard.

Sometimes staybolt taps are provided with a threaded guide at the upper end of the thread. This guide is not fluted and should be made slightly smaller in diameter than the cutting size of the tap. The amount which the diameter is smaller is usually about 0.010 inch, and should apply to the angle diameter as well as to the top of the thread. While not fluted, this threaded guide ought still to be grooved by a small convex cutter for oil passages to the flutes.

Spindle Staybolt Taps.

The spindle staybolt tap, as shown in Fig. 2, is not provided with a reamer, and with but a short chamfer. It is fluted about half the way of the threaded part. The remaining part of the thread acts as a guide, and should be made in the same way as threaded guides for radial staybolt taps. The guide E on the end of the spindle holds the tap in place in relation to the inner tube sheet, while the outer one is threaded. The standard dimensions for these taps are given in Fig. 2 and in Table II.

Straight Boiler Taps.

Straight boiler taps are, strictly speaking, only a special class of hand taps. They have a long chamfer, and a straight guide at the point. The chamfered portion is relieved on the top of the thread. These taps are fluted in the same way as hand taps. In Table III the dimensions for these taps are given. The most important of these dimensions are determined from the formulas:

$A = 3D + 2\frac{3}{4}$ inches,
$E = 2\frac{1}{4}D + \frac{7}{8}$ inch,
$F = D$,
$H = \frac{3}{8}D + 3/16$ inch,

in which formulas

A = total length of tap,
D = diameter of tap,
E = length of threaded portion,
F = length of full or parallel thread, and
H = length of guide.

In making these taps the same limits in regard to oversize diameters as employed for regular hand taps should be adopted. (See MACHINERY, July, 1907: Remarks on the Making of Hand Taps.)

Straight Pipe Taps.

Straight pipe taps are only a variation of hand taps, but have the same number of threads per inch as the corresponding sizes of taper pipe taps, and a diameter arbitrarily adopted by the manufacturers of these taps. Table IV gives the dimensions for taps up to and including ¾ nominal diameter. The larger sizes are given in Table V. It will be noticed that the difference in appearance between the larger and smaller sizes is simply that the latter is provided with a short neck, turned down below the root diameter, while on the larger sizes the whole shank is turned down below the root of the thread.

These taps are chamfered the same as plug hand taps, and relieved only on the top of the thread on the chamfered part.

TABLE IV. STANDARD STRAIGHT PIPE TAPS.

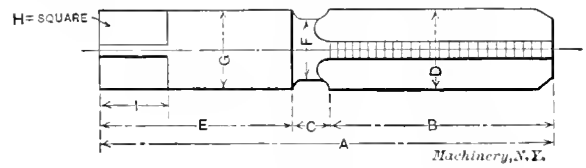


Fig. 4.

Nominal Size.	Diameter of Tap.	Total Length.	Length of Thread.	Length of Neck.	Length of Shank.	Diameter of Neck.	Diameter of Shank.	Size of Square.	Length of Square.
	D	A	B	C	E	F	G	H	I
1/8	0.398	2 5/8	1	5/16	1 5/16	0.335	3/8	9/32	7/16
1/4	0.531	2 7/8	1 1/8	3/8	1 3/8	0.440	1/2	3/8	1/2
3/8	0.672	3 1/16	1 1/4	3/8	1 7/16	0.575	5/8	15/32	9/16
1/2	0.828	3 1/4	1 3/8	7/16	1 7/16	0.705	3/4	9/16	5/8
3/4	1.041	3 5/8	1 5/8	1/2	1 1/2	0.915	1	3/4	3/4

TABLE V. STANDARD STRAIGHT PIPE TAPS.

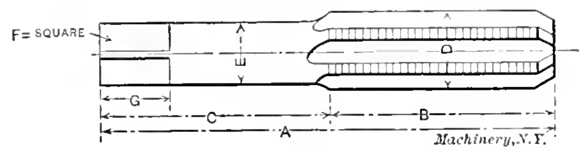


Fig. 5.

Nominal Diameter.	Diameter of Tap.	Total Length.	Length of Thread.	Length of Shank.	Diameter of Shank.	Size of Square.	Length of Square.
	D	A	B	C	E	F	G
1	1.293	4	1 3/4	2 1/4	1 1/8	13/16	13/16
1 1/4	1.645	4 7/16	1 15/16	2 1/2	1 1/4	15/16	15/16
1 1/2	1.880	4 7/8	2 1/8	2 3/4	1 3/8	1 1/16	1
2	2.359	5 11/16	2 7/16	3 1/4	1 5/8	1 1/4	1 3/16
2 1/2	2.836	6 1/2	2 3/4	3 3/4	1 7/8	1 7/16	1 5/16
3	3.461	7 3/8	3 1/8	4 1/4	2 1/8	1 5/8	1 1/2
3 1/2	3.971	8 3/16	3 7/16	4 3/4	2 3/8	1 13/16	1 11/16
4	4.398	9	3 3/4	5 1/4	2 5/8	1 15/16	1 13/16

TABLE VI. ENGLISH STRAIGHT PIPE TAPS.

(See Fig. 4 for meaning of letters in table.)

Nominal Size.	Diameter of Tap.	Total Length.	Length of Thread.	Length of Neck.	Length of Shank.	Diameter of Neck.	Diameter of Shank.	Size of Square.	Length of Square.
	D	A	B	C	E	F	G	H	I
1/8	0.385	2 5/8	1	5/16	1 5/16	0.335	3/8	9/32	7/16
1/4	0.520	2 7/8	1 1/8	3/8	1 3/8	0.448	1/2	3/8	1/2
3/8	0.665	3 1/16	1 1/4	3/8	1 7/16	0.593	5/8	15/32	9/16
1/2	0.822	3 1/4	1 3/8	7/16	1 7/16	0.726	3/4	9/16	5/8
5/8	0.902	3 7/16	1 1/2	7/16	1 1/2	0.806	7/8	21/32	11/16
3/4	1.034	3 5/8	1 5/8	1/2	1 1/2	0.938	1	3/4	3/4

TABLE VII. ENGLISH STRAIGHT PIPE TAPS.

(See Fig. 5 for meaning of letters in table.)

Nominal Size.	Diameter of Tap.	Total Length.	Length of Thread.	Length of Shank.	Diameter of Shank.	Size of Square.	Length of Square.
	D	A	B	C	E	F	G
7/8	1.189	3 13/16	1 11/16	2 1/8	1 1/16	13/16	13/16
1	1.302	4	1 3/4	2 1/4	1 1/8	13/16	13/16
1 1/8	1.492	4 1/4	1 7/8	2 3/8	1 3/16	7/8	7/8
1 1/4	1.650	4 7/16	1 15/16	2 1/2	1 1/4	15/16	15/16
1 3/8	1.745	4 11/16	2 1/16	2 5/8	1 5/16	1	15/16
1 1/2	1.882	4 7/8	2 1/8	2 3/4	1 3/8	1 1/16	1
1 5/8	2.021	5 1/16	2 3/16	2 7/8	1 7/16	1 1/16	1 1/16
1 3/4	2.047	5 5/16	2 5/16	3	1 1/2	1 1/8	1 1/16
1 7/8	2.245	5 1/2	2 3/8	3 1/8	1 9/16	1 3/16	1 1/8
2	2.347	5 11/16	2 7/16	3 1/4	1 5/8	1 1/4	1 3/16
2 1/8	2.467	5 7/8	2 1/2	3 3/8	1 11/16	1 1/4	1 3/16
2 1/4	2.587	6 1/8	2 5/8	3 1/2	1 3/4	1 5/16	1 1/4
2 3/8	2.791	6 5/16	2 11/16	3 5/8	1 13/16	1 3/8	1 5/16
2 1/2	3.001	6 1/2	2 3/4	3 3/4	1 7/8	1 7/16	1 5/16
2 5/8	3.124	6 3/4	2 7/8	3 7/8	1 15/16	1 7/16	1 3/8
2 3/4	3.247	6 15/16	2 15/16	4	2	1 1/2	1 7/16
2 7/8	3.367	7 1/8	3	4 1/8	2 1/16	1 9/16	1 7/16
3	3.485	7 3/8	3 1/8	4 1/4	2 1/8	1 5/8	1 1/2
3 1/4	3.698	7 3/4	3 1/4	4 1/2	2 1/4	1 11/16	1 9/16
3 1/2	3.912	8 3/16	3 7/16	4 3/4	2 3/8	1 13/16	1 11/16
3 3/4	4.125	8 5/8	3 5/8	5	2 1/2	1 7/8	1 3/4
4	4.339	9	3 3/4	5 1/4	2 5/8	1 15/16	1 13/16

The number of flutes may be made the same as for corresponding sizes of Briggs' standard pipe taps (see MACHINERY, March, 1908: Taper Taps); if it is considered that less flutes would be more advisable, approximately the same number of flutes as is given to regular hand taps will be satisfactory. In cases like this the number of flutes, within reasonable limits, is largely a matter of judgment. The straight pipe tap, being actually a hand tap, should evidently be fluted like a hand tap. But inasmuch as the tap has a greater number of threads per inch than corresponding sizes of ordinary hand

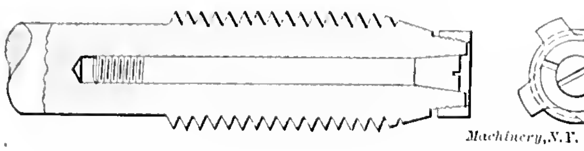


Fig. 6. Adjustable Tap made from Solid Stock.

taps, there is a reason for providing it with a greater number of flutes. English pipe taps, having Whitworth form of thread, and made according to Whitworth's thread system for gas and water piping, are given in Tables VI and VII.

Adjustable Taps.

Adjustable taps are made for the purpose of permitting adjustment to a correct standard size. As the solid tap, on account of changes in hardening, cannot be depended upon to measure exactly the diameter for which it was intended, and because of the impossibility of preventing a tap from decreasing in diameter through wear, the adjustable tap has a wide field of usefulness where correct size nuts must be produced. The adjustable tap may either be made from a solid piece,

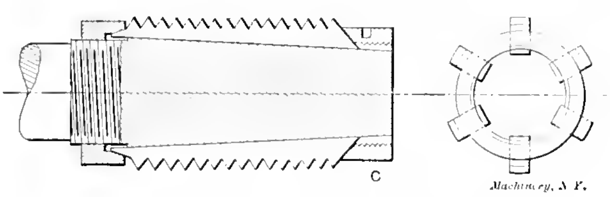


Fig. 7. Adjustable Tap with Inserted Blades.

split in a suitable manner to permit adjustment, or may be provided with inserted blades or cutters, which are so held in the tap body that a slight movement of these blades in the longitudinal direction of the tap moves the cutting points of the thread nearer or farther from the axis of the tap, thus decreasing or increasing the diameter, as the case may be.

Another cause for inserted blade taps other than adjustability may also be mentioned. The efforts constantly made by progressive manufacturers to decrease the cost of tools without impairing their efficiency, have resulted in the design of a number of taps of this type, which permit a cheaper grade of material to be used in the tap body, while the best quality steel may be used for the inserted blades, the total

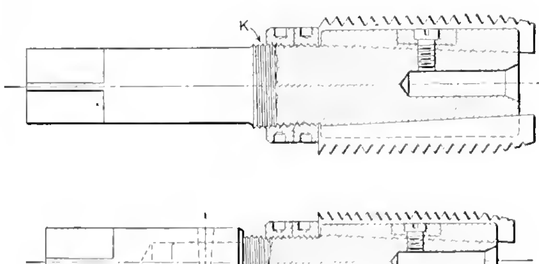


Fig. 8. Improved Design of Adjustable Tap.

cost, especially in the case of large taps, being smaller than if the tap were made solid of ordinary tool steel throughout. Incidentally another advantage is also gained. Inasmuch as the cutting portion of the tap is the only one which, in general, when worn, has caused the tap to be discarded, the inserted blade design makes it possible to retain the body proper and replace the cutters only.

In the case of large taps and coarse pitches, the adjustable tap does not give very good satisfaction if a thread is cut by one passage of the tap, because the strain on the tap is so great as to spring it to a certain extent. It is evident that an adjustable tap cannot possibly be made fully as rigid as a solid tap. But in such cases the tap still retains its superiority as a "sizing" tap, used to finish the thread after it has been roughed out by means of an ordinary tap somewhat under size.

Examples of Adjustable Taps.

The form of adjustable tap, previously referred to, which is cut from a solid piece and split, is shown in Fig. 6. The body is split straight through, a nut with a taper thread serves to hold the tap together at the end, and a screw with a taper head is used to expand the tap, as shown. As the expansion is effected by bending the cutting lands when the tapered head of the screw travels inward, the thread form is not accurately retained, and the tap is not to be recommended. When accurate work is required, the inserted blade form of adjustable taps is the preferable form. The requirements for a good inserted blade tap are that the blades when bound in place shall be practically solid with the body, that the design shall permit a liberal adjustment in regard to size, that this adjustment shall be easily accomplished, and that the means employed for binding and adjusting the blades shall not be of such a kind as to prevent the use of the tap in any case where the solid tap could be used. This latter requirement involves the possibility of tapping clear through a hole as well as the tapping down to the bottom of a hole.

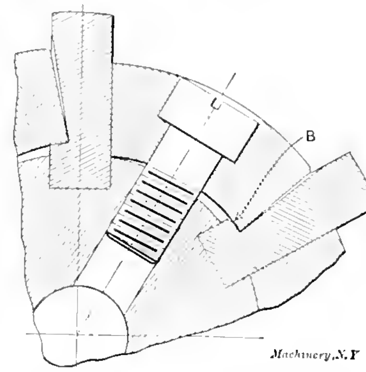


Fig. 9. Method of Binding the Blades in Tap, Fig. 8.

A tap which fills fairly well all these requirements, with the exception of the one mentioned last, is shown in Fig. 7. The blades are held in place by nuts, beveled on the inside to fit the tapered ends of the blades. In this manner the blades are prevented from longitudinal motion as well as from moving out or in in relation to the center line of the tap. The blades fit into slots in the tap body and are thus prevented from moving sideways. The adjustment is provided for by the tapered bottom of the slots in the body, by means of which the cutting size of the tap increases when the blades

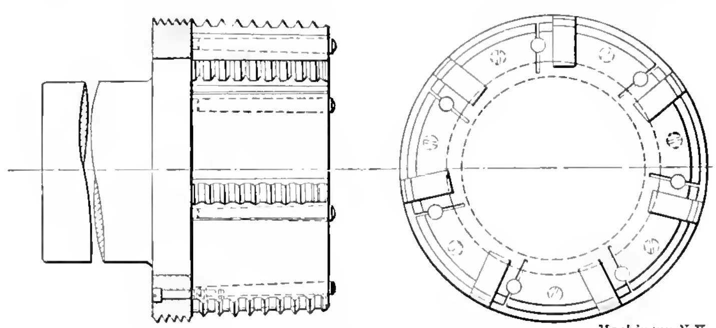


Fig. 10. Inserted Blade Pipe Tap

are moved upward toward the shank end of the tap. The adjustment is easily accomplished, it only being required to loosen the upper nut and push up the blades, and then tighten the lower as well as the upper nut solidly upon the blades. It is, however, not possible with the design shown to tap down clear to the bottom of a hole, nor is it possible to tap straight through a hole. This latter requirement could, of course, easily be obtained by making the slots deeper and the blades wider, thus making it possible to decrease the outside diameter of the upper binding nut so that it would be less than the root diameter of the thread. This would permit the tap to pass through a threaded hole. There is, however, a more serious objection to this design. The backing of the blade by means of a tapered surface in the nut is not very positive, and the blades are liable to be a trifle incorrect in their relative posi-

tiou in regard to lead. It is evident that if that is the case the thread cut will be incorrect in its shape, the space cut in the nut being wider than the thread itself. A tap which overcomes the objections raised in regard to the tap in Fig. 7 is shown in Fig. 8. The construction of this tap was described in the July, 1907, issue of MACHINERY, in an article entitled Adjustable Reamers and Taps with Inserted Blades. In this article the reasons for the superiority of the design of taps and reamers made as indicated in Fig. 8 were stated, and it is unnecessary to repeat this discussion here. Those who may not have read the article in question can easily see the principle of the design from the sectional view of the tap, Fig. 9, which shows the principle employed for binding the blades very clearly.

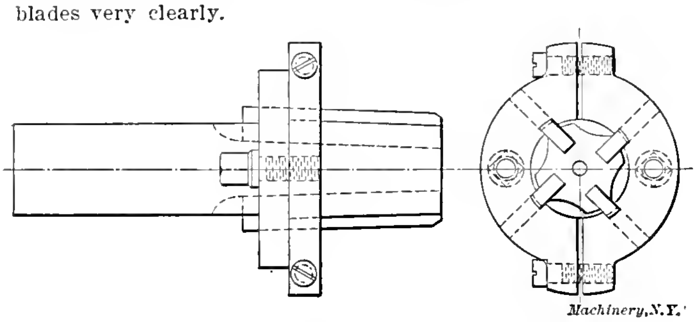


Fig. 11. Another Design of Inserted Blade Pipe Tap.

Inserted blade taps are not adapted to very small sizes. As a rule, it should not be attempted to make such taps in sizes smaller than 1½ inch, or, at least, not below 1¼ inch in diameter.

Other Examples of Inserted Blade Taps.

In Fig. 10 an inserted blade tap, of a design common for pipe taps, is shown. Here the chasers are held in place by means of taper pins, which wedge the metal of the body firmly against the blade. The correct location of the blades in a longitudinal direction is obtained by means of a ring, held to the body by screws. It is plainly seen from the construction that this tap is not intended to be adjustable, but is simply made with inserted blades from an economical point of view. This design which is most commonly used for large taps, affords a considerable saving in material. The tap shown in the engraving is provided with interrupted thread, as frequently used on pipe taps, and taper taps in general.

Another form of inserted blade tap is shown in Fig. 11. The blades are here held in place by means of a ring threaded on the inside to fit the thread of the blades or chasers, and split and provided with binding screws so as to make possible a positive grip over the blades. The advantage of this design is that the threads of the various chasers must necessarily be so located as to form a continuous helix all around the tap, inasmuch as the threaded ring fits upon the thread in the chasers. But the design is open to the objection that the ring prevents threading as far down in a hole as may sometimes be required, and the ring may interfere with lugs or projections on the piece to be threaded. In this respect the former of the two taps last described is superior, as it is free from any outside incumbrance, and takes up no more room than a solid tap.

* * *

THE TOOL ROOM VERSUS THE MACHINE SHOP SHAPER.

WILLIAM ECKER.*

A shaper for tool-room use can never answer its purpose with economy if used for regular machine shop work, as it cannot retain its accuracy when subjected to the strains and hard knocks common in machine shop practice. A tool-room shaper should not be expected to rush out work with heavy cuts, as this leads to distortion of the working parts, and constitutes an abuse of the machine. A reasonable cut indicates judgment.

The tool-room shaper should be well graduated on all screws used for adjustment in practical tool work; such graduations, if reliable, are more convenient for use than measurements made by scale or caliper. A first-class mechanic will have a great respect for a tool that is graduated and reliable, because this eliminates all guess work, and relieves the worker of anxiety, as he depends on the machine to produce the work correctly. "The smile that won't come off" is on both the tool-maker's and the apprentice's face when he takes a piece of work out of the shaper vise and finds it square and parallel; that smile, however, is never seen on the face of the man using the machine shop shaper, but only a look of anxiety, for he works by "guess." He knows his shaper is not true; consequently more cuts and calipering, with final filing and scraping, all of which is not economical. Filing and scraping in a first-class tool-room, after machining a piece of work, is only a indication that the work has been done on a poor machine, or in a hurry and not deliberately, and causes loss of time amounting to, perhaps, four times the time required for machining the work over again, and still not producing so good looking a job when inspected by a capable judge. To sum up, while graduations are desirable on the adjusting screws, if they are out of true, they are only confusing; for this reason few machanics use them even when they exist, because they have lost confidence in the machine.

The feed on a tool-room shaper is usually one, two, or three teeth. Rather than to use a heavier feed, the tool-maker, when cutting tool steel, may adjust the machine to take a deeper or shallower cut. The tool-room shaper does not require so large a range as is required by the machine shop shaper, and can, therefore, be designed along lines leading towards rapid and convenient manipulation, and more compact and rigid construction. The class of people the best tool-makers come from are generally thin, nervous and very sensitive, and a heavy and clumsy design does not appeal to them at all, but produces a feeling of antagonism. As they are the ones who have to use the machine, they are in general, the best judges of the machine. The standard of a tool-room is always greatly influenced by the standard of tools used, for even a good, first-class workman will grow indifferent, if indifferent tools are to be used.

The machine shop shaper, as considered apart from the tool-room shaper, is generally called upon to do a great variety of work, and must be designed with more liberal proportions, and is not so well adapted to perform small, reliable, exact operations; "snagging" and "hogging" is considered quite the proper thing with this tool. This always produces the same result. The machine will not long remain reliable, and consequently there is a great deal of measuring, calipering, squaring and swearing, all multiplied four times by waste of time. In the machine shop practice, the work to be done calls for a greater variety of feeds than a tool-maker usually demands. The machine shop shaper is also often in the care of workmen of inferior training. This fact always influences the design of the machine and leads toward clumsiness, which is the opposite of the tool-room shaper.

On account of these differences between the tool-room shaper and the machine shop shaper, it is reasonable to assume that the design fitted for tool-room purposes is not suitable for the machine shop. Therefore, we should have a tool-room shaper built for the purpose of tool making, and a machine shop shaper for machine shop purposes. This difference cannot be denied, or all claims for specializing machinery must be renounced. "Happy mediums" are sometimes good, but should be called so, and there are very few of them at present.

A suggestion in the designing of shapers which may not be out of place is that on account of the fact that in any make of shaper the ram has considerable weight, and travels at a comparatively high speed, it would only be reasonable to make an attempt at counterbalancing, having the same kind of springs or shock absorbers as usual in some other kinds of machinery, to take up the shock at the end of the stroke.

* * *

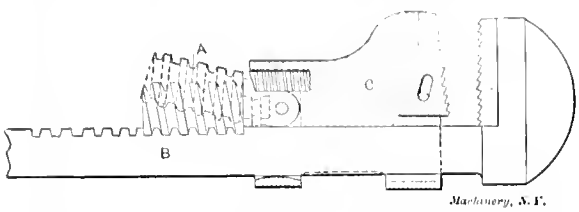
Steel wool is a by-product much used by wood finishers, painters, etc., in preference to sandpaper, especially on molded work. It is the long, hair-like chips produced in drilling rifle barrels. A curious commercial fact about this product is that it sells for several times the cost of the steel composing the barrels, the retail price being about 50 cents per pound.

* Address: Gould & Eberhardt, Newark, N. J.

ITEMS OF MECHANICAL INTEREST.

QUICK-ADJUSTMENT PIPE WRENCH.

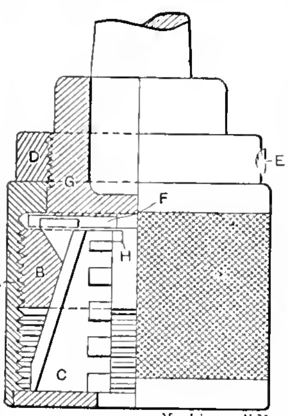
The accompanying engraving shows an interesting pipe wrench made on the monkey-wrench principle and patented by Mr. M. G. Ewer, of Detroit, Mich. The principal feature of this wrench is its quick adjustment to various sizes of pipe. It will be seen that the binding or adjusting screw A, which engages with the thread cut in the handle B of the wrench, is pivoted to the movable jaw C, and when it is required to move this jaw a long distance out or in, the adjusting screw is simply lifted out of engagement with the thread on the shank as shown by the dotted lines, and the jaw is slid along the shank until it has approximately reached the location required. Then the screw is pushed into engagement with the thread on the shank, and the final adjustment and clamping are made as usual.



Pipe Wrench which is adjusted quickly by disengaging Adjusting Screw, as shown by the Dotted Lines.

A NEW DRILL CHUCK.

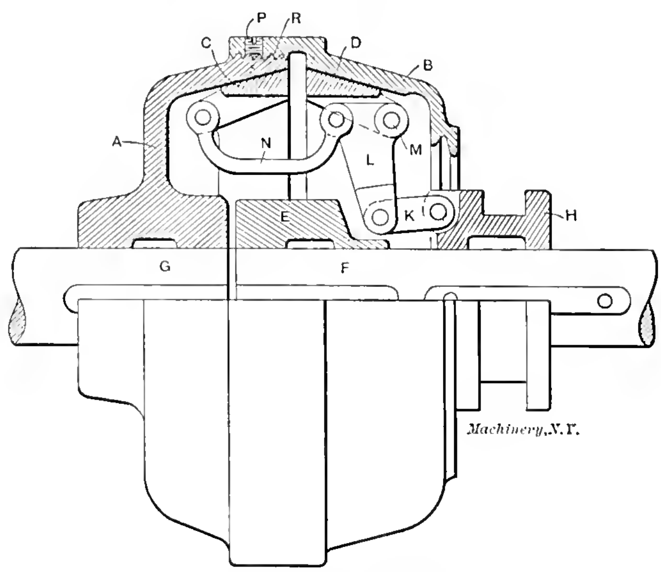
A drill chuck, embodying an interesting feature, whereby the drill is clamped more firmly in the chuck as the pressure on the cutting tool increases, has been designed by Mr. P. G. Lagerbäck, of Aktiebolaget Nordiska Artilleriverkstäderna, Finspong, Sweden. The following description of this drill chuck is abstracted from *Industritidningen Norden*. The sleeve A is threaded on the inside and engages with the chuck ring B, provided with grooves for receiving the chuck jaws C. The sleeve A is prevented from lateral motion by the nut D, provided with binding screw E for holding it in place. The jaws are provided with a projection F, which enters in a groove in the chuck holder G. When the sleeve A is turned in relation to the holder G, the jaws C and consequently the chuck ring B, are thus prevented from taking part in this rotary motion, and consequently the chuck ring B will move in a lateral direction, thereby closing the chuck jaws on, or releasing them from the tool shank. A small projection H is provided on each of the jaws, and the end of the tool shank rests against this projection. The length of the jaws is slightly less than the place within the chuck provided for them, so that after having been clamped upon the tool shank, when the pressure is applied on the tool, the end of the tool shank will press on the projections H, thereby having a tendency to force the jaws upward, and this, in turn, will clamp the tool more firmly in the chuck, inasmuch as the jaws, in order to move upward, will also be forced inward by the taper on their back surface.



Drill Chuck which clamps Tool more firmly as Pressure Increases.

FRICTION COUPLING OF SIMPLE DESIGN.

Judging by the great number of different designs of friction couplings placed on the market during the last year, it seems as if special energy had been devoted to the design of simple and efficient friction couplings in Germany. We have illustrated several of these designs in the columns of MACHINERY during the past year. The accompanying engraving shows another design which, in regard to simplicity, probably excels most of the others. This coupling is manufactured by the Sächsische Maschinenfabrik, Chemnitz, Germany. As seen in the engraving, this coupling consists of a housing made in two sections A and B. The inside of this housing is made tapered from the center, and friction rings C and D transmit the motion from this housing to a central hub E, which in turn is keyed to the shaft F. The housing itself is keyed to the shaft G, power being thus transmitted from the shaft G to the shaft F. The friction rings C and D are operated through a lever mechanism from the sleeve H, which in turn is operated by a fork bolted to the shifting lever. The sleeve is connected through link K with the lever L which is pivoted at M. The link N connects the two friction rings C and D, and according to the position of the lever L, the rings will be pressed against the housing or released from it. On account of the shape of the link N a certain spring action is possible in this member. It will be noted that the two sections A and B of the housing are connected with each other through the threaded portion at R, a set-screw P being used for binding the part B to the part A after being adjusted. This threaded joint permits of a very close adjustment of the two halves of the housing so that the tapered surfaces on the inside can be placed in such positions as to insure a binding action at exactly the place required by the position of the levers. It



German Friction Coupling.

also makes it possible to adjust the two sections of the housing when worn on the gripping faces. It is evident that a coupling of this character can be made of comparatively small diameter. The friction rings C and D are running in oil, and on account of the spring action of the lever N and this oiling arrangement, a very gradual gripping is insured and breakages and wear are reduced to the minimum. The objectional pressure in one direction, which is common with many friction clutches of the usual design, is obviated by the use of two conical friction surfaces inclining in different directions. It is claimed that under normal conditions couplings of this type can be used to advantage for shafts up to about 5 inches diameter. Upon examination of the lever arrangement it will be found that the coupling cannot accidentally release inasmuch as the levers are arranged to give a kind of toggle action so that when lever L once comes into position where it clamps the friction rings to the housing it cannot again release, unless considerable force is applied at its lower end from sleeve H through the link K. In a design of this kind there are, of course, normally two or four sets of links of the same kind as the one set shown in the sectional part of the engraving.

* * *

A FEAT OF HALF-TONE ILLUSTRATION IN JOURNALISM.

Here is the record of the latest feat of half-tone illustration in journalism. A New York daily newspaper photographed the finish of the Brooklyn handicap at Gravesend, L. I., race track, June 1, at 4 o'clock, carried the negative in an automobile to Herald Square, developed it, made a half-tone plate, electrotyped it and placed printed papers containing the illustration on the street at 6 o'clock that night.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JULY, 1908.

PAID CIRCULATION FOR JUNE, 1908, 21,397 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

SELF-OILING MACHINERY.

We believe that if there is one great improvement in modern machinery and machine tools that should be extolled beyond all others, it is the self-oiling feature that is being used on high-grade high-speed steam engines and certain machine tools. It seems, when one reflects on it, that many manufacturers must have been asleep to be content to go along year after year building and using machines that require the continual attention of the operator's oil-can. The common attitude of indifference among machinists and machine builders to self-oiling machines doubtless is largely because of early education. About the first thing that an apprentice or machine tender is taught is to keep his machine well oiled. Oiling his machine regularly becomes part of his mental make-up and it is something of a shock to his ideas of the fitness of things to see and use highly developed machinery that requires no attention whatever from the oil-can. We must get away from the antiquated idea that each and every bearing requires individual inspection and oiling two or three times a day, for there is no good reason why a machine should not oil itself. To be sure, the first cost of such machinery is more, but the difference is negligible when the advantages are considered. The mechanical efficiency may be increased so much as to save in power the extra cost of the improved oiling facilities in the first six months. Bearings carrying comparatively light loads will run indefinitely with no perceptible wear if they are continually oiled. Then there is the item of cleanliness which alone makes the self-oiling feature worth adoption in shops that require all machines to be kept in a cleanly condition.

* * *

OBSOLETE TOOLS IN MACHINE TOOL SHOPS.

Machine tool builders are interested directly and indirectly, more than any other manufacturers, in promoting the general use of up-to-date labor-saving machinery; yet the experience of one who has visited a large number of works indicates that the best equipped machine shops are sometimes *not* those engaged in the building of machine tools. The demand for nearly all new machine tools depends largely on the ability of the seller to demonstrate their economy in production over preceding types; yet we have noticed in some machine tool shops obsolete machines that occupy valuable space and waste a large part of the operator's time because of their inefficient productive capacity. Think of the effect of such examples on a possible purchaser who is being taken through a shop containing such tools—not to speak of the result of this policy on ultimate profits as well as on the progress of the shop and the development of its product.

This is a good time for each machine tool builder to take stock of his own equipment and decide what machines are unprofitable or can be replaced by others that will yield a good return on the investment and perhaps raise the standard of the product by their superior work. Although no manufacturers can live by "cutting each other's hair," the machine tool builders can help one another considerably just now by installing some of the valuable machines built by their contemporaries. Such purchases will greatly increase the general efficiency of American machine tool shops and prove a welcome addition to the order books of most manufacturers. Both buyers and manufacturers can take the time now to ensure the right tools being installed for the work required, which may not be the case three months from now.

* * *

BACK TO FIRST PRINCIPLES IN STOCK-KEEPING.

Years ago when the building of machines was conducted in a primitive manner, stock-rooms under the charge of responsible persons were practically unknown, and the small parts needed in construction work were commonly produced as they were needed. This applied to castings, bolts, screws, nuts, shafts, pulleys and all other parts that are now commonly made up into stock and used as required. Then followed the period when small parts were manufactured and kept in a stock-room to be issued only upon requisitions made by the foremen or other responsible employes. This system naturally followed the discovery that it was cheaper to manufacture parts than to make them one by one when needed. The requirements of bookkeeping and economical administration apparently made the store-room system a necessity to avoid the losses that would follow where employes were free to help themselves to finished parts. So obvious is this proposition that to keep stock parts worth thousands of dollars in open bins in the shop, freely accessible to workmen, seems a rank heresy, but that is exactly the present practice of a number of western machine tool builders who have followed it for some time with much success. In the manufacture of drill presses, lathes, etc., it is possible to make large quantities of small gears, pulleys, handles, knobs, spindles, pinions, clutches, tool-posts, worms, worm-wheels, etc., at low cost per piece, but if they are stored in a stock-room and given out only on requisitions, there is a chance that a considerable part of the saving made possible by the system of manufacture will be lost because of time wasted by men waiting for these parts and the time consumed by foremen and store-keepers in attending to these wants.

Where the parts are freely accessible, each man helps himself, under the supervision of the sub-foreman, of course, who sees that no parts are wantonly wasted. It saves time and promotes rapid work. There is little incentive to purloin these parts as they are of practically no value to individuals, being made of iron and steel. Of course, in the case of parts made of brass or other intrinsically valuable metal the system would hardly be practicable, nor would it be feasible, perhaps, for such parts as might be applied to mechanical uses outside of the designed use.

A saving of considerable importance in shops where space is at a premium is the abolition of the large store-room. The parts to be readily accessible should be in the erecting shop, and it is usually possible to utilize space under benches or by the walls, that is of little value for other purposes. This factor alone might sometimes be a deciding one in the adoption of the "open shop" store-room plan.

* * *

Imitation indicates limitation.—*The Silent Partner.*

THE PERSONNEL OF WORKMEN.

The "Confidences of a Manufacturer" (see November, 1907, issue) enunciated one principle that has been applied, by at least a few manufacturers, with great profit to themselves and their employes. It is a principle that foremen should understand and foster, as it will tend to make the management of their departments easy and successful.

The principle is simply to hire new help, so far as possible, only upon the recommendation of old employes. Of course, good judgment must be exercised to prevent the formation of parties or cliques, and that is exactly what the system will discourage if rightly directed. If a new man is hired upon an employe's recommendation, that employe feels a certain responsibility in his success, and will help the stranger to make good, instead of discouraging him at the outset, as he might do under different circumstances.

A man of good habits and a master of his trade is not likely to recommend a man of bad habits or one who is incompetent, and while trade union influences may change all this in certain cases, in general it will apply. The plan has proved successful in the employment of girls in manufacturing.

* * *

LIMITATION OF AUTOMATIC MACHINERY.

Notwithstanding the great development of automatic machinery, there yet remains a large number of mechanical operations for doing which no automatic machinery has been developed that can compete successfully with hand-operated machines, especially in the machine tool field. The manufacturers of brass valves and other brass goods use hand-operated lathes almost exclusively for turning, boring and threading spindles, caps, stuffing-boxes, bodies, collars, studs, etc. These manufacturers, of course, are keenly anxious to displace manually-operated machines wherever they can do it profitably, but little automatic machinery has been developed, so far, that is as efficient in operation and that does not cost far more for up-keep. The operators of brass lathes become so expert that the time required for some operations is but little more than that required for picking up the piece, chucking it and removing it from the machine. Unless the competing automatic machine is so highly developed that it will feed itself from castings thrown into a hopper, the saving in wages is more than eaten up by the interest and depreciation on the larger investment, and by the cost of the tool-maker's attention. The hand-operated lathe is a simple machine costing only \$300 or \$400 with a full equipment of tools. The automatic machine for doing the same work would cost, perhaps, five or six times as much, and the tool-maker's annual charge against it is likely to be heavy.

In another line—the manufacture of twist drills—we find automatic machinery used to a very small extent. In the making of small twist drills there is a large amount of hand work. Twist drills are fluted, relieved, hardened, tempered, straightened, polished and pointed by hand. No automatic machinery has been devised, so far as we know, that does not cost more for attendance and repairs than the present human and simple machinery equipment. The difficulty seems to lie in the necessity of many handlings of pieces by operators who must feed the machines. Automatic machines there are that display almost human dexterity in handling and selective qualities, but they are costly and complicated in construction and very likely to fail in operation. There is little or no profit in an automatic machine that requires an attendant constantly. An attendant can soon acquire the skill that will enable him to run the much simpler and cheaper hand-operated machines. The success of automatic machinery in the machine tool field is most noticeable in the case of screw machines wherein the parts are practically finished complete on the end of a bar and when once cut off require little further work, of consequence. In this way the difficulty of handling parts of irregular shape is avoided. The practicability of automatic machinery for manufacturing twist drills apparently lies in the application of the same idea, that is, avoiding the handling of parts by doing all operations, including *hardening, tempering* and *straightening* while yet attached to the stock bar. This perhaps means a machine of the multiple-spindle type with spindles mounted in a revolving cylinder or the equivalent. So far as we know the scheme has never been tried, but it may be found to be the most feasible way of manufacturing twist drills by automatic machinery.

In the very nature of the proposition, an automatic machine can be successful only when it requires the operator's attention a small part of the working time; by this we mean machines built automatic to save labor cost, and not those made to perform certain functions automatically because of the impossibility of doing them by hand. The conclusion then is that automatic machinery is most successful in manufacturing when it is of essentially simple construction in both the operative and feeding parts. We do not think that such will always be the condition, but it appears to be so in the present state of the art of designing and building machinery.

* * *

INTERLOCKING FORMED MILLING CUTTERS.

When concave milling cutters, provided with eccentric relief, have part of the cutting edge lines perpendicular to the axis of the cutter, it is often a perplexing problem to know whether it is best to relieve those perpendicular parts or not. If the cutting edges are not relieved at those points, it is evident that they will not cut in the ordinary meaning of the word, but will simply scrape the work on the sides. If, on the other hand, these edges are relieved, then when the formed cutter is subsequently ground in the usual manner, that is, by grinding on the face of the tooth, the outline of the teeth will be changed, the perpendicular parts of the cutting edges becoming further apart as the faces of the teeth are ground down more and more. In general, of course, cutting edges perpendicular to the axis are avoided as much as possible on eccentrically-relieved cutters, but sometimes it is necessary to have them. If the exact width of the work is not of particular importance, it may be advisable to relieve the perpendicular edges, but otherwise it should never be done. One of the common fallacies in the making of eccentrically-relieved formed cutters having perpendicular edges, and one that we, in particular, want to call attention to, is that those cutters can be interlocked in such a manner as to provide for adjustment when the faces of the teeth are ground off, even though the teeth be relieved on the perpendicular faces. When the cutter has been ground so that the distance between these perpendicular faces is enlarged, it is supposed that the interlocking faces can be ground off an amount corresponding to the increase between the perpendicular faces, and that the shape of the cutter is thus retained. A little thought, however, will convince anybody that there are very few cases of formed milling cutters where the original shape of the cutter would be retained. If the cutter be concave at the center where the two halves of the cutter are interlocked, then, if it be perfectly circular when the cutter is new, the grinding away of the faces will produce a sharp corner at the juncture, which will become more and more pronounced as the faces are ground off.

The interlocking of formed milling cutters, which are relieved on the perpendicular faces, therefore, should only be permitted when the width between these faces is the most essential dimension, and the form of the work, otherwise, can stand slight changes; but, if the work is expected to be absolutely of the same shape in all respects, perpendicular cutting edges on the formed cutters should be avoided. Whatever finish is necessary on the sides of the work should be performed in a separate operation with ordinary cutters. The belief that formed cutters, however relieved, can be ground without changing their shape, and that they can be interlocked so as to provide for any changes that would occur on account of their side relief, is so common that we consider it important to call attention to this error.

* * *

It may be that we seldom are able to achieve all that we try to achieve, but it is well to constantly have a high aim ahead of us. The man with ideals measures higher and grades better than the man without ideals and ambitions; and besides, if one measured up to one's ideals, and achieved all that one's ambition demanded, that would simply be a sign that one's ideals and ambitions were not high enough.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

It is reported by Consul-General Robert J. Wynne that the ninth tunnel under the Thames, London, will shortly be opened. Of the tunnels under the Thames, five are used exclusively by subways and railroads, and the other four used for general traffic.

Evidence of the industrial progress of Germany is given by the increase in its coal consumption which, according to the *Mechanical World*, increased nearly 40 per cent between 1902 and 1907. In 1907, the increase in the coal consumption over that of 1906 was 9 per cent.

Japan's advance in machine building is indicated by the fact that its exports during the last year were five times greater than the average for the last five years. A large proportion of the exports consists of cotton gins, textile machinery, and printing presses, for China.

It is mentioned in an item in the *Horseless Age* that the city of Milwaukee will, in a short time, use no horses for municipal purposes, except to draw fire engines. The city officials are convinced that the automobile is so far in advance of the horse in cost, maintenance, and utility, that there is hardly any room for a comparison.

Another step toward the accomplishment of aerial navigation made by Mr. Henry Farman, the winner of the Deutsch-Archdeacon prize referred to in the March issue of the engineering edition, in covering a complete circle two and a half times at Issy-les-Moulineaux, France. The total length of the flight was over a mile and a half.

A chimney, 400 feet high, is to be erected for carrying off the fumes from the assay furnaces from the new ten-story Assay office building of the United States Treasury Department in New York City. The chimney is intended to carry the poisonous fumes entirely above the surrounding high office buildings in the neighborhood.

The second largest masonry arch in the world has, according to *Engineering News*, recently been built on a new railway in Austria. This arch is the largest span of a bridge over the Isonzo River, and is 278.9 feet, having a rise of 78 feet. The arch is of cut stone founded on reinforced concrete footings, backing into solid rock. It is 6.6 feet thick at the crown. The largest masonry arch in the world is at Plauen, Germany, having a span of 295 feet, and the hitherto second largest, at Luxembourg, with a span of 277.6 feet.

England's first skyscraper will, according to the news despatches, be built in Liverpool, the city having authorized the construction of an office building which will rise to a height of 300 feet over the street level. The site of the new building is opposite the Prince's landing stage on the bank of the Mersey. It is rather surprising that conservative England is the first European country to adopt the American high building construction. On the other hand, considering the disadvantages that follow high buildings, it is not likely that continental Europe will permit itself to be deluded into allowing structures of such enormous height.

Lead, according to *Cassier's Magazine*, is said to act like steel at ordinary temperatures when reduced to a very low temperature in liquid air. It will serve as a helical spring, for example. This behavior of soft, non-elastic metals is very interesting. It shows how very important temperature is. Just as iron is soft and inelastic at a high red color, so lead is dull and soft at ordinary temperatures, for it is well on its way to be melted. Mercury is actually fluid at ordinary temperatures, but can be frozen at about 20 degrees F. into a soft metal. At lower temperatures it may, perhaps, be possible to make springs of mercury.

A correspondent to the *Times Engineering Supplement* states that a well perfected process for the construction of artificial gems has been developed by the Deutsche Edelstein Gesellschaft, at Idar, Germany. Instead of building up a stone from fragments, by which means the so-called "reconstructed rubies" are obtained, this company is said to make flawless rubies and other precious stones of perfect color and brilliance, and of great size, directly from the chemical elements. These gems possess all the chemical and physical properties of the real stones, and are indistinguishable from the genuine, even by experts. They can moreover be obtained in the most perfect tints, and of any required size.

The experimental stage of electric traction on the Swedish State Railways has now been concluded, and the Department of Railways has furnished the government with a report of all the experiments. The fact particularly accentuated is that mono-phase alternating current provides for the simplest, best, and cheapest system for electric traction on railways. The department states that, in its opinion, there is, at the present time, no reason for delaying the electrification of the main portions of the state railways. The experimental section will be left intact for carrying on experiments later on for determining some details which may be required to be investigated as the work proceeds.

An interesting phenomenon that may be of use in the ignition of explosives is creating some interest in Germany. According to a consular report, it has been discovered that an alloy of iron and cerium, lanthanium, or any other of the rare substances which are used in the manufacture of incandescent gas mantles will create luminous sparks on being struck with a metal tool, such as a knife edge, file or the like. The sparks given off at the point of impact are sufficient to ignite not only gas, but even a cotton wick saturated with alcohol, and it is possible that these alloys may be utilized for igniting all kinds of explosives. The behavior of these alloys has been found to vary according to their percentage of iron, the sparking reaching a maximum when the iron content is 30 per cent.

The substitution of a cheap and indestructible material for timber used in mines is a problem which sooner or later will come forcibly before mine owners and engineers. Experiments have been carried on in England with reinforced concrete beams, which point to the possibility of using this material largely as a substitute for wood, especially for work which is intended to be of a relatively permanent nature, and in which the increased cost of the concrete beam is justified by its indestructibility and freedom from decay. As the cost of Portland cement tends to fall, while that of timber rises, it is, says the *Times Engineering Supplement*, only a question of time when concrete will become a very effective means of construction for mining operations. In this country, at the present time, reinforced concrete beams are manufactured and sold for mining purposes in the mining districts of Colorado.

In the February and March, 1907, issues of MACHINERY the Poulsen system of wireless telegraphy was referred to. At the present time the inventor is paying more attention to the question of wireless telephony than that of telegraphy, although, of course, an advance in one direction may, in a sense, always be considered as an advance in the other. The results so far obtained by wireless telephony by the Poulsen system have been gratifying. Music has been transmitted for a distance of 290 miles, and conversation 170 miles, the reproduction of the speech being clear, and the voice easy to recognize. The question of wireless telephony is of particular importance in Europe, where many of the countries are segregated from one another by the sea, for comparatively

short distances. Telephoning through submarine cables has presented great difficulties, and for this reason it is expected that wireless telephony will fill a distinct demand.

An idea in electric heating which, however, would not be applicable to the United States, is mentioned in the *Western Electrician*. Throughout Germany and most of Continental Europe, the prevailing method of heating rooms is by means of large ornamental tile stoves, which reach nearly to the ceiling, and have a large heating surface at a rather moderate temperature. These, of course, are usually intended for wood or coal. A system of electric heating adapted to these stoves has, however, recently been brought out in Berlin. An electric radiator is mounted inside the stove, so that it will rapidly heat the walls by a circulation of the enclosed air. The heat is given off from the exterior tile surface of the stove, and is thus tempered so as to avoid the dry, high temperature effect. As the average cost of current in Germany is about 4 cents per K. W. hour, this system seems to have opened up a promising field for electric heating in that country. It is stated that an average sized room can be heated in one hour, and will then remain warm for a considerable period, as the tiles retain their heat for a long time.

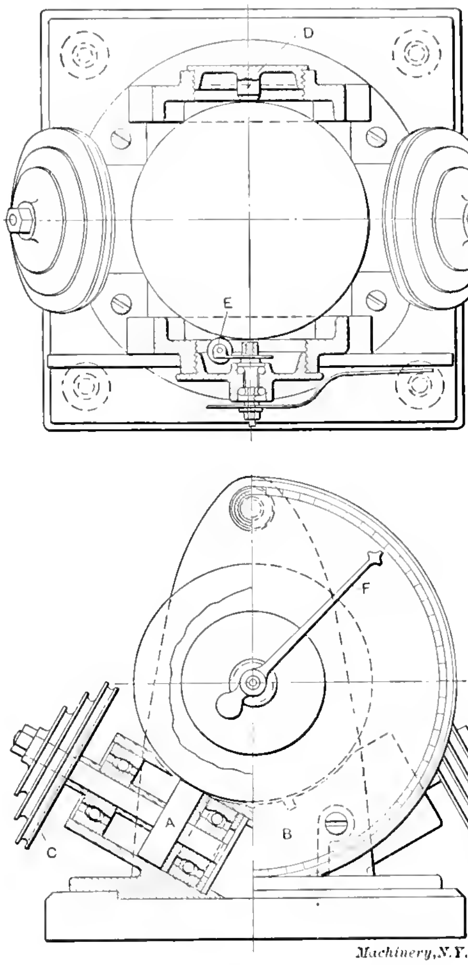
In view of the present agitation for the safeguarding of the life and limb of industrial workers, and in connection with the recent exhibit of safety appliances which took place in New York City during April and May, some figures given by Dr. Joseph A. Holmes in the Bulletin of the United States Geological Survey, although they refer in particular to the coal mining industry, should be of interest to everybody who realizes the necessity of greater vigilance in regard to safety appliances. Dr. Holmes says that the experience in deeper and more dangerous coal mines, particularly in Belgium, indicate that American mine accidents may be reduced to less than a third of their present frequency. He says that American coal mining methods are less safe than those of any other country. In 1906, 3.4 men were killed for every one thousand employed. In Belgium the corresponding figure was only 0.94 in the same year. In Great Britain the corresponding figure was 1.29, and in France 0.84 in 1905, and in Prussia 1.8 in 1904. What makes this comparison all the more significant is a further statement by Dr. Holmes that in no country in the world are the natural conditions so favorable for the safe extraction of coal as in the United States. The work done both privately and publicly for safeguarding industrial workers, both in the coal mining industry and in other fields of industrial activity, should receive increased impetus from statistics of this character.

NEW USE FOR MANGANESE STEEL.

A good example of how the development of one industry helps another is found in an order for manganese steel disks recently placed by the Cutler-Hammer Clutch Co., of Milwaukee. This company, in addition to manufacturing magnetic clutches, makes a specialty of lifting magnets for handling pig iron and scrap metal. The growth of this latter business and the natural desire of the manufacturers to perfect every detail of their product has led to the adoption of manganese steel for coil shields—the coil shields being the flat disk fastened to the under side of the lifting magnet for the double purpose of protecting the magnetizing coil and interposing between the two poles of the magnet an area of non-magnetic material. Brass, which is non-magnetic, has heretofore been used for this purpose. Ordinary steel will not do, because it is a magnetic metal and would serve to conduct the magnetic lines of force from pole to pole instead of compelling them to seek a passage through the material to be lifted. Manganese steel seems to be the ideal metal for this purpose. It is non-magnetic, like brass, and infinitely harder—so hard, in fact, that the continued hammering of the pig iron or other metal on the under surface of the magnet makes not the slightest impression on it. The 50-inch magnets recently furnished by the Cutler-Hammer Clutch Co. to a number of steel mills in the Pittsburg district are all equipped with manganese steel coil shields instead of with the brass coil shields formerly used.

DIFFERENTIAL SPEED INDICATOR.

An interesting differential speed indicator was shown at the Exhibition of the Royal Society, London, England, on May 13. The device was exhibited by Sir John Thornycroft, and the accompanying illustration is taken from *Engineering*, issue of May 15, 1908. The device consists of two cylindrical rollers, one of which is shown at *A*, and the other located at the opposite side of the device inside of the cover *B*, in a position similar to that occupied by the roller *A*, only inclined to an opposite angle. The axes of the rollers are in the same vertical plane, simply being inclined to one another, as mentioned, after the fashion of the guide rollers of a conveyor. These rollers are mounted on shafts on the ends of which are mounted pulleys *C*, which in turn are driven from the shafts the relative speeds of which are to be compared. Resting on these cylindrical rollers is a solid steel ball, 3 inches in diameter. To prevent the ball from rolling off the rollers, it is held in place at the back by a small stop *D*, and



Differential Speed Indicator.

at the front by a small wheel *E*, as shown in the plan view of the device. The wheel *E* is mounted on an arm fixed to a spindle, free to rotate, so that the wheel with its carrying arm forms a sort of caster. It is clear that if both the supporting rollers are driven at an equal speed in the same direction, the ball will rotate about a transverse horizontal axis and will carry the caster wheel either vertically up or down, as the case might be. Its direction will be indicated by the pointer *F* on the graduated scale of the device. If either of the supporting rollers runs faster than the other, the ball would rotate about some inclined axis, and the caster wheel would naturally turn so that its axis would be parallel to that of rotation of the sphere. The indications of the instrument are claimed to be very definite, and it is stated that a difference in speed of the rollers due to a nominally $2\frac{1}{2}$-inch diameter driving pulley being 0.001 inch less in diameter than the other, can be detected.

While the device itself may be as sensitive as this statement indicates, it seems, however, that to make the indications absolutely sure the motion should be transmitted from

the respective driving shafts, not by belt drives, as indicated, but by some means of positive drive, like gearing, or at least by chain drive. The slip of the belt alone, it seems, could effect a change in the speeds of the two cylindrical rollers, so that the sensitiveness of the device would be largely neutralized.

RECENT DEVELOPMENT OF THE GAS TURBINE.

Alfred Barbezat in *Cassier's Magazine*, April, 1908.

In the March, 1907, issue of MACHINERY an illustrated article was published on practical results with actual operative gas turbines in France. This article consisted of an abstract from an article on the gas turbine in *Cassier's Magazine*, for January, 1907. The same magazine has again published additional information regarding the recent developments in this field, the following abstract containing the most important points regarding these developments.

The first experiments with gas turbines were made with a small turbine of the same type as the De Laval steam turbine, capable of developing about 30 H. P., and after noting the performances of this machine when driven by compressed air alone, arrangements were made to use it in connection with a combustion chamber, delivering the products of the combustion of liquid hydro-carbon fuel at constant pressure through a nozzle upon the blades of the turbine. The combustion chamber is provided with a refractory lining, and in dealing with such high temperatures of combustion as are met with in engines of this kind, the temperature of combustion being over 3,200 degrees F., the best refractory lining has been found to be carborundum, this material being a product of the electric furnace, and thus having already sustained a higher temperature than that in the turbine combustion chamber. An elastic backing of asbestos provides for the expansion of the carborundum lining. The nozzles through which the cases are discharged are also made of carborundum. In addition to the refractory lining, the combustion chamber must be provided with a water jacket in the form of a coil of pipe imbedded in the metal of the chamber walls. When the water has circulated in the jacket tube, it is sent through small holes into the combustion gases just before they enter the nozzle, and the water is there converted into steam which acts to lower the temperature of the issuing gases to a point where they will not injure the blades of the turbine.

In order to obtain the desired result of a machine involving only rotary motion, it has been found necessary that the compressed air, by which the combustion chamber is fed, should be produced, not by a reciprocating combustion compressor, but by some form of rotary motion, preferably so arranged that it can be coupled directly to the turbine itself. This means that the complete gas turbine must also include a rotary air compressor, and that such a compressor must have a high efficiency in itself, otherwise it will produce such a large proportion of negative work as to detract materially from the efficiency of the compound machine.

After several experiments, a multiple turbine compressor was decided upon, which was found to be capable of delivering one cubic meter of air per second, at a pressure of six or seven atmospheres, with an efficiency ranging between 60 and 70 per cent. A large-sized gas turbine has been built, and in this machine the compressor is found to absorb about one-half of the power developed by the turbine. The machine when running at about 4,000 R. P. M. develops about 300 H. P. over and above the negative work absorbed by the compressor. It is stated, however, that the thermal efficiency of the machine it not as yet as high as that of a reciprocating gas engine. During the past few months a practical application of the gas turbine has been made in connection with the operation of submarine torpedoes. The turbine made for this purpose developed 120 H. P. at a speed of 1,000 R. P. M. The weight of the turbine alone is about 2.86 pounds per H. P.

While the gas turbine is, of course, still in its experimental stage, it has made a material advance during the past year, the 300 H. P. compound compressor turbine being an accomplished fact, and a number of 120 H. P. machines of special type being actually installed for service. When this rate of progress is compared with the time required to bring the reciprocating gas engine to its present state of perfection, there appears to be a reason for encouragement and interest in this form of gas engine.

PHOSPHOR-BRONZE.

Edwin S. Sperry, in the *Brass World*.

The term phosphor-bronze is used to designate an alloy of copper, tin and phosphorus, or of copper, tin, lead and phosphorus. The phosphorus is added in small quantities, with the sole object of reducing the oxide of copper, which forms during the melting. Any greater amount of phosphorus than the amount required for deoxidizing the bronze is injurious. The determination of the amount necessary to reduce the oxide of copper is quite difficult, as no two melts of copper oxidize the same. One melt may be heated longer than another, and thus absorb more oxygen. In general, however, it may be said that 0.05 per cent of phosphorus is sufficient. In making castings where scrap is used, it is often advisable to add more than enough to deoxidize the copper. From 0.10 to 0.25 per cent of phosphorus is advisable for this class of work.

Phosphor-bronze may be made in two ways: First, by introducing the phosphorus into a mixture of copper and tin; second, by first introducing the phosphorus into molten tin and making a phosphor-tin. This, in turn, is then added to the copper. The introduction of phosphorus into copper and tin while melted, as in the first process, is a dangerous operation, and accompanied by a loss of phosphorus. Sticks of phosphorus, kept under water to prevent spontaneous ignition, are placed in a bell-shaped arrangement of graphite called a phosphorizer, and the whole is pushed down under the surface of the molten copper. A violent ebullition takes place, with much loss of phosphorus, and danger to the operator. From 20 to 30 per cent of the phosphorus burns, the rest alloying with the copper.

The second process, in which the phosphorus is introduced into the molten tin, to make phosphor-tin, embodies the same processes as those outlined above, except that the phosphorus is first introduced into tin alone. As tin melts at a much lower temperature than copper, the introduction of phosphorus is attended with less danger. The copper is then melted in the usual manner, and the tin, and lastly the phosphor-tin, added.

One of the principal uses of phosphor-bronze is in the form of springs. A good mixture for phosphor-bronze springs is as follows:

Copper	95 parts by weight
Tin	4½ parts
5 per cent phosphor-tin	½ part

For phosphor-bronze of the highest possible strength, the following mixture is recommended:

Copper	90 parts
Tin	9 parts
5 per cent phosphor-tin	1 part

The mixture made according to this formula is poured into ingots, and then remelted and poured into sand castings. The remelting increases the strength. For ordinary work, when a medium strength is required, and when scrap must be used over and over again, the following mixture is recommended:

Copper	90 parts
Tin	8 parts
5 per cent phosphor-tin	2 parts

The scrap from this mixture may be used over and over again, with good results.

Phosphor-bronze, for use as bearings, which is one of the principal uses of phosphor-bronze in machine tool construction, must always contain lead. It is the lead which gives the bearing its "anti-frictional" qualities. The phosphorus prevents the separation of the lead. Lead may be present in the mixture up to 15 per cent, but the majority of makers use less. Tin must be used in the mixture as well. A good, general mixture of phosphor-bronze bearings is as follows:

Copper	80 parts
Tin	8 parts
Lead	10 parts
5 per cent phosphor-tin	2 parts

Zinc should never be present in phosphor-bronze. It causes liquidation and formation of tin-spots in a marked degree.

Tin-spots are small, hard, white masses in the interior of the casting. Frequently they are so hard that a file will not touch them. The excess of phosphorus in phosphor-bronze mixtures is also a cause of tin-spots. The secret of success in producing phosphor-bronze, in fact, is simply, in the first place, to keep the phosphor content down as low as possible in consistency with the serving of its purpose, and not to add any zinc.

NEW DEVICE FOR VARIABLE SPEED TRANSMISSION.

Abstract from pamphlet entitled *Theory and Practice of the Dieterich Universal Drive Axle.*

An interesting variable speed device has been brought out and patented by Mr. L. M. Dieterich, president of the Herma Securities Co., Kansas City, Mo. The fundamental principle of the device is best understood by reference to the diagrammatical view in Fig. 1. In this, *A* represents the shaft driven at the variable speed, while *B* and *C* are two disks receiving their motion in some suitable manner from the driving source, and running loose on the shaft *A*. The disk *D* is pivoted on the arm *B* at *O*, so that it can be inclined as shown by the dotted lines. The arm *B* is keyed to the shaft *A*. The drive to the shaft *A* is transmitted through this arm *B* from disk *D*, provided that this disk with its pivot *O* is given a rotary motion around the axis of shaft *A*.

It will be noticed that the inside of disks *B* and *C* are of spherical shape, so that when disk *D* is inclined, it will still be in contact with both of these outside disks. Now, if disk *D* is parallel to shaft *A*, and the two disks *B* and *C* are revolving in an opposite direction at the same speed, it is clear that while the rim of disk *D* will be revolving about its pivot *O* and around an axis at right angles to the axis of shaft *A*, the center of disk *D* will be stationary in relation to the axis of shaft *A*. Consequently, the arm *B* and the shaft *A* will also remain stationary. If, however, the disk *D* is placed in an angular position as indicated by the dotted line *EF*, it will be in contact with the disk *B* at the point *E* and with the disk *C* at the point *F*. The point *E* on disk *B* is revolving at a higher circumferential speed than the point *F* on disk *C*, the former point being located on a larger circle than the other. Under these conditions, it being assumed that there is no slip be-

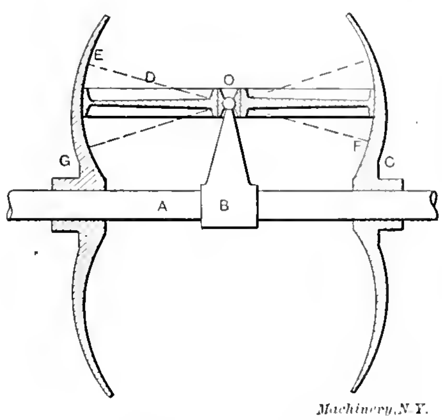


Fig. 1. Diagrammatical View Illustrating Principle of Variable Speed Device.

tween the disk *D* and the driving disks *B* and *C*, the center *O*, where the disk *D* is pivoted, must assume a rotary motion around the axis of shaft *A*, and the shaft *A* will consequently be carried around or driven at the speed determined by the angularity of the inclination of the disk *D*. The greater the angularity, the greater will be the difference in the driving diameters of the two disks *B* and *C*, and the greater also the speed of shaft *A*. It will be seen that it is possible to revolve the shaft *A* to any speed desired from zero to maximum, by giving the disk *D* different angular positions. It is also evident that by inclining the disk *D* to a position opposite to that of the line *EF*, as shown by the other dotted line in Fig. 1, the shaft *A* can be revolved in a reverse direction, although the two driving disks revolve constantly at the same speed, but, of course, in opposite directions.

This principle has been made use of in constructing the variable speed device shown in Fig. 2. A bevel gear *H*, mounted on the end of the driving shaft, gives motion to two bevel gears mounted on bearings concentric with the shaft *A*, which is the shaft to which motion is to be transmitted. These two bevel gears are provided with spherical surfaces on the inside, which form a contact path for the cork surface of the disk *D*. This disk revolves on an annular ball bearing, the inner surface of which is placed on a ring, pivoted on a stud in the head-bearing of an arm, keyed to the hollow shaft. As will be seen, the principle of the drive has been transferred almost identically to the practical working apparatus.

A lever, integral with the pivoted ring is operated by a linkage system, consisting of a stud reaching through a slot of the axle wall to a rod, the outer end of which is similarly connected with a sleeve revolving with the axle. An annular groove of this ring forms the path of the studs inserted into a forked lever, which, being pivoted in the axle housing, permits, by its operation, the oscillation of the floating disk. This device shows the simplest design of the principle ex-

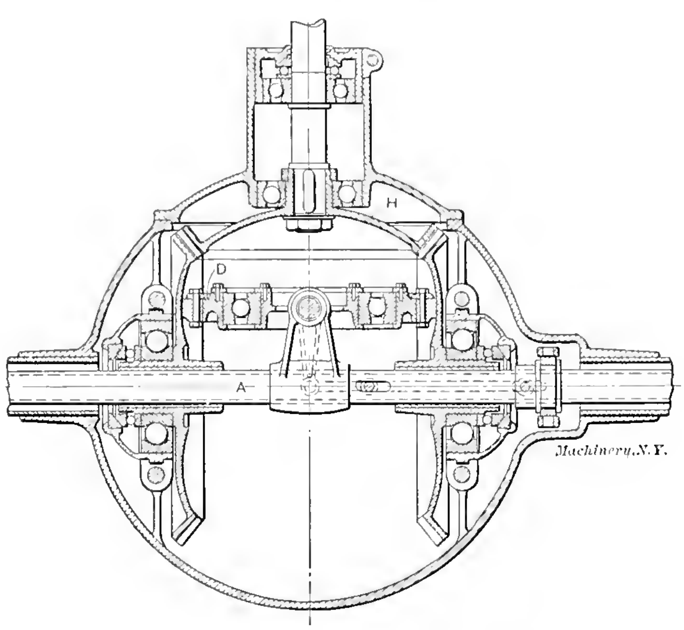


Fig. 2. Sectional View of the Variable Speed Device.

plained, applied to a variable speed mechanism intended for automobile work. Or course, the principle can be applied to more complicated devices, fulfilling their object in even a more perfect way than the one shown, and the inventor has brought out several different models.

[The one objection to drives based on this principle is that the variation of speed does not change the torque, so that even though the speed be small, the torque will not be proportionally greater, on account of the fact that the limiting factor for the torque is the frictional adherence between the driven and driving contact surfaces, and this frictional resistance is independent of the speed at which the shaft *A* is running. Consequently, while variable speed devices in general are of such construction that the torque increases when the speed decreases, in the present case the speed is variable, while the torque remains constant. As the main feature of variable speed devices is often not the variation of speed in itself as much as the increased torque obtained by a decrease in speed, the objection referred to is one of great importance —EDITOR.

* * *

The Cunard steamer *Lusitania* established a new record for a day's run June 9, when she reeled off 641 knots in 24 hours. Until the advent of the *Lusitania*, the record was held by the *Deutschland*, of the Hamburg-American line for her performance of 603 knots, July 29, 1901.

* * *

Felice Nazarro, an Italian automobile driving expert, made a world's record June 8. He drove a car on the Brooklands track, London, 23¼ miles at the rate of 120 miles per hour. This record does not include the swiftest mile, however. Demogeot, driving a car on Ormond beach, January, 1906, covered two miles in 58 1-5 seconds, or at the rate of 122.4 miles per hour. The best mile straightaway is held by Marriott, driving a Stanley steam car one mile in 28 1-5 seconds.

MAXIMUM STRESSES—3.*

JOHN S. MYERS.†

COMBINED TORSION AND BENDING.

One of the most familiar examples of combined stresses is that of torsion and bending, the torsional stresses being shearing stresses, and the bending stresses being tension and compression stresses. The maximum stress may be found by first calculating each separately, and then combining them according to formulas 26 and 27 as given in the May issue. A more direct method is to combine these equations with those for torsion and bending, thus producing formulas which give maximum stresses at once.

Let M_b = bending moment,
M_t = torsional moment,
I_r = rectangular moment of inertia,
I_p = polar moment of inertia,
Z_p = polar section modulus,
C_r = distance to extreme fiber from rectangular axis,
C_p = distance to extreme fiber from polar axis,
S = unit shearing stress due to torsion,

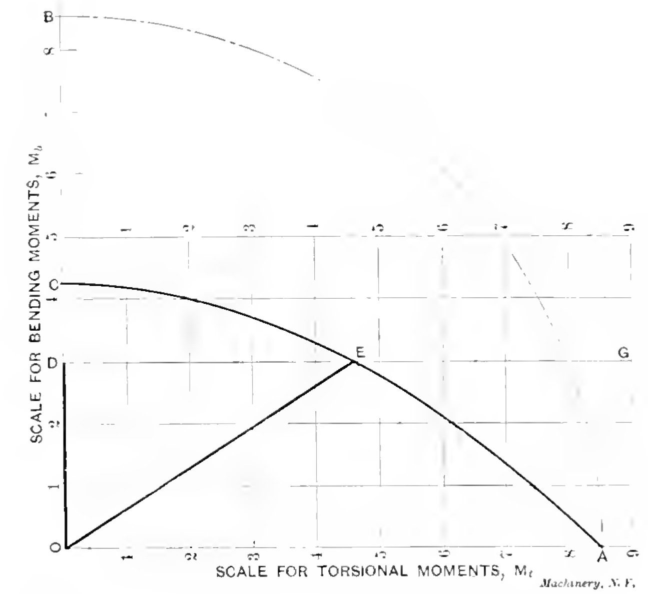


Fig 8. Method of plotting Curves for Combined Torsion and Bending.

t = unit tensile or compressive stress due to bending,
S_m = maximum or combined shearing stress,
t_m = maximum or combined tensile or compressive stress.

Then

$$S = \frac{M_t C_p}{I_p} \quad (31) \qquad t = \frac{M_b C_r}{I_r} \quad (32)$$

$$S_m = \sqrt{S^2 + \left(\frac{t}{2}\right)^2} \quad (26) \qquad t_m = \frac{t}{2} + \sqrt{S^2 + \left(\frac{t}{2}\right)^2} \quad (27)$$

Substituting the values of S and t as given by formulas (31) and (32) in equations (26) and (27), gives,

$$S_m = \sqrt{\left(\frac{M_t C_p}{I_p}\right)^2 + \left(\frac{M_b C_r}{2 I_r}\right)^2} \quad (33)$$

$$t_m = \frac{M_b C_r}{2 I_r} + \sqrt{\left(\frac{M_t C_p}{I_p}\right)^2 + \left(\frac{M_b C_r}{2 I_r}\right)^2} \quad (34)$$

Formulas (33) and (34) are general, being applicable to any case of combined torsion and bending. The most usual cases, however, are either round or square sections for which $C_p = C_r$ and $2\, I_r = I_p$. Substituting these values in equations (33) and (34) gives, for round and square sections,

$$S_m = \frac{C_p}{I_p} \sqrt{M_t^2 + M_b^2} \quad (33a)$$

$$t_m = \frac{C_p}{I_p} (M_b + \sqrt{M_t^2 + M_b^2}) \quad (34a)$$

The polar section modulus $Z_p = \frac{I_p}{C_p}$; then.

$$S_m = \frac{\sqrt{M_t^2 + M_b^2}}{Z_p} \quad (33b)$$

$$t_m = \frac{M_b + \sqrt{M_t^2 + M_b^2}}{Z_p} \quad (34b)$$

Now from equation (33*b*) we have the quantity $\sqrt{M_t^2 + M_b^2}$ which expresses the measure of the two moments to produce torsional or shearing stresses. This quantity may be called the ideal torsional moment. Equation (34*b*) gives the quantity $M_b + \sqrt{M_t^2 + M_b^2}$ as the measure of the two moments to produce bending stresses, *i. e.*, tension and compression stresses. This quantity is generally termed the ideal bending moment, although this name is rather misleading, inasmuch as it is developed in connection with the polar section modulus, which is used for torsional or shearing stresses. The ideal bending moment if used in connection with the rectangular section modulus should be taken as $\frac{1}{2}(M_b + \sqrt{M_t^2 + M_b^2})$, which could more logically be called an ideal bending moment. For

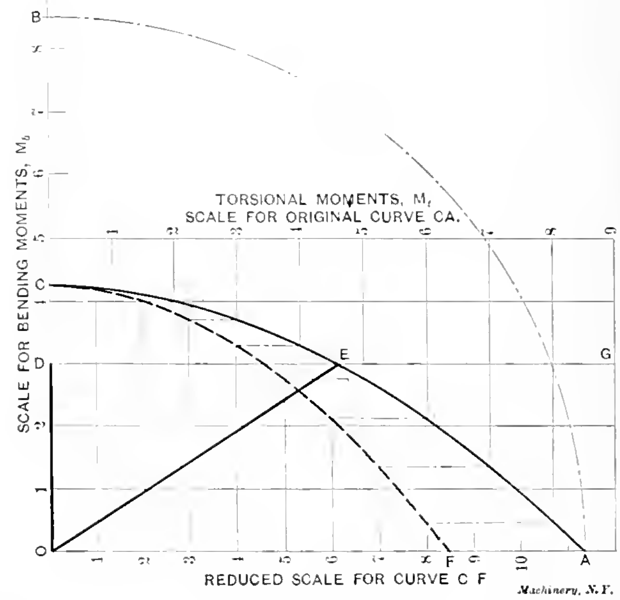


Fig 9. Method of plotting Curves for Diagrams Figs. 10, 11, 12, and 13.

the present article, it was deemed advisable to have both expressions developed for the polar section modulus, in order that they may show the relative values of the maximum combined shearing stress as compared with the maximum combined tension or compression stresses.

Tables IX and X of the Supplement give tabulated values of the ideal torsional moment T, and the ideal bending moment B, according to the formulas

$$T = \sqrt{M_t^2 + M_b^2} \quad (35)$$

$$B = M_b + \sqrt{M_t^2 + M_b^2} \quad (36)$$

both being for use with the polar section modulus as before mentioned.

Equations (33b) and (34b) may now be written,

$$S_m = \frac{T}{Z_p} \quad (33c), \quad \text{and} \quad t_m = \frac{B}{Z_p} \quad (34c)$$

It will be noted that B is always greater than T. It is then the combined tension and compression which determines the size of section to be used, and the ideal torsional moment may be neglected entirely.

Authorities do not all agree on the subject of combined torsion and bending. The above formulas agree with Rankine's, while Grashof gives as the ideal bending moment $B = \frac{3}{8} M_b + \frac{5}{8}\sqrt{M_b^2 + M_t^2}$, or, if expressed for use with the polar section modulus as is formula (36), it becomes $B = \frac{3}{4} M_b + \frac{5}{4}\sqrt{M_b^2 + M_t^2}$. An inspection of the two formulas will show that Grashof gives greater value to the torsional moment than does Rankine, for if the bending moment be zero, then $B = \frac{5}{4} M_t$, which would agree with the usual assumption

* Continued from the May issue.
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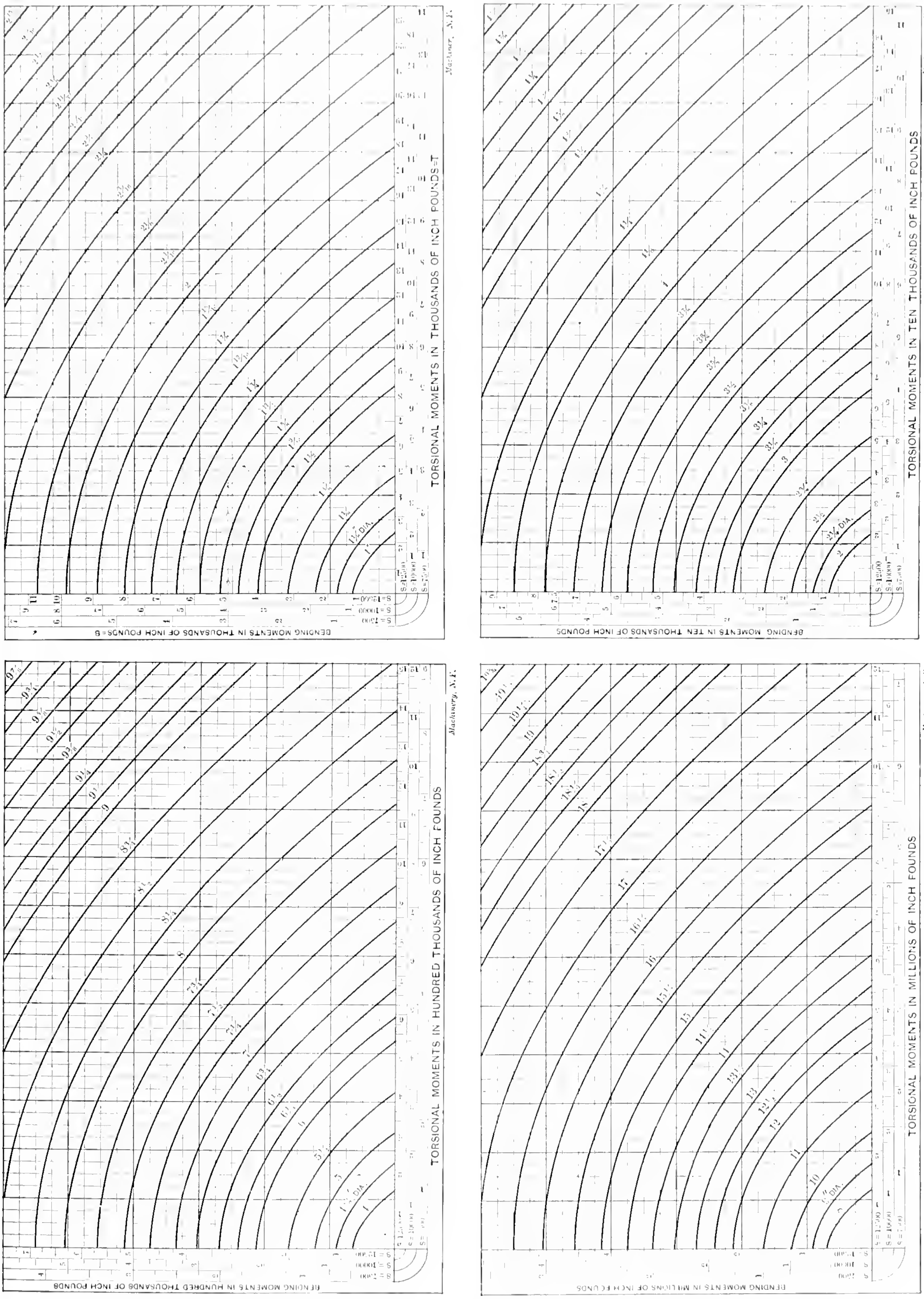


Figs. 10, 11, 12, and 13 Diagrams giving Diameters of Shafts for Combined Torsion and Bending Stresses in Thousands, Ten Thousands, Hundred Thousands and Millions of Inch-pounds.

that the ultimate shearing strength of steel is about 4/5 of the ultimate tensile stress.

In this connection it is well to note that, in the case of shafting, the location and direction of the tooth loads or belt pulls, producing bending, remain fixed while the shaft rotates. The bending stresses are thus constantly varying in direction, and since a greater factor of safety should be used for reversible stresses than for those constant in direction, some

designers recommend that the allowable working stress vary, higher stresses being used when the torsional moment predominates than are allowed when the bending moment is the greater. One of the exponents of this idea assumes an ultimate tensile stress of 62,500 pounds per square inch, and gives as the safe value of the working stress $t_m = 11{,}350$ when $\frac{M_b}{M_t} = \frac{1}{4}$, or less, and $t_m = 8{,}750$ when $\frac{M_b}{M_t} = 2$ or more, t_m to be proportional for intermediate values of $\frac{M_b}{M_t}$.

On the other hand, the ultimate tensile stress is approximately 25 per cent greater than the ultimate shearing stress; the determining stress is always the combined tension or compression, and not the shear, and since the Rankine formula is less liberal in its recognizance of the torsional moment than is that of Grashof, the writer believes the use of the Rankine formula, with a constant allowable safe stress, makes ample provision for the fact that the bending stresses are reversible.

Example.—A shaft $3\frac{1}{2}$ inches in diameter is subjected to a torsional moment of 36,000 inch-pounds, and a bending moment of 35,000 inch-pounds. What is the combined shearing stress and the combined tension compression stress?

Solution.—Referring to table X (see Supplement of current issue), and remembering that all values may be multiplied by 10 we have for $M_t = 36{,}000$ and $M_b = 35{,}000$, $T = 50{,}210$ and $B = 85{,}210$. From table VII of the Supplement to the May issue for a $3\frac{1}{2}$-inch shaft $Z = 4.209$. The polar section modulus being twice this, we have $Z_p = 2 \times 4.209 = 8.418$.

By formulas (33c) and (34c)

$$S_m = \frac{T}{Z_p} = \frac{50{,}210}{8.418} = 5970, \text{ and}$$

$$t_m = \frac{B}{Z_p} = \frac{85{,}210}{8.418} = 10{,}130, \text{ approximately,}$$

A formula for computing the diameter of a shaft for combined torsion and bending may be derived from equation (34c) by substituting for Z_p its value $\frac{\pi D^3}{16}$, and for B its value as given by formula (36), and then solving for the diameter D, which results in the expression

$$D = 1.72 \sqrt[3]{\frac{M_b + \sqrt{M_t^2 + M_b^2}}{t_m}} \qquad (37)$$

Tables XI and XII of the Supplement give diameters of shaft for combined torsion and bending according to formula (37), the tables being arranged for fiber stresses of 7,500, 10,000, and 12,500 pounds per square inch to suit different classes of work or grades of material at the discretion of the designer.

Example.—At 10,000 pounds per square inch fiber stress, what should the diameter of a shaft be to sustain a bending moment of 80,000 inch-pounds, and a torsional moment of 100,000 inch-pounds?

Solution.—Referring to table XI, opposite 80 in the 10,000 pounds stress column, and vertically under 100 in the same stress column, the required diameter is seen to be $4\frac{3}{4}$ inches. The above problem, if solved by the application of formula (37) would be,

$$D = 1.72 \times \sqrt[3]{\frac{80{,}000 + \sqrt{100{,}000^2 + 80{,}000^2}}{10{,}000}} = 4.735 \text{ inches.}$$

which shows the labor saved by a convenient table. One trouble with tables is the interpretation for intermediate values. A diagram or chart is much better in this respect, and if drawn to a convenient scale should be preferable. In Fig. 8 is illustrated a graphical method of plotting a curve which will represent all the various combinations of torsional and bending moments that a shaft of given diameter and given fiber stress can withstand. The method is as follows:

Let D = diameter of a shaft, and t_m = fiber stress. Then the torsional moment the shaft can withstand $= t_m \frac{\pi D^3}{16}$. Calculate this value for any particular size of shaft and lay it off on the scale of torsional moments, as OA in Fig. 8. The location of the point A on the scale then represents the torsional moment the shaft can sustain. The bending moment the shaft can withstand is $t_m \frac{\pi D^3}{32}$, or one-half the torsional moment. Consequently, to find a point C on the scale of bending moments, which by its location will represent the bending moment the shaft can withstand, take O as a center and, with a radius equal to OA, describe an arc AB, intersecting the scale of bending moments at B. Bisect the line OB, thus locating the point C. The points A and C are now the two limits of the desired curve. To locate any intermediate point, as E, where the curve cuts any line, as DG, take a radius equal to DB, and with O as a center describe an arc, cutting the line DG at E. To show that E is a point in a curve which satisfies the conditions of the problem, equate the torsional resisting moment with the ideal moment as given by formula (36), which results in the expression,

$$t_m \frac{\pi D^3}{16} = M_b + \sqrt{M_b^2 + M_t^2} \qquad (38)$$

Now, in the location of this point, $OD = M_b$, and $DE = M_t$, then $OE = \sqrt{M_b^2 + M_t^2}$, and $OD + OE = M_b + \sqrt{M_b^2 + M_t^2}$. By construction, $OA = OB = t_m \frac{\pi D^3}{16}$; also, by construction, $OE = DB$; then $OD + OE = OD + DB = OB = t_m \frac{\pi L^3}{16} = M_b + \sqrt{M_b^2 + M_t^2}$, or location of point E satisfies equation (38), which shows the method of construction to be correct.

Having the method of locating points on the curve, we have only to locate a number of such points and then draw the curve. A diagram constructed in this manner will, however, make the length of sheet double its width, which is not a desirable proportion. To overcome this difficulty, the curves of diagrams, Figs. 10, 11, 12, and 13, were first plotted as illustrated by Fig 8. Then a new scale for torsional moments was constructed three-fourths the length of the original one, as illustrated by Fig. 9. Points where the curve intersected an ordinate on the original scale were then projected onto the equivalent ordinate of the new scale, resulting in the curve as shown by the dotted line CF.

* * *

A very satisfactory steam-pipe covering consists of a wrapping of asbestos, followed by a layer of excelsior and, over all, a piece of canvas fastened down with wire. The canvas may be painted to insure greater longevity.—*Valve World.*

* * *

On a trip made the latter part of May, the *Mauretania* had the misfortune to break one of her propeller blades. Upon her return to Liverpool the propeller was stripped, but lack of time prevented replacing it, and she made another crossing with three propellers. The absence of the propeller seemed, if anything, an advantage, and according to veracious (?) newspaper report, it is proposed to use only three propellers hereafter, instead of four.

* * *

Casein cement consists of casein and tannate of lime. A solution of tannin is first prepared, either by dissolving tannin in water or boiling Chinese gall-nuts in water and straining the fluid. Clear lime is gradually added to this solution till precipitation ceases and red litmus paper, dipped in the fluid, is colored blue. The fluid is then decanted and the precipitate dried. The dried product designated chemically tannate of lime, is then mixed with casein and the mixture ground and sifted. The proportion in which the ingredients are mixed depends upon the purpose to which the mixture is to be applied; as a rule, 90 parts of casein and 10 of tannate of lime are taken. When required for use, a sufficient quantity of water is added to the cement. A tenacious binding material of the requisite consistency is thus obtained. When completely dry the cement is very hard and tough, and absolutely insoluble in water, petroleum, or oil; consequently it is admirably adapted for a large variety of purposes.—*Scientific American.*

EVENING SCHOOL OF TRADES—RINDGE MANUAL TRAINING SCHOOL, CAMBRIDGE, MASS.

E. R. MARKHAM.*

When one has been engaged for some time in a certain work, and has seen many cases where those with whom he has associated in the work have been directly benefited, he naturally becomes very much interested therein. Eight years ago, while superintendent of a shop building machinery, I was asked to take charge of the machine shop in an evening school. I accepted the charge, and have been identified with such work ever since. Our school—The Rindge Manual Training School, Cambridge, Mass.—is open three evenings a week for 21 weeks each year to men who are anxious to learn certain branches of shop work which their experience has not given them an opportunity to learn. In our shop building there are classes in blacksmithing, pattern-making and machine-shop work, each under the supervision of an instructor who has worked for years at the particular trade he is teaching.

to the school by those who have been with us for a year, or a number of years, and that many who had several years shop experience ask us to start them off with preliminary work, in order that they may become thoroughly familiar with the principles that underlie a successful knowledge of the business.

We have had in our evening school a number of first-class tool makers, die-makers, and others, who ranked high in the particular branches in which they were employed. These men came to us to learn some particular thing in which they knew themselves weak. I have in mind two men who were excellent workmen, both tool-makers, who had been engaged for a number of years on punch press die work; they were anxious to learn to harden dies and punches; both men spent two terms with us, and on a number of occasions have said that the time in the school was well spent.

Scope and Nature of Instruction.

As previously stated, we intend to adapt the work to the man, and thus try to help him to improve his condition. To accomplish this, we have classes in mathematics in connection

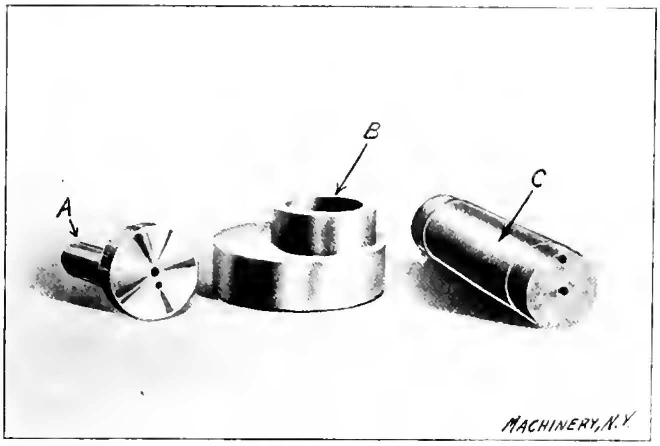


Fig. 1. Work done in Trade School—Examples of Shrink Fits and Eccentric Turning.

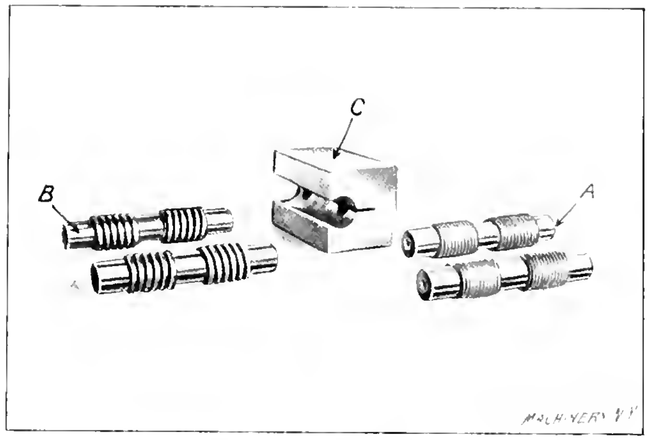


Fig. 2. First Threading Jobs.

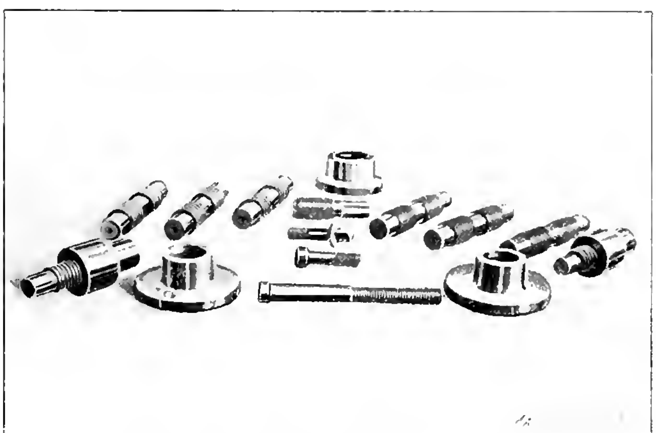


Fig. 3. Face-plates, and Additional Threading Jobs.

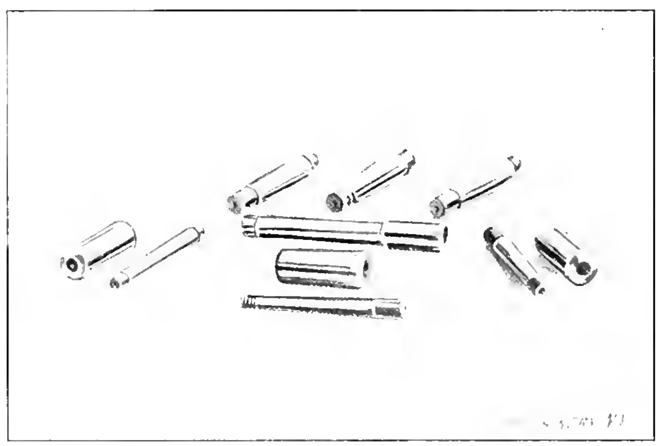


Fig. 4. Examples of Taper Turning.

As I am engaged in teaching machine-shop work, I will confine myself to the work done in that particular department. I would say, however, that the patterns for such parts of our work as are made from cast iron are made by the men in the pattern-shop, and all forgings, both of machine parts and cutting tools, are made in our forge shop.

The Purpose of the Evening Courses.

The applicants for admission to our evening courses must be engaged in the daytime in the same, or similar, lines of work. We have lathe hands who have been running lathes for years, doing straight turning, who are anxious to learn to turn tapers, to cut screw threads, or to lay off work and locate it on the face-plate of the lathe, for machining some portion or for drilling and boring. In fact, we intend making each case an individual case, and give the man just what he needs. Many times we are able to help the man in deciding just what will be for his best interest. We find, as time goes on, that new men come to us who have been induced to come

* Address: 7 Greenough St., Cambridge, Mass.

with our shop work. In the mathematical work our men are divided into three classes, the elementary, the intermediate, and the advanced class. Each class meets one evening each week in the class room, the other two evenings are spent in the shop. The instruction given is all of a practical nature. The elementary class is composed of those men who have had very little training in arithmetic, and includes the simple principles of arithmetic, common fractions, ratio and proportion, and decimal fractions. The problems are all practical shop problems. We find the men greatly interested in the work, and they make remarkable progress.

The intermediate class, after a hasty review of the things given the elementary class, commence with ratio and proportion. They are given problems in figuring change gears of lathes for screw cutting, and similar work. Then follows mensuration of surfaces, such as finding the area of circles, rectangles, triangles, hexagons, octagons, etc.; then the finding of the cubical contents of bars of various sections; then the weight of such bars, if made of wrought iron, cast iron,

steel, lead, or various alloys. This instruction is continued until the men are able to compute the weight of bars of various sizes, shapes and lengths. The student measures a bar, figures out the weight, and then weighs the bar to verify his figures. After sufficient ground has been covered, the class is given general shop problems and formulas that pertain to shop work.

The advanced class commences with weights of materials, problems in belting and gearing, and such problems and formulas as enter into ordinary shop work. The men take great interest in shop mathematics, and several have asked to be allowed to spend two evenings a week in the class room. The majority ask for extra problems to take home and work out between times. In fact, we have been very pleasantly surprised at the interest the men manifest in this branch of the work.

Instruction in Shop Work.

In the shop we have no set order of procedure. The man is given such work as seems best adapted to his particular needs. However, men who are not familiar with lathe work, or those who manifest a desire to commence at the beginning, are given the same exercise as we give the boys in our day school, as we have found by experience that greater progress is made, with a minimum waste of stock, if the elementary principles are taught by the use of exercises which involve these principles. In general, I am not an advocate of exercises, and do not use them in my day school, except to teach the elementary principles, as stated above.

The first exercise is turning a cylindrical piece of cast iron. The pupil centers it according to instructions given, squares

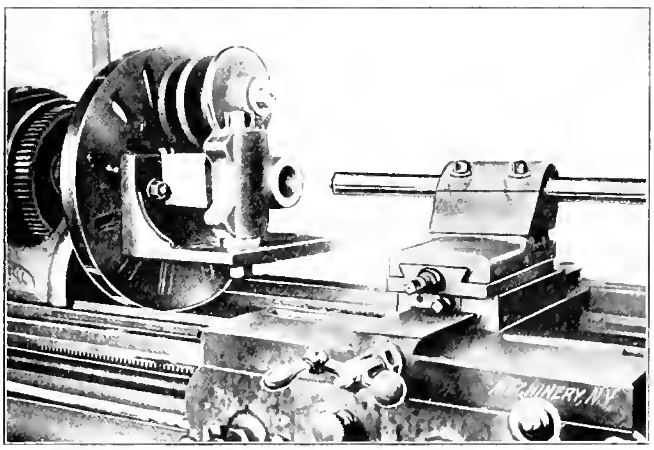


Fig. 5. Boring Job.

the ends in the usual manner, then turns it to a given size, gaging the size by means of spring calipers set to a scale. He is taught how to use the calipers to get a definite size. The lathe is then set to turn a given taper; this is done by setting over the tail-stock. No fit is attempted on this piece. The small end is turned to a specified diameter.

The second exercise is making a lathe center. The pupil is taught to compute the amount he must set over the tail-stock center to produce a taper that will fit a given lathe spindle; he measures a center that fits the spindle hole, finds how much it tapers in a given length, and then finds, by proportion, how much the tail-stock must be set over to produce the same taper on the piece he is to turn. He turns, tries, and fits it in the usual manner. When the taper is turned to a fit, and so it enters the spindle hole the proper distance, it is inserted in the hole, and the end is pointed by setting the compound rest at the proper angle, thus producing the desired angle on the point.

The third exercise is making a shrink fit. The completed piece appears as shown at *A*, Fig. 1. A disk is placed in the lathe chuck so that a center punch mark which is $\frac{3}{8}$ inch from the true center of the disk will run true. A hole is drilled and then bored from 0.003 to 0.005 inch less than $\frac{7}{8}$ inch, and then reamed with a $\frac{7}{8}$-inch hand reamer. The gaging of this hole is done with a pair of inside spring calipers set to a micrometer. After reaming, the hole is measured, and the end of the cylindrical piece is turned 0.003 inch *larger* than the hole. The disk is then heated and shrunk onto it. The sides of the disk are faced parallel, and eccentric centers ($\frac{3}{8}$ inch eccentricity) are drilled in each end. The disk is then turned on the eccentric centers. We consider this a valuable exercise, as it enables us to teach several things. At first, it is not wise to try to teach more than one step at a time, and on this piece but one step is taken at a time, but successive steps bring out several different points.

After completing the shrink-fit exercise, a threading job is taken up. A cylindrical piece of cast iron is turned and threaded as shown at *A*, Fig. 2. A right-hand thread is cut at one end, and a left-hand at the other, as shown. No at-

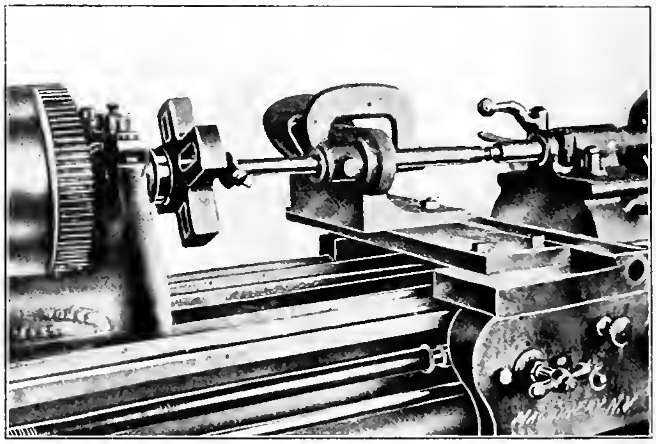


Fig. 6. Using the Boring-bar.

tempt is made to fit this to a nut, as experience has taught us that new processes are the more readily grasped when the beginner has but one thing in his mind at a time. He next cuts a right- and left-hand square thread, as shown at *B*, Fig. 2.

After these two preliminary pieces of work are completed, a face-plate is made. The face-plate is made to fit the spindle of one of the wood-turning lathes used in the pattern-shop. The hole is drilled and bored, and the thread cut with an internal threading tool until a tap of the proper size will just enter. The three end threads are recessed out. The face-plate is then taken from the chuck and the thread finished by the tap. After this operation it is placed on a threaded mandrel and turned to final dimensions. In Fig. 3 two of the face-plates are shown in the foreground, while at the back of the table is shown a chuck back. In the case of a man wanting to get an added experience in internal threading, he is allowed to make one or more chuck backs after he has completed the face-plate. Some of the men are anxious to devote considerable time to screw cutting. To these we give the job

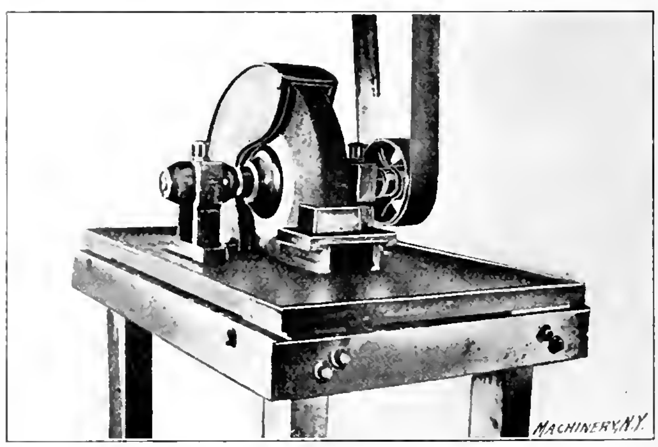


Fig. 7. Tool Grinder built in the Trade School Shops.

of making various forms of screws and threaded mandrels, as shown in Fig. 3. We are constantly reminding them of the necessity of keeping their lathe centers in proper condition, in order that the various portions of a piece shall be concentric.

Fig. 4 shows three tapered sleeves with taper holes, a drill collet, and several tapered mandrels. These mandrels have hardened ends and soft bearing portions. The ends are hardened, and the tapered portion turned afterward. After making one or more of the tapered pieces shown, the men are

given such work as will be to their advantage. We have found that it is wise for us to build machines, provided we do not "bite off more than we can chew." We do not consider it advisable to build anything that would necessitate our keeping our machines tied up for a number of weeks on one piece. It is necessary to bear in mind the fact that our men are with us but three evenings a week, and but two hours each evening.

The various parts of the different machines being built furnish a variety of work that enables us to select jobs adapted to the various men. Fig. 5 shows a job of boring, the piece being held on an angle-iron. The hole at right angles to the one being machined was bored and reamed first, the piece being held in a lathe chuck. The piece was then placed on a stud on the angle-iron as shown, and the hole bored to size.

Fig. 6 shows a boring-bar job. It was necessary to make a number of tool rests for our wood-turning lathes. The bottoms of the rests were planed. The rests were then clamped to the angle iron as shown, and the holes bored to size.

Fig. 7 shows a tool grinder built in the shop. As it was necessary to use this before the pattern for the base was completed, it was mounted on a wooden frame. We have several of these grinders under way.

Fig. 8 is a combined surface grinder and tool grinder. The knee supporting the tilting table is adjustable up and down by means of the hand-wheel shown. We have two more grinders similar to the one shown, under way. At either end of the driving pulley are hardened collars to take the end wear. One of these is threaded into the pulley, and is adjustable to compensate for wear. The grinder shown has cast iron spindle bearings, while the two being built have babbitted bearings. The babbitt is poured around a mandrel considerably smaller than the finished size of the bearings. It is then hammered and bored and reamed to size. The spindle bearings are all draw filed to fit.

We are building two small friction-driven sensitive drill presses. As we have no boring machine, we are obliged to use a lathe, or drill-press, for work that is done with a boring-bar. As we have no lathe large enough to bore the base to receive the column, we found it necessary to use the upright drill for the job, as shown in Fig. 9. In the center of the table is a bushing to receive the boring-bar. The bushing has a key which enters the keyway in the bar, shown in Fig. 10. The bushing then, of course, revolves with the bar. The table of the drill-press we make is bored to receive the column by means of a boring-bar in a lathe, as shown in Fig. 11. The table is held on an angle-iron, as shown.

The head is bored to receive the column, as shown in Fig. 12, the head being held on an improvised jig. The cutter is held in a device which screws on the nose of the spindle. Both jig and cutting tool were made by the students in the evening school. When getting ready to bore the hole in the head, it is, of course, necessary to locate the head on the lathe, so that the spindle holes are in exact alignment with the axis of the lathe, in order to insure the spindle standing at right angles to the table when the drill press is assembled.

While we would welcome a horizontal boring machine as a part of our equipment, I am inclined to think that the use of a machine for purposes other than it was originally designed for gives the men a certain knowledge that may be of value to them when they find themselves confronted with a special job and no machine at hand especially adapted to it. When we do a piece of work in a manner different from that ordinarily pursued in a shop, the usual method is fully explained, in order that the man may know how to go to work when the proper machine is at hand, and also how to improvise a method for doing it, if necessary. When it is necessary to have any special fixtures or cutting tools—except gear-cutters—we make them, either in the evening school or in our day school.

By the way, we read at times in our mechanical journals articles regarding manual training schools that would lead one to think that little of practical value is taught in them. I do not claim to know much about such schools in general, but I do know what our boys get. Their work is exactly parallel to that given the men in the evening school. They build machines, special holding and cutting tools, repair the machines in our different shops, and, in fact, the work is as nearly parallel to actual shop work as we can make it.

Fig. 13 shows a number of the small parts of a press, other parts not being far enough along to photograph. We make it a point not to let anything go into the machines we are building that is not as nearly correct as would be found in the ordinary commercial article of the same type, but do not claim that as large a proportion of the pieces made pass inspection, as would be the case in a manufacturing establishment. Fig. 13 also shows two punch press blanking dies. The one at the left is for producing a blank, and the other receives a punch used in trimming the edge of the sheet.

Fig. 14 shows a two-jaw chuck for use on a large pattern-maker's lathe. The jaws are operated by means of the right- and left-hand screw shown. This chuck is about 15 inches in diameter.

In Fig. 1, at *B*, is shown an eccentric, and the eccentric mandrel *C* used in turning it. A large variety of eccentric work not shown in any of the photographs has been done. The individual pieces are designed to give some pupil the special training needed in his particular line of work.

At *C*, Fig. 2, is shown a fixture used in holding a sleeve that acts as a rack for moving the spindle of the drill press up and down, in the operation of drilling. The sleeve has rack teeth cut along one side to receive the small pinion shown

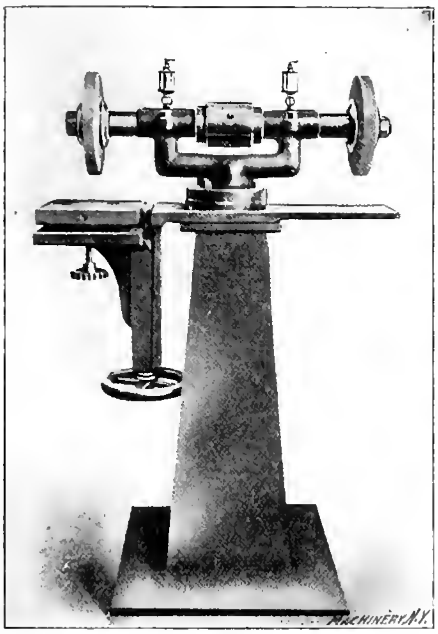


Fig. 8. Combined Surface and Tool Grinder built in the School Shops.

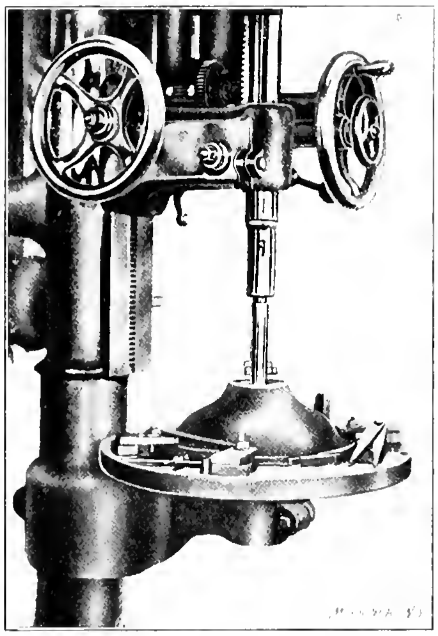


Fig. 9. Boring Small Drill Press Base.

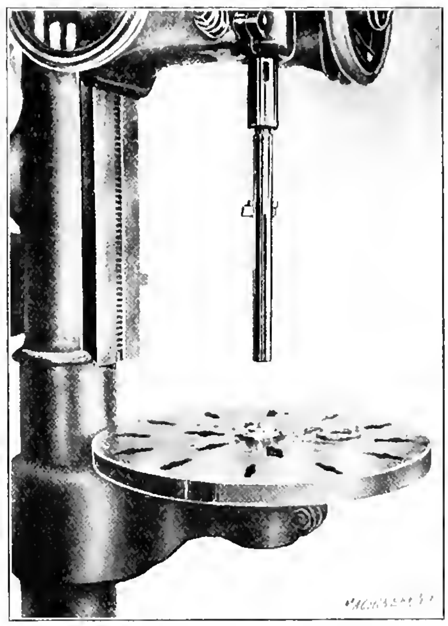


Fig. 10. Method of Guiding the Boring-bar while boring Drill Press Base.

in Fig. 13, by means of which it is raised and lowered. The opening to receive the sleeve was drilled, bored, and reamed to size, the piece being held on an angle-iron attached to the face-plate of a lathe. It was then placed on a special mandrel, having a straight holding portion, the ends of which were of exactly the same size. These ends were supported in V-blocks on the planer, and the bottom planed with a tongue as shown. This tongue fits one of the cross slots of our milling machine tables. By the use of this fixture the rack teeth are milled at right angles to the axis of the sleeve.

In cases where special fixtures are not absolutely necessary, they are still sometimes made, and the advisability of their use is explained to the men. When it is not necessary to make them, the advantage of their use in shops where many pieces of a kind are made, is explained to them. The men attending our evening school have shown a remarkable interest in the work. The attendance has been very gratifying. Quite a number have been able to materially better themselves since attending the school; some have had an increase in pay, because they were able to do a class of work that demanded higher wages; others have obtained better positions on account of increased knowledge. A little incident, extremely gratifying to those in charge, came to our attention a little while ago. In a certain shop it was necessary to cut a fractional thread on a piece of work. The gear plate did not show gears for this thread. Several of the men were asked to "figure out" the gears; but as the lathe was of compound gear construction none of those asked were able to do it. Finally one of the men as a joke said: "Get 'Jerry' to tell you what gears are needed." "Jerry" is an apprentice in the shop, and attends our evening school. "Jerry" was consulted, and was able to tell them the proper gears to use. He says that he would not have been able to "figure the gears" but for the knowledge gained in the school.

Each man attending the evening school is given a set of notes. These notes are written or compiled by the instructor. They are then typewritten and mimeographed at the office of the "Massachusetts Commission on Industrial Education," under whose supervision the school is run. The past year has been the first that we have given the notes in the form mentioned; before this they have been given in the lectures, the men taking such notes as they saw fit. By the present system much valuable time is saved, and the men have the notes in note-book covers. Each year we propose adding to them, and think that in a few years they will make a text-book that will be of value to the men.

We do not think our course is perfect and we are constantly endeavoring to improve it; but we have the satisfaction of knowing that some of the men have been materially benefited by attending the school.

* * *

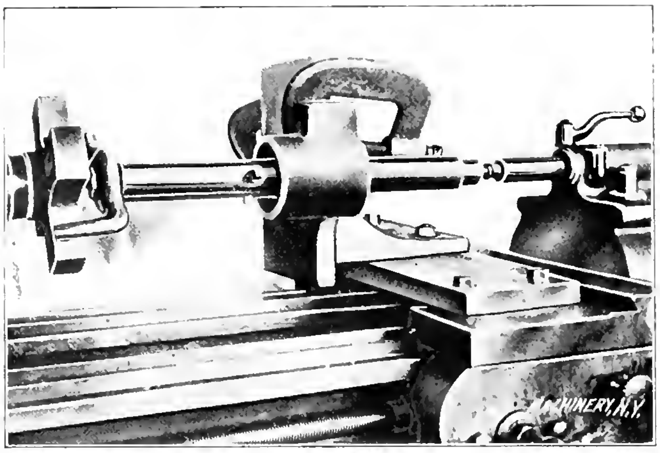


Fig. 11. Boring Column Hole in Drill Press Table.

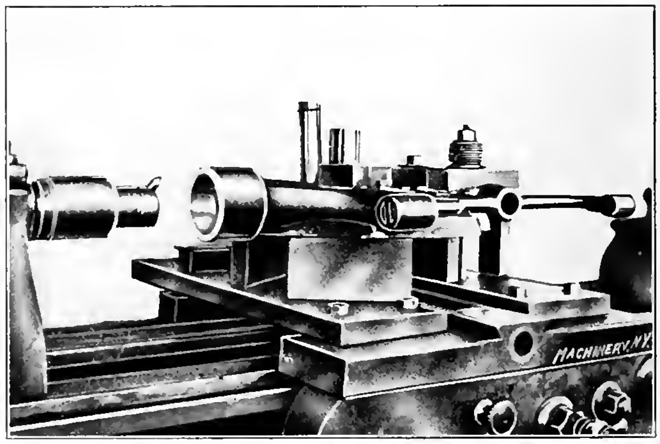


Fig. 12. Boring Hole in Head to receive Column.

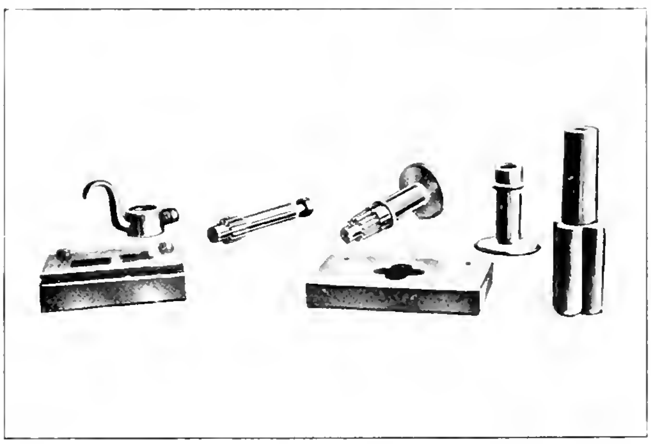


Fig. 13. Examples of Punch and Die Work, and Miscellaneous Jobs done in the Trade School

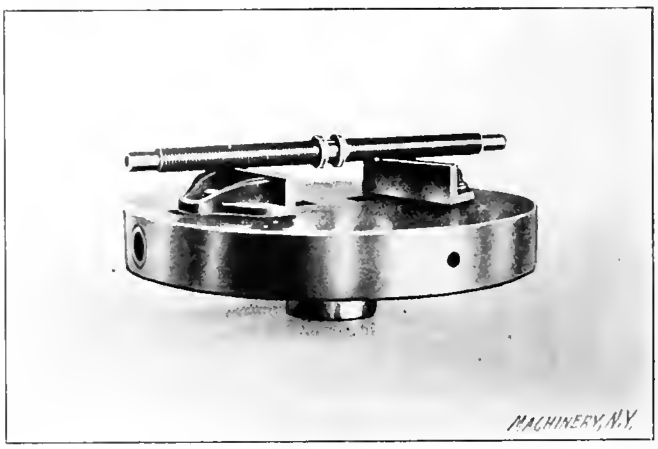


Fig. 14 A Two-jaw Chuck Completed in the Evening School.

It seems that the April fool joke in the technical journal mentioned in the May issue of MACHINERY was one on the inventor of the device as well as on the readers of the paper. Instead of being the inoperative apparatus the picture and description shows, the construction is really practical and unusually ingenious. The connecting tube is made of flexible armor construction with a waterproof cover which automatically collapses under the pressure of the water until its weight per volume is equal to that of the water which it displaces. When it is collapsed to this extent, it is in equilibrium and floats in water, and it attains this equilibrium automatically. The sleeves through which the work is done are not of loose flexible material, as would be surmised from the printed description, but are of metallic construction self-sustaining because of the lateral pressure to which they are subjected. This apparatus has been built by the Williamson Submarine Mfg. & Operating Co., Newport News, Va., and used in 30 feet of water, and has been employed in actual salvage work. Of all this, however, not a word was said in the paper to which reference was made.

* * *

The battleship *Georgia* of the Atlantic battleship fleet holds the world's championship record for rapid coaling. Several days ago she took aboard 1,779 tons of coal in five hours and twelve minutes. The best former coaling record was made by the German war vessel *York*, which took on 468 tons in one hour and 870 tons in two hours.

LETTERS UPON PRACTICAL SUBJECTS.

MILLING AND DRILLING FIXTURES FOR OFFSET ROD.

In Fig. 1 is shown a slender connecting-rod which is a part of a complicated machine. One end of this rod is 3/16 inch lower than the other, and it is necessary that the 5/32-inch holes should be parallel with each other. Should either one be reamed on an angle, there being such a long distance between the holes, it would destroy the free movement which is required. Several methods were tried in drilling the holes and milling the faces of the bosses, but none gave satisfaction until the fixture and jig shown in Figs. 2 and 3 were made.

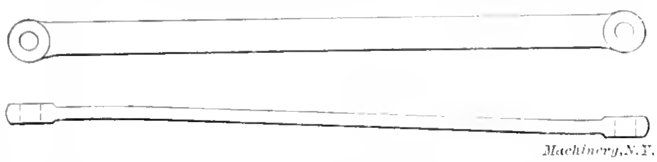


Fig. 1. Offset Connecting-rod which is milled and drilled in the Fixtures.

In Fig. 2 is shown a plan and elevation of the fixture used for milling the ends of the rod. The sides of the rod on each end are sized in one cut by a gang cutter, and the fixture is so designed that when one end of the rod is finished the other can be brought facing the cutter and yet have the required offset. The fixture consists of a cast iron body *A* with an attached part *B* which swivels about the bolt *G*. The lugs *C* on part *B* engage the slots *D* when *B* is turned one-half revolution, thus giving the rod, which is bolted to the hardened pieces *F* by the clamps *E*, the 3/16-inch offset. In setting the rod, it is passed under the clamps *E*, and against

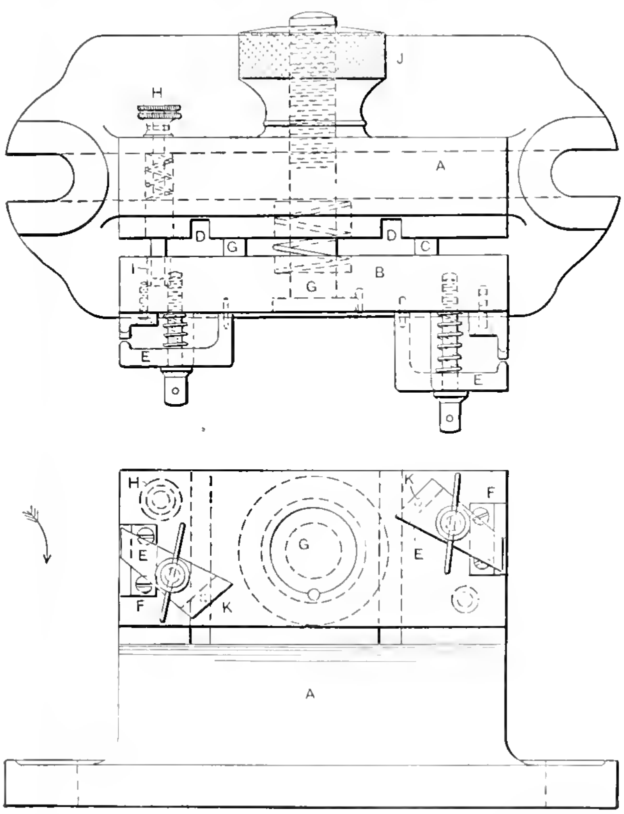


Fig. 2. Fixture for Holding the Rod while the Bosses are being milled

the stops *F*. The bearing points of both the clamps and stops are rounded off and made small, and directly opposite each other. This eliminates all possibility of the piece tipping when being clamped. As the cutter runs in the direction shown by the arrow, it has a tendency to hold the rod against the shoulders on the parts *F*. Consequently no heavy clamps are required. The lugs *C* and slots *D* are off center so that when the high side of the rod has been milled, the stud *G* is loosened and *B* is swung around bringing the opposite side to the cutters, and lugs *C* outside of the slots *D*, thereby raising the opposite end of the rod 3/16 of an inch and bringing it in line with the cutters. *H* is a locating stud which engages with the hardened bushing *I*, bringing *B* in position for the second operation. The part *B* with the work is held firmly by screwing up the nut *J*. Two small pins *K* prevent the clamps *E* from swinging around when not in use.

The drilling jig is shown in Fig. 3. The steel body *A* has a V-piece at each end, and under each of these there is a hardened base, having a 3/16 inch difference in their heights. The V-piece *B* is screwed down solidly, while *C* is movable, sliding on ways. There is a small pin *D* extending down into the body *A*, against which presses a small spring. The two clamps *F* swing around and engage the heads of screws *H*. When setting the rod in the jig, preparatory to drilling, one end is placed in the V-block *C* which is forced

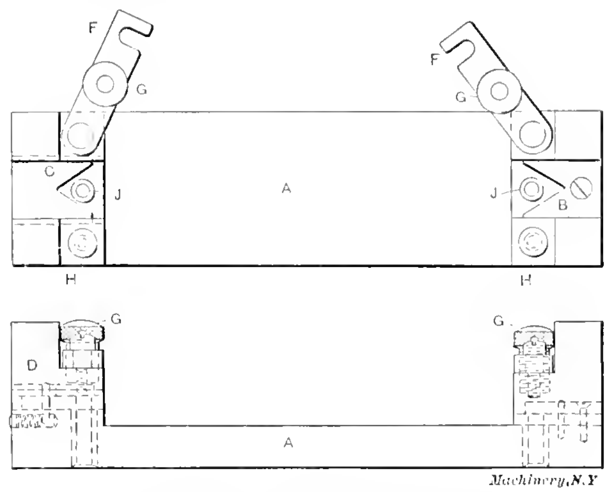


Fig. 3. Jig for Drilling the Ends of the Rod.

back until the other end of the rod drops into place. As the block *C* has a pressure on it, it keeps the rod located centrally. The clamps are then swung around under the heads of screws *H*, and the binding screws *G* are brought down on the milled surfaces of the rods, holding them securely while they are being drilled. These screws have clearance holes through them, and at *J* are the bushings in which are placed the drill and reamer bushings.

PEDRO.

IMPROVED DRIVING PLATE FOR THE MILLING MACHINE.

Everyone who is familiar with milling machine work knows how annoying it is to have the set-screw in the driving plate of the index head just miss the tail of the dog placed on the work, or, what is nearly as bad, strike it on the rounded part, so that when the screw is tightened it is apt to spring the

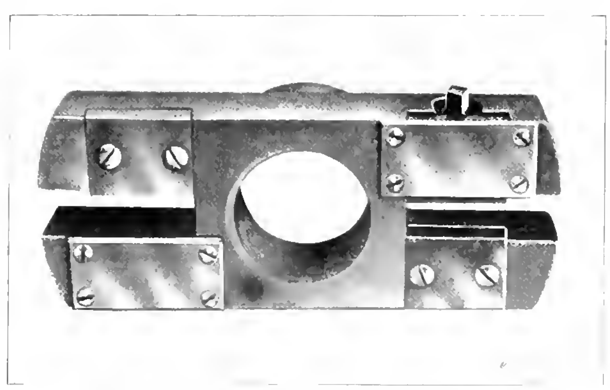


Fig. 1. Improved Form of Driving Plate for the Milling Machine

arbor, if it be a light one. In our shop the work necessitates several different sizes of dogs, and in order to remedy the trouble caused by location of the set-screws, the device illustrated in the accompanying halftones, Figs. 1 and 2, was made and applied to the plate as shown. This improvement was introduced about three years ago, and has been in satisfactory use ever since

In Fig. 1 the plate is shown exactly as it appears on the machine, while Fig. 2 shows the general construction of the device, which consists of four separate parts and six screws for each end. The stationary jaw is shown at *E*. This is made of hardened tool steel, and sunk into the cast iron plate, being held by two screws as shown. At *F* is shown an end view of the corresponding jaw which sets into the other end of the plate, and at *A* is shown the movable jaw, turned

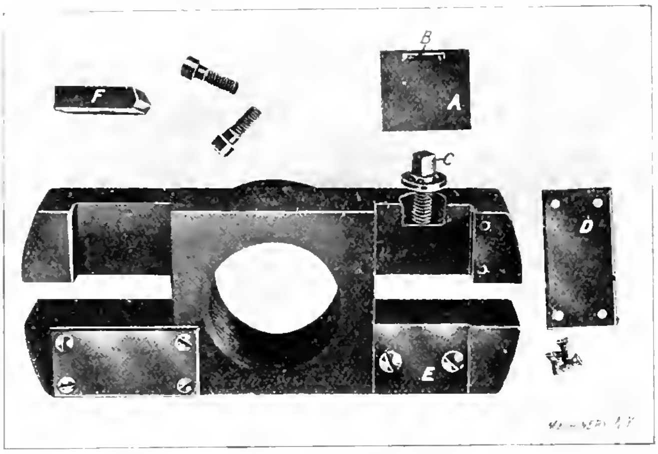


Fig. 2. Component Parts of the Driving Plate.

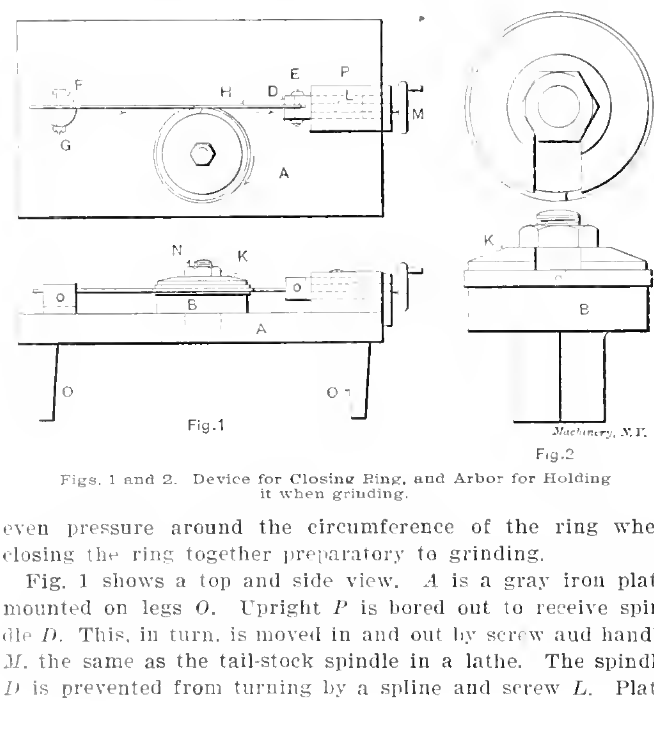
so as to shew the slot *B* into which the shoulder of the adjusting screw *C* fits. The inside edges of both jaws are planed to an angle of 90 degrees, similar to the face of a chuck jaw. The movable jaw is also made of tool steel and hardened, and the screw *C* is made of machine steel and case-hardened. The plate *D*, finally, is used to hold the movable jaw in place, and is made of machine steel.

The writer has wondered why the milling machine manufacturers have not introduced something similar to this, as a driving plate constructed in this manner is far superior to one provided with set-screws. Of course, this improvement increases the cost somewhat above the ordinary driving plate, but the usefulness and convenience of the device compensate for the extra expense. ETHAN VIALL.

Decatur, Ill.

FIXTURE FOR GRINDING PISTON RINGS.

After experimenting with many different devices for holding piston rings, with unsatisfactory results, we designed the arbor and fixture shown in the engraving, the object being to eliminate egg-shaped rings. All brother craftsmen in the automobile business know that this is a mean proposition. This fixture was built with the intention of producing an



Figs. 1 and 2. Device for Closing Ring, and Arbor for Holding it when grinding.

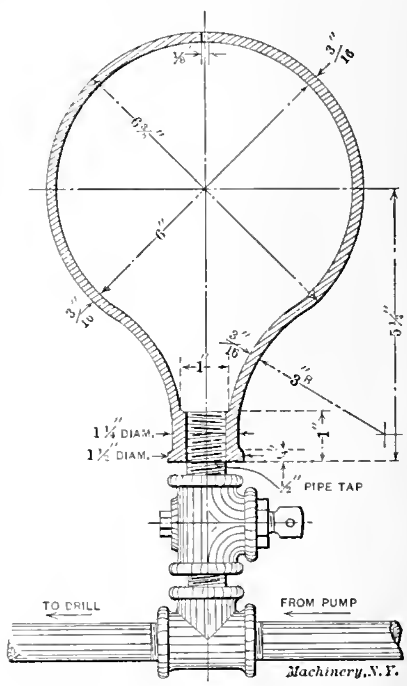
even pressure around the circumference of the ring when closing the ring together preparatory to grinding.

Fig. 1 shows a top and side view. *A* is a gray iron plate mounted on legs *O*. Upright *P* is bored out to receive spindle *D*. This, in turn, is moved in and out by screw and handle *M*, the same as the tail-stock spindle in a lathe. The spindle *D* is prevented from turning by a spline and screw *L*. Plate or base *A* has a square hole for arbor *B* to fit in. Stud *F* and end of spindle *D* are split to receive wire *H*, this being gripped tightly by drawing up bolts *E* and *G*. In operation, arbor *B* is placed in the square hole in *A*, a ring is put in place, the soft copper wire *H* is gripped in stud *F* and passed around the outside of the ring in the direction of arrows shown, and gripped again in the end of spindle *D* by bolt *E*. The wire *H* is tightened by the screw and handle *M*, thus drawing the ends of the ring together. The split collar *K* is put in place, then nut *N* is screwed against it, holding the ring firmly in a closed position. Now the wire *H* is released, and arbor *B* with ring in place is ready for the grinding operation. The face-plate of the grinder has a plate with a square hole that acts as a dog or driver for the arbor. Fig. 2 shows the arbor and work together. The body of the arbor, of course, is turned eccentric to suit the ring, and there is a mark to locate the ring in the proper position. This fixture produced rings that were round after grinding, the point being that the soft copper wire caused an even pressure all around the ring in closing it. E. W. NORTON.

North Tarrytown, N. Y.

RESERVE CHAMBER FOR PRIMING PUMPS.

The accompanying engraving shows a reserve chamber for pumping systems connected with drill presses, milling machines, automatics, etc., where individual pumps are used for oil or compounds of any kind. We found, in our drill press department, that whenever the drills stood still for a while, the pumps had to be primed before starting again, and by the way, some of the workmen were spending quite a large share of their time priming their pumps. To overcome this, we have put in use a reserve chamber which is used for priming. This chamber is placed in the pipe line between the pump and the point of discharge. The valve leading into the chamber is left open when starting the first time, and the chamber is allowed to fill up. The small hole in the top serves two purposes; it allows the air in the chamber to escape when filling, and also acts as a tell-tale to indicate when the chamber is full. After filling, the valve to the chamber is closed and the chamber is kept full, the compound flowing through the pipes as usual. The pump may be left any length of time now, and started again without the trouble of priming in the old way. The next time the pump is to be started, all that is necessary is to open the valve and allow the compound to fill the pipes. This does away with priming, and is very quickly and easily done. The chamber is now allowed to fill while the driller is drilling his first few holes, the valve is again closed as before, and everything is in readiness for starting the next morning.



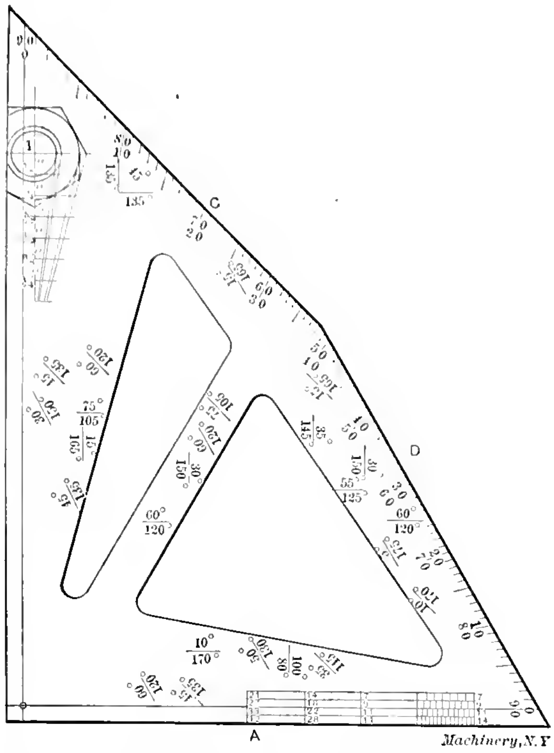
Reserve Chamber for Priming Pumps on Machine Tools.

TOOL DESIGNER.

IMPROVED DRAFTSMAN'S TRIANGLE.

The triangle which is shown in the engraving is one which I have used for a number of years, and I think that this form is an improvement over any which I have seen. One which I made for myself was of 1/16 inch transparent celluloid, with a vertical side 12¾ inches long; of course, the size could be such as would be most convenient. It will be

noticed that this is really a 60-degree triangle with the top cut to form an angle of 45 degrees with one side, while the inside is cut out to give various angles. In the top corner a one-inch nut is laid out, and the scale gives the sizes of tapping holes, sizes across corners and flats for nuts from ¼ to 1 inch in diameter. In the bottom corner there are scales with odd divisions not found on the ordinary scale. These could, of course, be varied, and others added if necessary. This



Draftsman's Protractor and Triangle.

triangle is also a large protractor which can be used for all angles up to 90 degrees by working from the small hole in the lower left-hand corner and the graduations along the edge. The figures shown with lines between indicate the angle of that particular edge to the T-square when that outer edge of the triangle which is parallel with the line is against the T-square. The accompanying table shows the large number of angles which can be obtained directly by placing the sides *A*, *B*, *C* and *D* against the T-square. It will be seen that there is a 45-degree side for all four positions, and a 30- and 60-degree side for two and three positions of the triangle, respectively, in addition to the various angles given in the table.

SIDE SET AGAINST T-SQUARE.

A	B	C	D
Angles in Degrees.	Angles in Degrees.	Angles in Degrees.	Angles in Degrees.
10	15	10	5
45	30	15	15
55	35	35	30
60	45	45	45
75	80	60	50
90	90	75	60
105	100	105	120
120	135	120	130
125	145	135	135
135	150	145	150
170	165	165	165
...	...	170	175

R. W. Dickinson.

Accrington, Eng.

TRICKY FOUNDRY PRACTICE.

A friend of mine having made a complete set of patterns for a bench lathe (18-inch bed, 4-inch swing) and built a first-class, serviceable machine with lead-screw and gears complete to cut any standard thread, I decided that I would like a similar machine, so I borrowed the patterns and took them to the nearest foundry and ordered a set of castings to be made. I attended to this business through the office, and was told to call for the castings in three or four days. However, as I was impatient to begin work upon the little lathe, I went around the second morning about eight o'clock and went directly into the foundry where the molders were getting ready for the day's work, and the helpers were cleaning castings. As the foreman was not on the floor at the moment, I inquired among the men until I found the molder who was working with my patterns. He informed me that they had *only got one of the lathe beds out, but had two sets of head- and tail-stocks and carriage pieces*. I asked him how many he had been told to make and he replied, "Three sets." I said I guessed one set would do me, and, gathering up the patterns, I took them out and put them in the rig I had brought, and then went back for the coreboxes, which I soon found and also deposited with the patterns. Next I hunted up the foundry foreman and got him to gather all the castings that had been made from the patterns and weigh them. He was surprised that I should order three sets and then go with only about one and a half. However, he went up to the office to get the bill while I put the castings into the rig.

I judged by the look on his face that all the surprise at my action had died away through certain things he had learned in the office, but I did not make any remarks, and paying the amount due, I drove off. The question involved is whether the proprietors of a foundry have any right to make castings for their own use from patterns brought to them by customers. Personally I think not, unless by permission. W. L. McL.

EFFICIENCY OF AUTOMOBILE TRANSMISSION.

We noticed in the June issue of Machinery a report of a test made by the H. H. Franklin Co., Syracuse, N. Y., in which the loss in transmission between the motor and the rear wheels is given as 6 2/3 per cent with direct drive, and 8½ per cent with intermediate gear, giving a mechanical efficiency of 93½ and 91½ per cent, respectively. While this test shows that the transmission of the car is very efficient, it is probable that the tire losses were not considered. If they were, the efficiency would be considerably lower.

As to the statement that the mechanical efficiency of automobiles, in general, is rated at 75 per cent, the test made on the Automobile Club of America's dynamometer shows that many cars develop much less power at the ground than their engine rating, and that, in general, the effective power at the ground is approximately 75 per cent of the nominal engine rating. This statement, however, should not be interpreted to mean that the efficiency of the transmission, including the tires was 75 per cent or less. The power developed by the engine is *not* determined in the Automobile Club of America's dynamometer tests. The fact has caused considerable misunderstanding, especially in the automobile trade, and it should be distinctly understood that the dynamometer does not show the efficiency of the automobile, but only the effective horsepower at the ground, and that the 75 per cent statement refers only to the rated engine power of cars in general.

E. H. Waring.

Ampere, N. J. Crocker-Wheeler Co.

TAPER PER FOOT OF WHITWORTH OR ENGLISH TAPER PIPE TAPS.

In Mr. Charles E. Smart's article in the June issue of Machinery on Whitworth or English taper pipe taps, he states that the dimensions of these taps should be based upon the standard Whitworth pipe tap gages, made in England by the Whitworth Company which have a taper of 1 inch per foot.

If Mr. Smart will refer to paragraph 7, page 6 of the "Report on British Standard Pipe Threads for Iron or Steel Pipe and Tubes," of April, 1905, issued by the Engineering Standards Committee, he will find the taper of Whitworth pipe is equal to ¾ inch per foot. Before this report was issued, it was the custom to make these taps with a taper of 1 inch per foot.

This information should put an end to any question in regard to the taper per foot of Whitworth pipe taps.

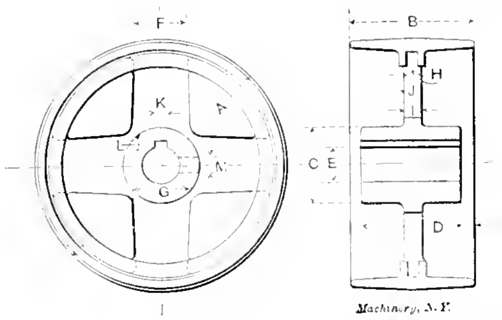
Greenfield, Mass. G. W. Carpenter,

Wells Bros. Company.

NOTES ON HIGH-SPEED PULLEYS.

In looking over some notes the other day I ran across the accompanying sketch and data regarding pulleys, which may prove of interest. These pulleys were designed for fast-running machinery, and finished on both the outer and inner surfaces of the rims, and also on the hubs. The pockets *H*, between the arms, were cored for lead balances, the lead being calked in place as required. The average belt speed was approximately 3,000 feet per minute. The practice of one shop was to place the set-screw on the quarter as shown by the sketch, while that of another was to place it directly over the key. I think the former way the better one as it gives a three-point contact on the shaft, while with the latter method the pulley has but a two-point contact and has a general tendency

TABLE GIVING DIMENSIONS OF PULLEYS AND H.P. TRANSMITTED.



Approx. H. P. Transmitted.	H. P. Transmitted per in width of Belt	A	B	C	D	E	F	G	H	I	J	K	L	M
4	1.58	7 1/2	3	7/8	2 5/8	9/16	1 3/8	1 5/8	1/4	5/16	3/8	5/16	5/32	3/8
8	2.26	8	4	1 1/8	3 3/16	5/8	1 1/2	1 7/8	3/8	9/16	13/16	3/8	3/16	1/2
12	2.64	8 1/2	5	1 1/4	3 5/8	5/8	1 7/8	2	7/16	5/8	13/16	3/8	3/16	1/2
16	3.16	9	6	1 3/8	4 1/8	3/4	2 1/8	2 1/4	7/16	5/8	15/16	7/16	7/32	1/2
24	3.37	11 1/4	8	1 7/8	5 1/4	1	2 1/8	2 3/4	1/2	5/8	1	1/2	1/4	5/8
32	3.94	12	9	2 1/8	5 9/16	1	2 1/2	2 3/4	1/2	5/8	1 1/4	1/2	1/4	5/8
40	4.40	13	10	2 3/8	7	1 1/8	2 5/8	2 7/8	5/8	7/8	1 1/4	5/8	5/16	5/8
47	4.73	14	11	2 3/4	7 1/2	1 7/16	2 3/4	3	5/8	7/8	1 1/4	5/8	5/16	5/8
63	5.72	17	12	3	8 5/8	1 5/8	3	3 1/4	3/4	1	1 1/4	3/4	3/8	5/8
79	6.58	20	13	3 1/4	10 1/4	1 3/8	3 1/4	3 5/8	5/8	1 1/16	1 1/2	3/4	3/8	5/8

to rock and work. The first column in the table gives the approximate horse-power transmitted by each pulley, and the second column the horse-power transmitted per inch width of belt. It will be noted that the power transmitted per inch of width increases with the size of the pulley and the corresponding thickness of belt; a single belt being used on the first three sizes of pulleys, light double on the next three, and heavy double on the last four. The principal dimensions of the pulleys are given by the table. WM. SANGSTER.

Covington, Va.

SHRINKAGE AND EXPANSION OF STEEL IN HARDENING.

When hardening two tools of the same grade of steel and both of the same dimensions, why will one shrink and one expand? This question has been asked many times by

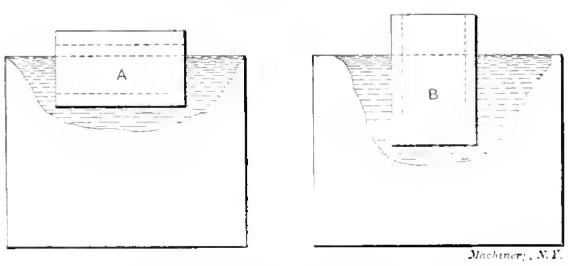


Fig. 1. Methods of Cooling when Hardening, to cause Shrinkage or Expansion.

mechanics. The answer is simply this: they do not receive the same treatment, although the inexperienced hardener is sure that they do. Take, for instance, a couple of small cams, collars, or any pieces at hand, just so they are the same in regard to make and finish, and have the hole in each fit to the same plug gage. Then number them so they will not get mixed in the operation, heat both to the same degree of heat, and dip one as shown at *A*, Fig. 1, and the other as shown at *B*. Put each piece under the water and remove when cold; then try the plug gage. I claim that the piece *A* will not go on, while *B* will fit looser than before heating and dipping.

Not long ago we had a job of shrinking a collar on a shaft that was wanted in a great hurry. When the work arrived in the forge department, the man about to do the shrinking

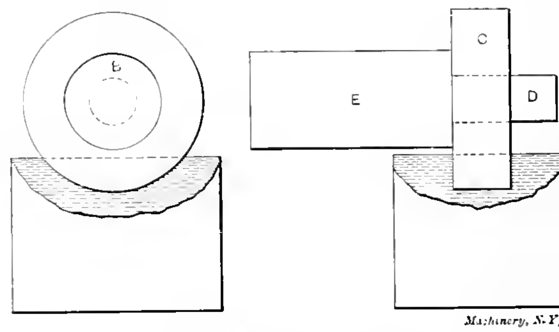


Fig. 2. Method of Shrinking a Collar on a Shaft which is Smaller than the Bore of the Collar.

called my attention to the fact that the collar would already go on the part it was supposed to be shrunk on. Knowing the piece was wanted in a hurry, I told the man to heat the collar *C*, (Fig. 2) to a very low red, and after placing the collar on the end *D* of shaft *E*, to cool it, as shown in the illustration, turning the work rapidly without letting the shaft come in contact with the water, it was impossible to move the collar, when cold, with a good-sized arbor press. Both collar and shaft were machine steel. A great many mechanics have an idea that it is necessary to have the internal piece quite a bit larger than the external piece, but this is not necessary. Of course, if the piece to be shrunk on is large and has a 6- or 8-inch bore, and is of cast iron, it is advisable to leave it 1/64 inch smaller than the internal piece, as cast iron expands more than steel.

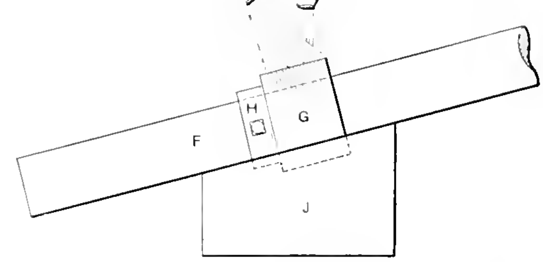


Fig. 3. Arrangement of Cooling Tank when Shrinking Collars on Shafts.

Several years ago I worked for a firm that built saw-mill machinery and tools for repairing all kinds of circular and cross-cut saws. Among the tools was a machine steel shaft about 3 inches in diameter, on which was shrunk a collar of high carbon tool steel. This collar had to be very hard, and after it was shrunk on the shaft, the shaft was turned up and the collar ground. These collars were always bored so as to be shoved on with the hands. In Fig. 3 is shown a shaft *F*, with tool steel collar *G*, and another small collar *H* held by a set-screw. This collar was used to form a shoulder for the tool steel collar *G* to rest against. When shrinking the collar *G* on the shaft, a tank *J* was used, constructed as shown. Another tank having two spouts *K* was arranged above this one. This upper tank was filled with cold salt water and sulphuric acid, there being about one gallon of acid to twenty gallons of water. The collar was heated to about 1,400 degrees F., quickly placed on the shaft in the proper position, and the above solution turned on full force. This chilled the outside of the collar quickly; then the shaft was removed to a tank of oil where it remained until cold. This particular job gave the best of satisfaction.

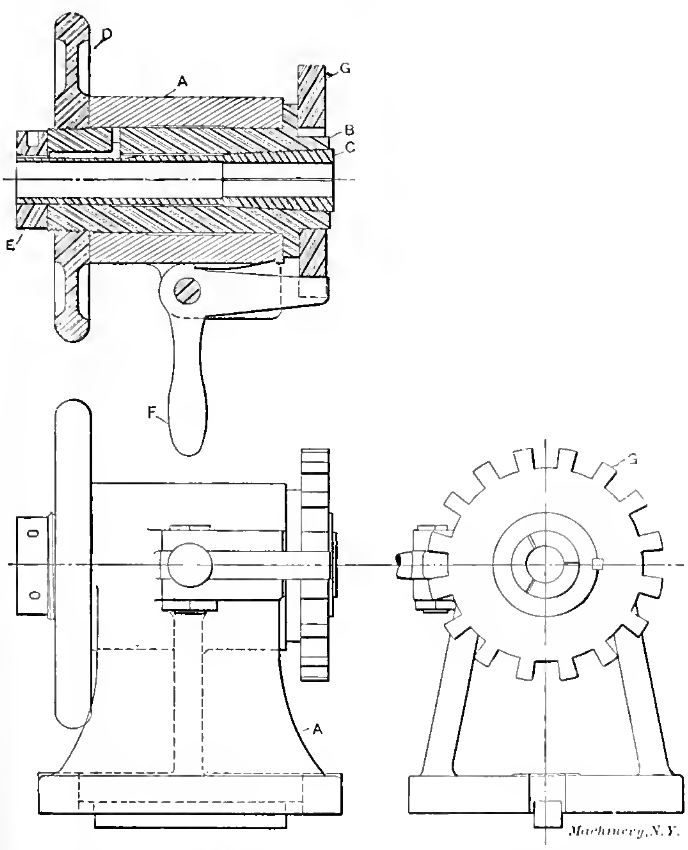
It is very annoying, after making an expensive punch and die, to have them vary in size after hardening. Sometimes

the die will be larger and the punch smaller, rendering them useless. It is a good idea to harden the die first, then leave the punch large enough to grind to fit if it is in such shape as to allow grinding. If a punch is completely cooled in water it will be smaller than if just hardened on the outside enough for the purpose and then removed to oil to relieve itself and cool off slowly. This has been proved to the writer's satisfaction. If the outside of the die is chilled before the inside it will become smaller, but if chilled on the inside before the outside it will be a trifle larger.' It is an easy matter to chill the outside first, but the reverse is not so easy. It can, however, be done by covering the outside with asbestos cement before placing in the furnace for heating. I have had punches and dies of large dimensions delivered to me for tempering, and they were in such shape as to be useless if they came out the same as they were before heating; for instance, if the die was too large for the punch, by using a little care, as explained, I was unable after the hardening to place punch inside of die before grinding. This cannot be accomplished by heating and cooling in a haphazard manner, as so many hardeners are apt to do. J. F. SALLOWS.

Lansing, Mich.

SIMPLE INDEXING DEVICE.

In the engraving is shown a device for holding and indexing a spindle, which has, at the middle, a pinion in which the teeth are to be cut. In the particular case in question, the spindle was $\frac{5}{8}$ inch in diameter, 20 inches long, the pinion being $\frac{1}{8}$ inch in diameter and located 7 inches from one end of the spindle. The spindle was supported by an ordinary center at one end, but the other end was held in the device



Section and Elevations of the Indexing Device.

shown, by a split chuck *C*, which was tightened by the nut *E* at the other end of the head of the device, this nut drawing the chuck through the steel sleeve *B*. This steel sleeve is keyed to an index plate *G*, notched on its circumference as indicated, and located in position by the index pawl *F*. When located, the index plate is clamped by the hand-wheel *D*, the hole of which is threaded as shown. The sleeve *B* when not locked by the hand-wheel *D* is free to revolve in the head casting *A*. When in operation, the spindle having the pinion to be cut is inserted in the chuck *C* and tightened by the nut *E*, the hand-wheel *D* is loosened, and the pawl *F* is moved out of the notch in the index plate *G*, thereby releasing it. By means of the hand-wheel *D*, which has a tight thread, the index plate is turned to the next notch and then the pawl *F* is again permitted to enter the notch, locating the spindle in its proper position for the cutting of the next tooth, the hand-wheel clamping the sleeve with the chuck and spindle in position. This operation is repeated for each tooth cut. A great many of these pinions have been cut by this device, and it has been found very satisfactory, as it is quicker and safer to operate than the regular dividing head for this kind of work. J. B. HASKELL.

Hamilton, Ohio.

HOME-MADE MACHINE FOR BORING LATHE SPINDLES.

The illustration shows a home-made machine, designed and built for boring hollow lathe spindles, which has given us satisfaction. We had orders for some 30-inch swing lathes with hollow spindles, $2\frac{1}{2}$-inch hole, and we first attempted to buy a machine in the market that would do this work, but were unable to get hold of one at a reasonable cost that would answer our requirements. The machine shown will bore a $2\frac{1}{2}$-inch hole through a lathe spindle 48 inches long, and do it right.

Home-made Machine for Boring Lathe Spindles.

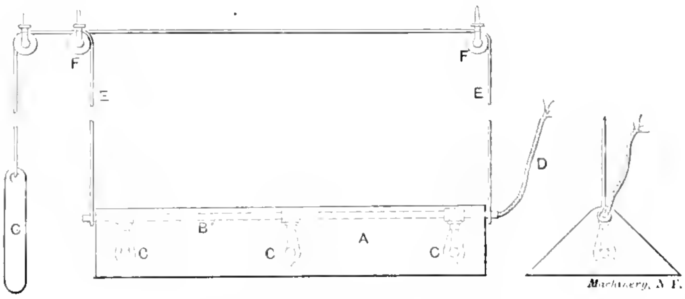
The foundation part of the machine had originally been built for reaming gun barrels. The framework was constructed of $\frac{1}{2}$-inch by 2-inch steel, there being four pieces 10 feet long, with long washers between bolted together, making two parts 12 inches wide. These formed the uprights, both being exactly the same. The two uprights were joined together by a $\frac{1}{4}$-inch steel plate 20 inches wide, extending from the floor up about 6 feet. This made a very stiff steel frame 10 feet high and 20 x 12 inches on the floor. At the top a 2 x 3-inch steel piece 30 inches long was bolted between the two middle sections of the uprights and extended to one side about 10 inches. Below this and parallel to it was erected a duplicate piece. The two pieces had holes bored through the projecting ends for the vertical spindle on which was mounted a bevel gear, and a screw chuck at the lower end. The horizontal shaft driving the vertical spindle also carries a spur gear of large diameter, and meshing with this is a pinion gear on the cone gear shaft. The spindle to be bored is fastened to the lower end of the vertical spindle and revolves with the shaft, while the drill remains stationary. The drill is fed upward from the bottom and relieves itself of chips by gravity. The feed rigging shows, in the illustration, between the spindle being bored and the frame. It is driven by a belt from the horizontal drive shaft.

Eugene, Ore. ED. B. ERY.

THE LIGHTING OF DRAFTING-ROOMS.

This is a subject often discussed without reaching a satisfactory conclusion for all cases; each one must necessarily be governed by local conditions. In the January number of MACHINERY, an editorial under the above title reminded me of a system used where I once worked. The apparatus is cheap and efficient, and for artificial illumination, when electricity is to be used, has proved to be entirely satisfactory in actual practice.

Referring to the illustration, the shade *A* was made of tin, painted dark green outside, and white inside, through which was passed a pipe *B* with T-connections at *C*. The insulated wires *D* were drawn through the pipe and connected with ordinary 16-candle-power incandescent lamps which were fastened at these T-connections. The whole thing was suspended from the ceiling by cords *E* drawn over pulleys *F*. The cords were attached to the counter-balance *G*, and to the shade as shown, allowing the lights to be raised entirely out of the way when not required, or lowered directly over each board



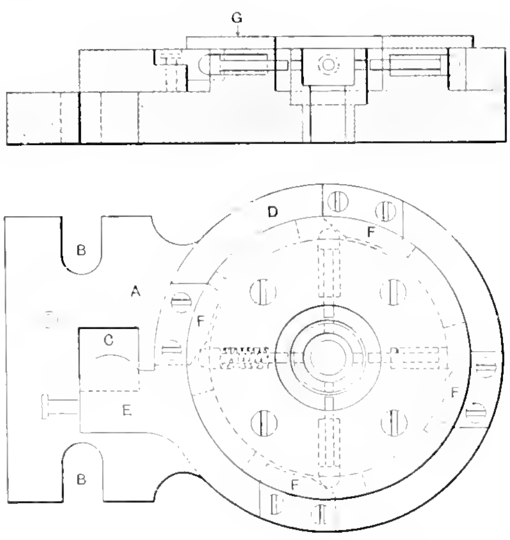
Adjustable Light for the Drafting-room.

sufficiently to shield the eyes of the draftsman and reflect the light over the entire board. The length and number of globes will, of course, depend upon the length of board.

This arrangement may be modified to meet the requirements of the more refined tastes willing to pay for elaborate furnishings. However, the leading features should remain the same: A suspended individual light of wide range, adjustable for height, while permitting the full swing of beam compasses or drafting machine, without encountering supporting brackets. It casts no shadows and protects the eyes of the workman. E. P.

MULTIPLE PIERCING TOOL.

A multiple piercing tool used for thin cup work is shown in the accompanying illustration. This tool can be used for stock from 18 gage down as thin as practicable to work. Of course, it could be made for thicker material, but this would mean very strong springs for stripping the punches, and hard work for the press. The reason I designed this tool was principally to avoid any chance of an accident to the operator's fingers, as in the multiple punches the punch or upper part of the tool covers a large part of the surface of



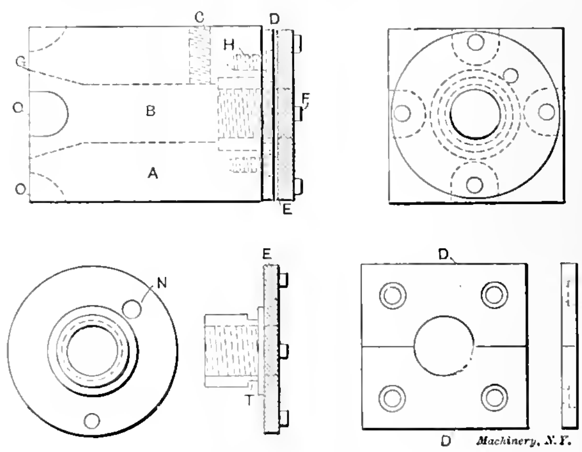
Section and Plan of Multiple Piercing Tool.

the die, thus subjecting the operator's hand to the danger of serious injury when putting the work on or off. This is a point that is not studied as much as it should be in tool design, and it is the duty of every tool designer or person in charge of a machine department to give this matter every attention. Referring to the illustration, *A* is a cast-iron base with two slots *B* for bolting to the bed of the press. A round or square hole *C* is cored through this base, into which the punch enters. A ring *D* having a projecting arm *E* fits over a boss on the base. The arm *E* comes into contact with the punch, which rotates the ring with the cams *F*, which are held in position by two screws. These cams, in turn, operate the four piercing punches and force them into the die. The punches are stripped off the work by spiral springs. A shell die is used so that the scrap from the piercing will fall through. A plate *G* is fastened to the base *A*, which serves to keep the ring *D* in place. A spring (not shown) is attached to the ring *D*, and serves to bring the ring back into position after being rotated by the punch. A plain punch, with a shank to fit the gate or slide of the press, is used. The working end, or the end which comes into contact with the arm *E* is tapered to an angle suitable to the stroke of the press. This style of tool can be designed for perforating almost any number of holes, and, obviously, it can be worked at a high speed with no danger to the operator. CHAS. PETIJEAN.

E. C., London, Eng.

SPRING CHUCK BLOCK.

The accompanying illustration shows a very handy tool for use in the tool-room for slotting screw heads, milling small counterbores, fluting taps, and numerous jobs of like nature. A steel block *A* is machined square, and with all sides parallel to the axis of the hole *B*. The hole *B* is bored to fit the drawn-in spring chucks of the bench lathe. Set-screw *C* engages with the spline on the spring chuck, and keeps it in position while releasing and tightening the work, by the member *E*. Grooves *O* are milled in the face of *A* for cutter clear-



Spring Chuck Block.

ance when milling work of small diameter. The rear end of *A* is counterbored out to receive the member *E*, which is held in place by two plates *D* which fit in groove *T*. These plates are held by four set-screws *H*. Piece *E* has four lugs *F* allowing *A* to be used in a vertical position. Hole *N* in *E* is in line with the set-screws *H*, and it is a little larger than the heads of the screws in plates *D*, thus making an easy job of assembling the parts. As the thread in *E* fits the thread on the spring chucks, it is obvious that when the chuck is in place it may be opened or closed by turning *E* to the right or left. All parts of the chuck block are hardened, it is inexpensive to make, and, with a fair assortment of chucks, makes a nice combination. E. W. NORTON.

North Tarrytown, N. Y.

CUTTING STEEL WITH A BAND-SAW.

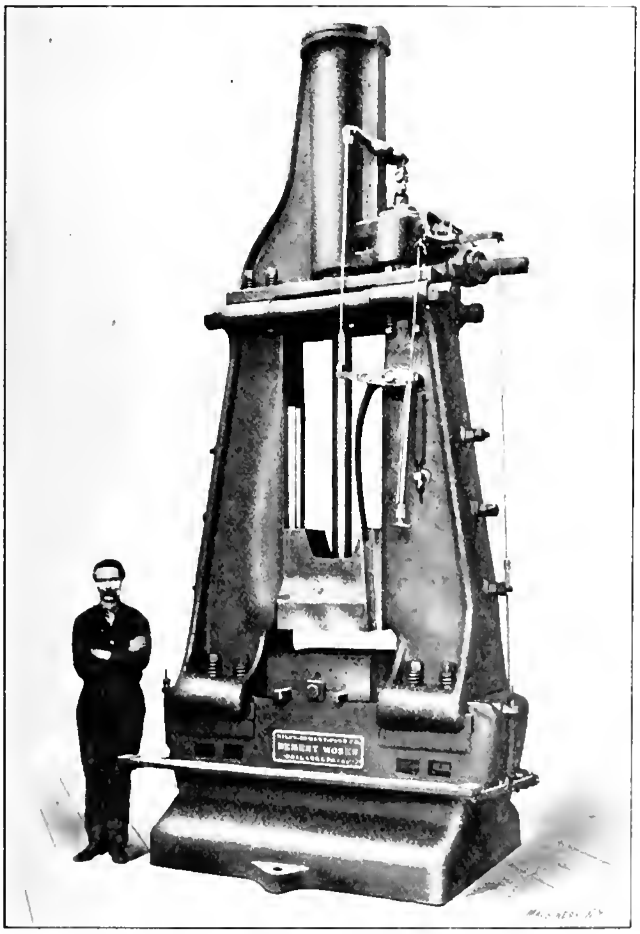
There is a shop on Clinton St., Chicago, that keeps three big band-saws constantly busy cutting tool steel. They do a good business cutting steel for numerous shops in the vicinity, charging seventy-five cents an hour. The band-saws cut very rapidly and accurately and with little waste, only a sixteenth being cut away. A band-saw will cut more than double the amount of steel that a number of common hack-saws costing the same money will do. Another great advantage of a band-saw is that it cuts continually, while a hack-saw only cuts half the time. The steel bars are fed up to the band-saw by a carriage running on slides and moved by weights which are varied to suit the different thicknesses of steel, otherwise the saw frame is practically the same as those used in wood shops, but the saws are made especially for metal.

Decatur, Ill. ETHAN VIALL.

THE DEVELOPMENT OF STEAM DROP HAMMERS.

Attention has been drawn to the article appearing on page 739 (engineering edition), June issue of MACHINERY, headed "Chambersburg Line of Steam Drop Hammers." This publication places the Chambersburg Engineering Co. as pioneers in steam drop hammers, which is very much in error.

Without raising the question as to who was the pioneer, but protesting against the wrong party receiving the credit, I have to make it known that Mr. F. B. Miles, who later became a member of the firm of Bement, Miles & Co., designed in 1872 what seems to be the first steam drop hammer made by his company, and which was sold to the Baldwin Locomotive Works. Since that time this class of machinery has grown to be a large factor in the product of Bement, Miles & Co., and now the Niles-Bement-Pond Company, of which the Bement Company became a part. It was something like a quarter of a century after the date mentioned that the Chambersburg Engineering Co. came into being, and this fact is sufficient for substantiating my claim that the above mentioned company were not the pioneers, for the very good reason that they did not depart in the construction of their



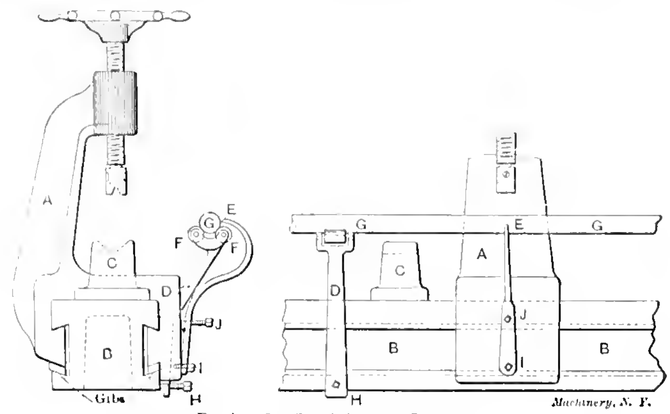
Steam Drop Hammer built by the Niles-Bement-Pond Co.

hammers from the principles involved in the older concern's designs. Since the first hammers were made by Mr. Miles, there has been little change in the important points of construction, such modifications as have been made being simply augmentation, with the vital or working parts as he conceived them. As a proof of the good design Mr. Miles produced, I have to point out that most, if not all, steam hammers manufactured in this country to-day are constructed on the same lines, and the illustrations of them point very strongly to direct copies of what has become known throughout the trade as "Bement hammers." Herewith is an illustration of a steam drop hammer as offered to-day by the Bement Works of the Niles-Bement-Pond Company, and very similar to the one you submitted with the Chambersburg article. The photograph simply shows a growth of the same mechanism produced over thirty years ago by practically the same company, and with no radical differences in principles.

Philadelphia, Pa. W. J. HAGMAN,
General Manager Bement-Miles Works.

DEVICE FOR STRAIGHTENING SHAFTS.

The engraving shows a handy press for straightening. The shafts require no centering in the ends, and can be straightened as perfectly as if they were straightened on centers. The press frame *A* is shown placed approximately at the center of the bed plate *B*, which latter can be made of any length. On the bed plate are placed two supporting V-blocks *C*. The bracket *D* of which there are also two in the complete device, carries hardened rollers *F* on which the shaft is resting while it is being tested by the test needle *E*.



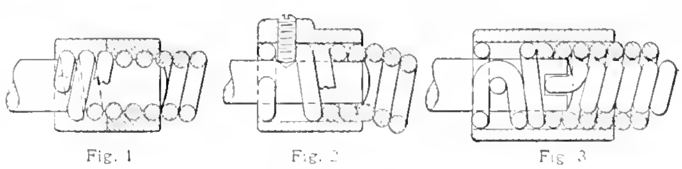
Device for Straightening Shafts.

This latter is secured to the press frame at *I* and adjusted by set-screw *J*. The bracket *D* is dove-tailed into bed plate *B*, but is a loose fit and is secured in position by means of set-screw *H*. The method of operating this device is obvious from the engraving. For rapid straightening it has proved very valuable. The straightening screw is screwed down from the top to give more or less pressure according to how much the shaft needs straightening.

TESTING ROOM.

FLEXIBLE SHAFTS.

A cheap substitute for universal joints or flexible shafts is a helical spring. Effective couplings between the shaft end and spring are shown in the sketches. The shaft is threaded (Fig. 1) for a few turns to a somewhat coarser pitch than that of the spring, and to a somewhat larger diameter at the bottom of the thread than the internal diameter of the spring, with a half-round groove which ends in a drilled hole. The spring has the end bent in toward the center. This end enters the drilled hole on the shaft when the spring is threaded over it. A two-part sleeve threaded internally, the threads having the same pitch as those on the shaft, is screwed over the spring and tightly checked together. The extreme end of the shaft may be slightly tapered and the outer end of the sleeve bell-mouthed so that the spring may not be too rigidly confined at that point. Fig. 2 shows a much cheaper arrangement in which the end of the spring is



Methods of Coupling Springs to Shafts.

looped around the end of a set-screw. Fig. 3 illustrates a method I employ for a flexible shaft using two springs. The outer spring was wound to be a tight fit over the end of the shaft and the sleeve bored to a pushing fit over the spring. A taper pin fastened the sleeve and spring to the shaft the free end of the spring being brought around back of the taper pin to form a hook. The inner or core spring is made as large as will draw freely into the outer one, and has its ends formed into loops which engage the slotted end of the shaft. The two springs are wound opposite hand so that the torsion tends to close in the outer one and open out the inner one. Arranged in this manner the shaft is very effective and is cheaply constructed. GEO. W. ARMSTRONG.

Norwich, Conn.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

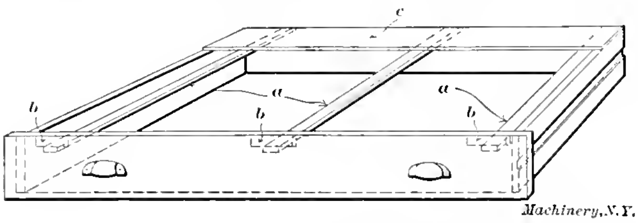
FIBER WEDGE FOR SECURING HAMMER TO ITS SHAFT.

A wedge made of fiber, particularly of the hard quality used for washers on automobiles, is an excellent substitute for the wood or steel wedge that ordinarily secures a hammer head to the handle. DONALD A. HAMPSON.

Middletown, N. Y.

DRAWER FOR DRAWINGS.

A simple and cheap method of making drawings lie flat in drawers is shown in the accompanying engraving. It consists of three blocks *b* fastened to the inside of the front of the drawer, a back top *c*, and three slats *a*, which are slipped

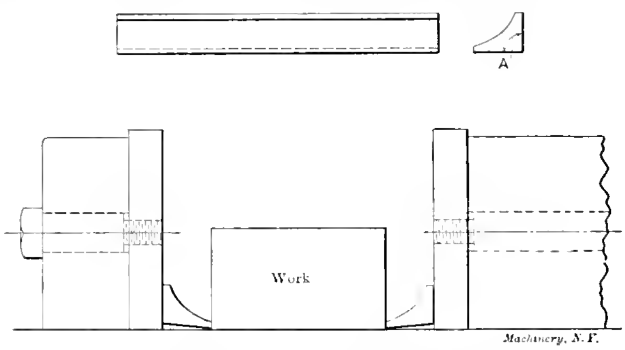


in under *c* and *b*. These slats keep the drawings from curling up and catching in the drawer case. By using a drawer of this description, the capacity is increased from three to four times. JOHN B. SPERRY.

Aurora, Ill.

CLAMPING APPLIANCES FOR THE PLANER.

The illustration shows a pair of handy hold-downs for holding work in the vise of a planer or shaper. A detailed view of the appliance is shown above clearly indicating how it is made. The angle *A* should be slightly more than a right



angle, so as to prevent the clamping piece from bearing on its bottom surface when used. These clamping pieces are especially handy for clamping thin pieces. The engraving plainly shows how they are used. C. W. R.

TOOL-MAKERS' DRILL PAD.

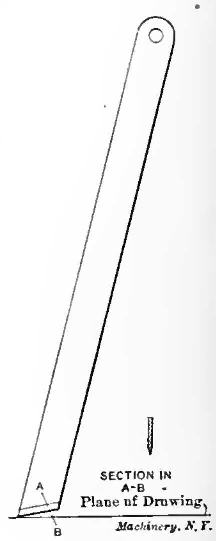
The engraving shows a simple device, made of leather, for carrying drills back and forth from the bench to the drill press, instead of using the ordinary drill block. It struck

me as being a very convenient and compact way of taking care of a set of drills. Most tool-makers know how handy it is for anyone to come along and pick out a drill from the ordinary drill block on the bench and return the drill in a very poor condition. I would make one improvement to the drill pad, and that would be to rivet a small piece of brass where each drill is placed and stamp the number of the drill on; then any drill could readily be selected. This drill pad can be rolled up and stuck in the pocket, which makes it mighty convenient when one has some heavy tool or jig to carry to or from the drill press. A. J. DE LILLE.

Minneapolis, Minn.

REMOVING INK FROM DRAWINGS.

One of the best tools for removing ink from a drawing, before using a rubber eraser, may be made from a worn-out hack saw blade. The accompanying illustration shows such an instrument. About six inches is broken off one end of the blade, the teeth are ground off, and the broken end is sharpened as shown. This end should be ground very thin, and on one side only. To prevent cutting the drawing, the edge is rounded slightly at the extreme point. Not every hack saw blade, however, will make a good scalpel. The blade should be evenly tempered from the teeth to the back, if possible, and no retempering will be necessary. To use the tool, hold it between the thumb and first finger, so that the edge is almost parallel to the surface of the drawing, but touches it at the point only.

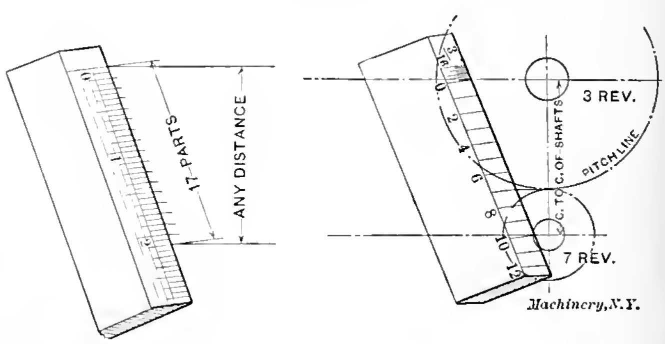


Detroit, Mich. A. L. CAMPBELL.

THE USE OF THE ORDINARY RULE FOR DIVIDING.

The operation of dividing a line into any number of equal spaces is a very simple one, and one of the first exercises in geometry, but however familiar men might be with its execution, I have rarely seen anyone use the rule for this purpose. When it is required, for instance, to draw a certain number of lines or a certain number of threads per inch, in a given space, sometimes the length of the single spaces will be figured, or a diagonally drawn line will be spaced off with the dividers and the spaces transferred with the triangles.

The shortest way is to use the ordinary or draftsman's scale. Use the graduation, nearest suitable to the eye, place the zero mark on one end of the space to be divided, and the number corresponding to the parts required on the line marking the end of the space, or its continuation, mark off points at every graduation, and with triangle or T-square draw parallel lines through these points. At the left is shown two lines, the distance between which is to be divided into 17 equal parts. In this case the regular scale of an



ordinary rule is used; after the points are marked off, parallel lines are drawn through them. This use of the rule for dividing without going to the trouble of figuring is applicable in a great number of cases. The distance center to center of two shafts is given, and a transmission of spur gearing of the ratio 3 to 7 between them is wanted. The pitch circles can be drawn immediately without figuring their diameters or number of teeth. Draw the distance between centers to scale, hold the zero mark of rule on a line through one center and the graduation 10 ($=3+7$) to a parallel line through the other center; the graduation 7 marks the line tangent to the two pitch circles, as illustrated in the right-hand view. MARTIN JOACHIMSON.

New York City.

FINISHING FLY-WHEELS, HOIST DRUMS AND PISTON RINGS ON THE LIBBY TURRET LATHE.

An illustrated description of the Libby turret lathe appeared in the March issue of MACHINERY. In this description some of the characteristic features of its design were pointed out; one of the most interesting features there called attention to was the unusual construction of the tool-post carriage. This carriage does not extend across the bed, as in the usual designs of this class of machines, but it is supported by a front

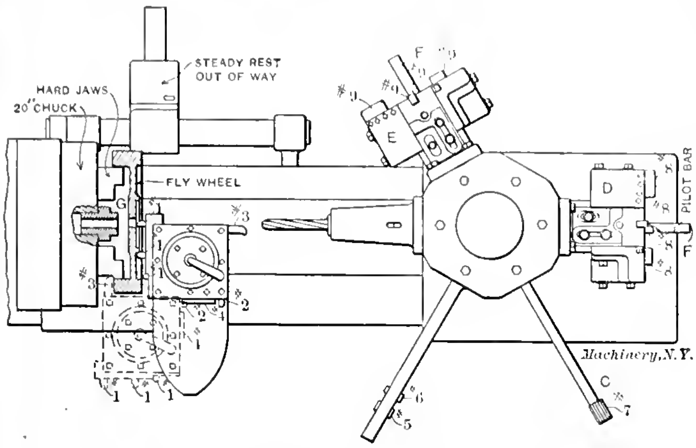


Fig. 1. Finishing a Fly-wheel in the Libby Turret Lathe. First part of First Operation.

way and by a V-guide at the bottom of its apron, bearing on a corresponding way on the lower edge of the bed. This permits the tool-post carriage to be moved past the chuck mounted on the spindle at the head-stock end. The turret can thus be used close up to the chuck, and overhanging tools, usually required to reach over the tool-post cross slide, can be avoided. Another advantage gained is also that, on account of its construction, practically the full capacity of the machine can be swung over the carriage.

In the present article a number of interesting operations, as performed on this machine by the International Machine Tool Co., of Indianapolis, Ind., are described. The operations which we will here deal with are the finishing of automobile fly-wheels, in two settings, the finishing of hoist drums, and the making of piston rings.

Finishing Automobile Fly-wheels in Two Settings.

The finishing of automobile fly-wheels on the Libby turret lathe is illustrated in the three line engravings, Figs. 1, 2, and

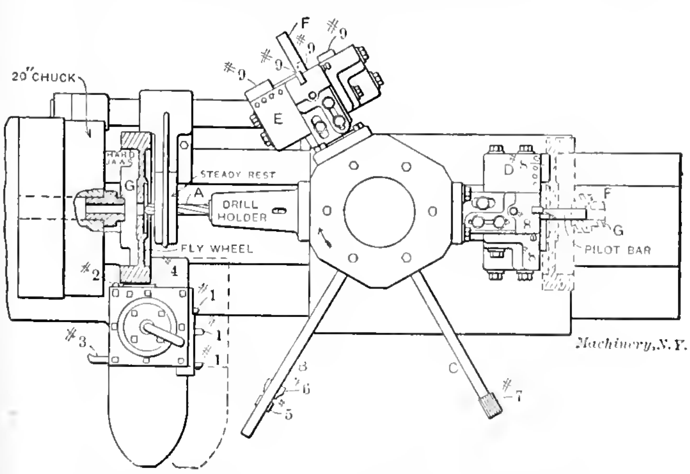


Fig. 2. Finishing a Fly-wheel in the Libby Turret Lathe. Second part of the First Operation

3. The fly-wheel is chucked from the inside by the hard steel jaws of the chuck, sufficient space being left between the chuck and the rim of the fly-wheel so that the tool for facing the back side of the rim of the wheel will have ample clearance, as shown by the dotted lines in Fig. 1, where tool No. 3 is indicated as finishing the back side of the rim.

The gang tools No. 1 are now set as shown in Fig. 1, and the tool-post carriage is brought into position, as shown, so as to rough all the faces at one operation. The tool-post carriage is next brought into position, as shown in Fig. 2, permitting the use of tool No. 2 for roughing the outside diameter of the fly-wheel. The steady rest, which was swung out of the way in Fig. 1, is brought into position for supporting the drill and boring-bar used for the hole in wheel in Fig. 2. This hole is being drilled and the rim of the wheel rough-turned, simultaneously. The cutter bar *B*, with cutters Nos. 5 and 6, is then used to bore the hole in the fly-wheel preparatory to reaming by reamer No. 7.

When the center hole is reamed, the roughing facing head *D* is brought into position. While the roughing head *D* is in operation, the tool-post carriage is placed in position so as to use tool No. 3, as shown by the dotted lines in Fig. 1, already referred to. This tool then rough-turns the rim of the fly-wheel next to the chuck. Finally, the finishing facing head *E* with the tools No. 9 is brought into position to be applied to the work, and the tool-post carriage at the same time set so that the broad finishing tool No. 4 finishes the outside diameter of the wheel, as shown in Fig. 2. The cutters Nos. 8 and 9 in the heads *D* and *E* are adjustable to cuts of various sizes and depths, within the range of the holders. The pilot bars *F* on the facing heads *D* and *E* are employed to steady the heads while in action, the pilot bars receiving their support from the bushing *G* in the chuck.

One side of the fly-wheel is now finished. For the second operation the wheel is held by the outside finished rim by soft jaws, as shown in Fig. 3. The gang tools No. 10 in the tool-post carriage are then used for rough-turning the web of the wheel. After that the roughing head *D* and the finishing head

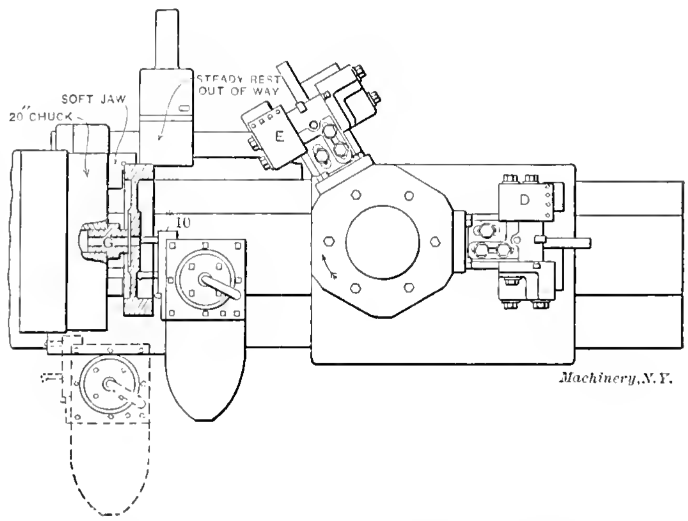


Fig. 3. Finishing a Fly-wheel. Second Operation

E are brought into position consecutively, the operations being the same as previously described for the finishing of the other side of the wheel.

Finishing 20 x 19-inch Hoist Drums.

The finishing of hoist drums 20 inches in diameter is ordinarily done on a vertical boring mill, or on a 32-inch engine lathe, or on a turret lathe, which then, when provided with a cross slide of the ordinary construction, requires a machine of 35 inches swing. On account of the peculiar construction of the tool-post slide of the Libby turret lathe, it is possible to finish drums of the size mentioned in a 21-inch Libby lathe, at one setting, the operations performed being the boring and reaming of the holes in the two hubs, the facing of one hub, the turning of the outside diameter of the drum, and scoring the drum for the rope as shown in Fig. 4.

The drum is chucked from the inside of the rim, the holes in the hubs are rough-turned by the boring-bar *A* and finish-bored by the boring-bar *B*. The tools Nos. 5 and 7 are for boring the holes in the hubs, and Nos. 6 and 8 are for facing. After boring, the holes are reamed with reamer No. 9 on bar *C*. It should be noted that bar *C* is long enough so that the projection reaches through the drum and acts as a pilot bar, the further end being supported by the bushing *F* in the chuck, this insuring true alignment of the holes when reamed.

The steady bar or arbor *D* is now brought in position into the reamed holes in the drum. The large diameter of this bar fits closely the reamed holes in the hubs, and the small

part *E* is of such a size that it will fit the bushing *F* in the chuck. This bar supports the drum while turning and scoring it on the outside. The advantage of being able to bring the turret close up to the work, on account of the peculiar construction of the tool-post slide, already referred to, is here plainly in evidence. The supporting bar can be made correspondingly short, and will consequently be more rigid, the turret being brought up very close to the end of the drum. The drum and brake band is now rough-turned with tool No. 1, and finished to size with tool No. 3. After that the edges on the flanges are rounded off with tool No. 4. Finally, tool No. 2 is used for scoring the drum to the required pitch, which, in this case, is one inch lead. Other leads may, of course, be obtained by simply changing the change gears. The four last-mentioned tools are all mounted in the tool-post carriage, as shown in Fig. 4. The position of this carriage as indicated by the dotted lines should be noted, the carriage in this case being opposite the chuck on the spindle.

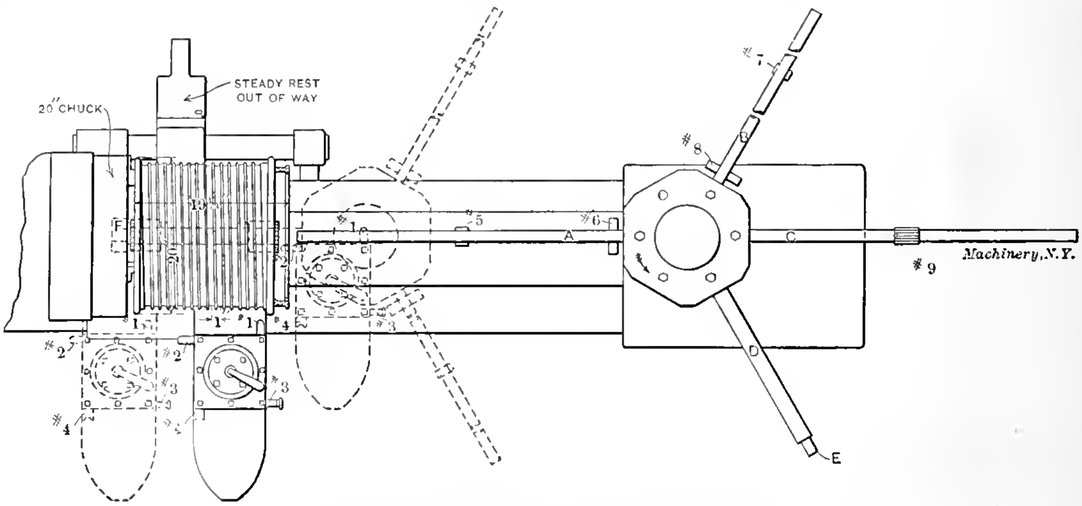


Fig. 4. Boring and reaming the Holes, facing the Hubs, and turning and scoring the Outside Cylindrical Surface of a Hoisting Drum, in One Operation.

This particular drum only requires the facing of one hub. If the other hub is required to be faced, this may be done by placing a cutter in the bar after it is inserted into the holes, provided that sufficient room is left for the cutter when the drum is chucked.

Making 18-inch Piston Rings.

In Fig. 5 is shown the method and tools used for making 18-inch piston rings on the Libby turret lathe. The line engraving shows the piston ring casting, which has had the lugs faced off, and is bolted to a shifting face-plate of the eccentricity desired in the rings. This face-plate, in turn, is fastened to the chuck after removing the jaws. Tool No. 1 in the tool-post carriage is used for roughing off the outside of the rings, and tool No. 2 for finishing. Then the shifting face-plate is adjusted so as to provide for the eccentricity desired in the rings. Now the roughing cutter head *A* is brought into action for roughing the side of the ring, it being followed by the finishing cutter head *B*. Each of these cutter heads has four cutters and is also provided with a pilot bar long enough to reach through the ring and engage with the bushing *C* in the chuck, thus providing for rigid guiding.

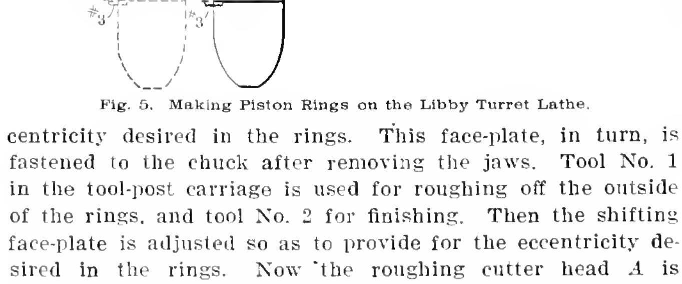


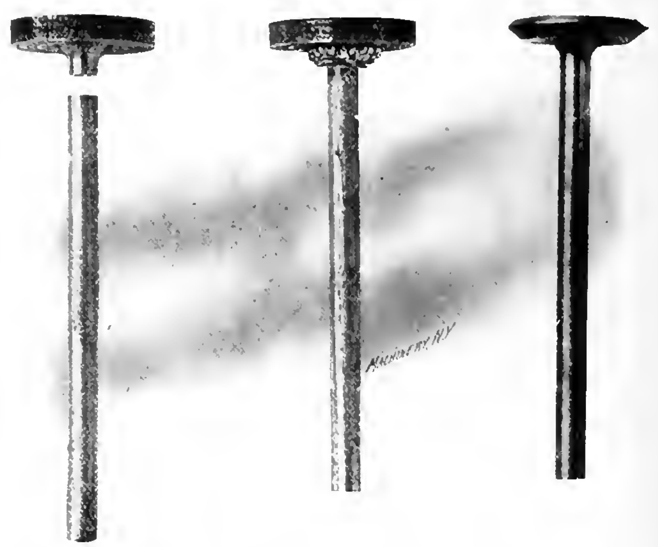
Fig. 5. Making Piston Rings on the Libby Turret Lathe.

The gang tool No. 3, mounted in the tool-post, is now brought into service. This gang tool is provided with seven cutting-off tools, and so arranged that each cutter, commencing at the right, is set slightly in advance of the one to the left. The longest, or the extreme right-hand cutter, is used as a gage, and will cut off its ring first; then each ring will be cut off in turn, and not all at once. As the inside of the ring is bored true with the spindle and the outside is eccentric, the tools will cut through and cut off the ring all around at the same time.

ELECTRIC WELDING OF DISSIMILAR METALS.

In the April, 1908, issue, examples of electric welding were illustrated, and the various electric welding processes were briefly described. A valuable feature of the Thompson process of electric welding is that the dissimilar metals can be perfectly joined. This possibility permits combination of metals best suited to the conditions of use to be made, as well as very substantial economies in the use of high-priced materials. The accompanying illustrations show specific examples of electric welding of dissimilar metals done by the Electric Welding Products Co., Cleveland, O., formerly the Cleveland Cap Screw Co.

The poppet valve shown in Fig. 3 is one of the exhaust valves of a high-speed gas engine. It is made up of a carbon steel stem, electrically welded to a nickel steel head. The parts before welding are shown in Fig. 1, and the combination immediately after welding in Fig. 2, while the finished valve is illustrated in Fig. 3. By making the head of nickel steel, of an alloy suited to the purpose, the very best metal is put in the head of the valve, which is the part subjected to the hardest usage. Nickel steel is peculiarly suited to the trying conditions surrounding gas engine exhaust valves, as it does not pit, warp nor corrode, as does common steel in

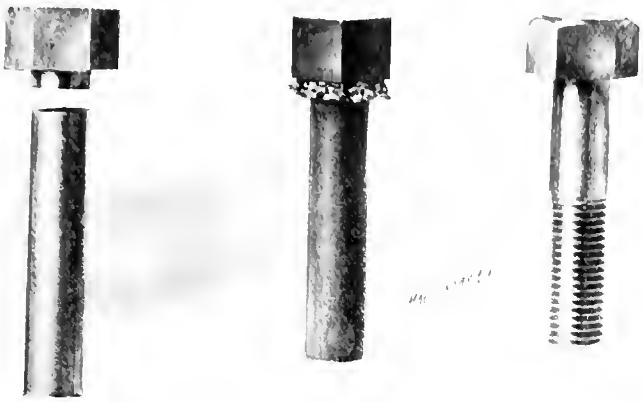


Figs 1, 2, and 3. A Poppet Valve made by electrically welding a Carbon Steel Stem to a Nickel Steel Head.

such a situation. Moreover, it is much tougher, and is not apt to break because of the hammering it receives. The stem, being made of carbon steel stands wear in the guide better than a nickel steel stem; it is stiffer also and can be hardened on the end. The latter consideration is important, inasmuch as high percentage nickel steel cannot be satisfactorily hardened to withstand the cam blow of the valve mechanism. Another important advantage of the combination is the saving of high-priced metal and the obvious

saving of labor over that required for making and machining a forging.

The cap-screw illustrated in Fig. 6 is made with a brass head and steel body. Figs. 4 and 5 show the parts of the welded screw before finishing. This screw is 50 per cent stronger than an all brass screw, and answers the practical requirements equally well or better, inasmuch as the body is stronger than a brass body. This combination was made for use in places where an ornamental finish was required, and as the head only shows, a brass body was not required.

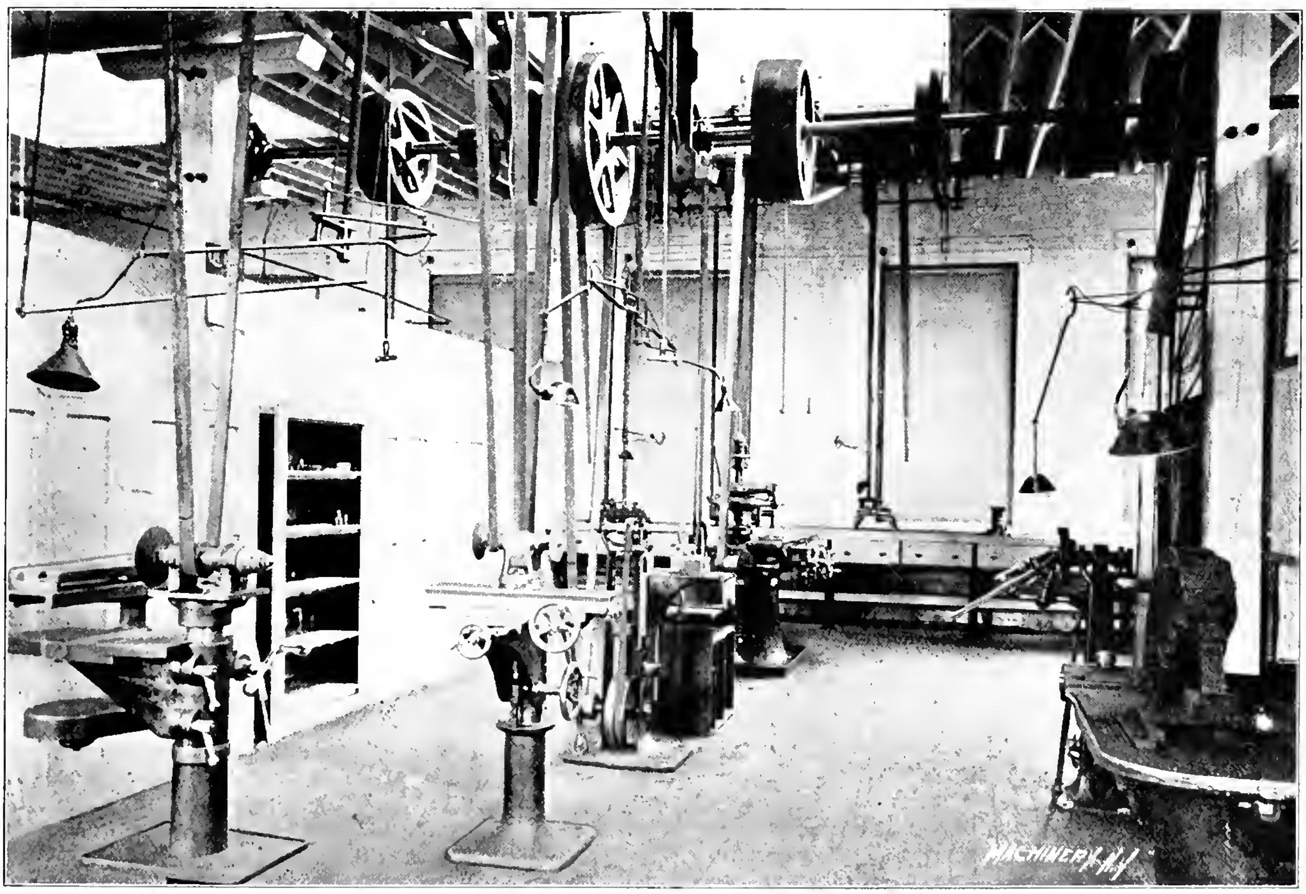

Figs. 4, 5, and 6. A Cap-screw made by electrically welding a Steel Body to a Brass Head.

Other valuable combinations of dissimilar metals could be mentioned, but the foregoing will serve to illustrate the advantage of electric welding in this line. The chief business of the company is the manufacture of all sorts of steel bolts and screws, and it has been engaged in it for several years. The claim made for electric welded all-steel bolts and screws is that they are stronger than when made by the ordinary methods. The reason is that the die-drawn surface of the stock is retained on the body, this portion of the body being much stronger than the center which is left when the bar is turned down to the body size from the head size. In the case of forged bolts this objection, of course, does not hold, but it is common practice to use inferior grades of stock which are unreliable in service. This fact is indicated by tests made of electric welded cap-screws and cap-screws made by twelve makers, from ordinary stock. The tests show that the average tensile strength of ½ to 1¼ inch electric welded cap-screws was 97,862 pounds per square inch, while the average of the ordinary stock screws was only 56,570 pounds per square inch. The difference in favor of the electric welded screws was 73 per cent.

As indicated in the foregoing, the process employed by the company is the Thompson process, which is believed to have advantage over the arc, forge and gas blowpipe methods. In the Thompson process the metals are heated for welding by their resistance to the electric current. The parts are gripped in copper-faced jaws of the welding machines, and in the case of large parts are forced together by hydraulic pressure. The interior of the parts heats first, and when the surface has reached the incandescent point, the interior has surely reached the proper welding heat. The great heat generated burns out all oxides and impurities, and the pressure exerted causes the joint to flow and brings the parts into intimate contact; thus only ordinary care is required on the part of the operator to make perfect joints.

INDIVIDUAL MACHINE LIGHTING.

The accompanying engraving shows the grinding room of the H. Mueller Mfg. Co. and the form of lamp brackets used. An ordinary pipe flange is fastened to the ceiling or to the hanger boards and into this a pipe of suitable length is screwed. A cast iron bracket is slipped on the lower end of this and held in place by a set-screw. The bracket arm can be swung in a horizontal plane, and the pipe extension which has a circular end passing through a hole in the end of the arm, can be moved in any direction, horizontally or vertically, and is held in place by friction only. There is also a wall bracket used, as shown over the bench near the windows. Both the clamshell and bell shades are used, according to the individual liking. For this photograph and description we are indebted to Mr. Ethan Viall, Decatur, Ill., who says that the fixtures are ahead of anything that he has seen.



Grinding Room of the H. Mueller Mfg. Co., equipped with a Simple Form of Adjustable Lamp Bracket

* * *

Most people would know more if they didn't take so many things for granted.—*The Silent Partner.*

MACHINE SHOP PRACTICE.*

GRINDING A GEAR-CUTTER.

Experience has taught the advisability of keeping keen cutting edges on all tools, whether used for working in wood or metal; and milling cutters, in particular, when in constant use, should be sharpened frequently, as a cutter with a keen cutting edge is the one that will produce the best results, both as to the quantity and quality of the work. When a cutter becomes dull, it rapidly becomes worse, the friction is greatly increased, and the resulting heat often impairs the temper of the tool, with the result that the cutting edges are

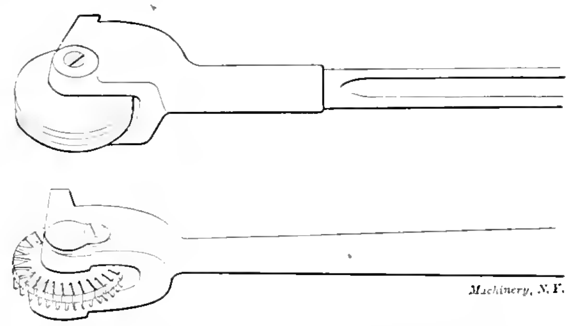


Fig 1. Two Types of Emery-wheel Dresseres.

rounded, which means considerable grinding in sharpening. More power is, of course, required for driving dull tools, and the wear and tear on the machine is also increased.

The gear-cutter which we are considering is a cutter of the formed type, which may be re-sharpened without changing its profile, provided the sharpening is done properly. The first thing which is essential in connection with any grinding operation is a true wheel, as an untrue wheel is not only a source of danger, but the work done by it poor in quality. The diamond, which is the hardest known substance, is best adapted to this work, owing to the hardness of the abrasive materials used for grinding. When the wheels are large and coarse, this method is somewhat expensive, and tools known as emery dressers are often used. Two types of these tools in common use are shown in Fig. 1. They consist of shanks, having mounted on a spindle on the end, hardened disks, the shapes of which vary in different makes. These disks are brought into contact with the wheel, and traversed across its face. As they revolve rapidly small particles of the abrasive are broken from the wheel's periphery, and it is trued. A diamond truing tool, which is extensively used, especially on small wheels, is shown in Fig. 2. It consists of a shank *A*, having a handle on one end and a small diamond *B* set in the other. This tool is applied to the wheel in various ways. Holders, similar to the one shown on Shop Operation Sheet No. 67 of the Supplement accompanying this issue, are often used, but some oper-

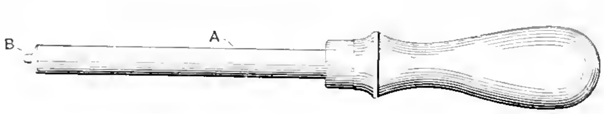


Fig 2. The Diamond Truing Tool.

ators prefer to support the tool on the foot-stock center, truing the wheel by traversing it or the table back and forth. A diamond of good quality will stand much use without showing any great amount of wear, but because of its brittleness, it should be brought very gradually to the face of the wheel to avoid the shock which would be the result of a sudden application.

The selection of a wheel suitable for grinding cutters is governed largely by conditions. Wheels which work satisfactorily on cutters made from carbon steel, are not so well adapted for high speed steel, which is ground with better results with a coarser and softer wheel than is used for the carbon steel. A wheel of medium fine grit, and medium or soft grade is best adapted for cutter grinding. Grit as used here refers to the size of grains of the abrasive, while grade is the degree of tenacity with which the bond holds the grit in place. For this particular operation a wheel having a beveled side, as shown in Fig. 3, is necessary in order that it may clear the work when grinding the inner faces of the teeth. If the working surface of the wheel is glazed, this should be removed with the diamond before using, as otherwise, the temper may be drawn from the teeth of the cutter, owing to the increased friction. Glazing can also be removed by a carborundum crystal, which is only inferior to the diamond in hardness. A glazed surface on the wheel does not necessarily mean that it is not adapted to the work, as oil or grease on the cutter is often the cause of this.

When the gear-cutter is being ground it is mounted on a fixture, similar to the one shown on Shop Operation Sheet No. 68. A stud on the fixture fits a hole in the cutter, which is kept from turning while being ground by a tooth-rest which bears against the backs of the teeth. The knee of the grinding machine is adjusted vertically until the axis of the wheel lies in a plane midway between the sides of the cutter. The table is also adjusted until the axis of the stud on which the cutter is mounted is in line with the grinding face of the wheel. It is very important that gear-cutter teeth be ground radially, or so that the faces of the teeth lie in a plane passing through the axis of the cutter. In Fig. 3 is shown the correct and incorrect way of grinding the teeth. As will be seen, the face of the tooth *A* is on the radial line, while tooth *B* is not. Teeth not ground radially, if sunk to the correct depth in the gear blank, cut a tooth space which is wide at the top, and the result is, of course, a gear having improperly shaped teeth which means that it will work unsatisfactorily. One reason why teeth are not ground radially is because they are thinnest at the top, and because of this are sharpened in less time by grinding them away faster at this point. This is, however, bad practice, for while the cutter may appear sharp, it will not only produce inaccurate work, but cut badly, owing to the negative rake. As the wheel contact on a gear-cutter is considerable, owing to the width of the teeth, it is inadvisable to attempt to do the work rapidly by taking heavy cuts, as this will result in drawing the temper of the cutter. Light cuts should be taken, and the work traversed rapidly across the wheel.

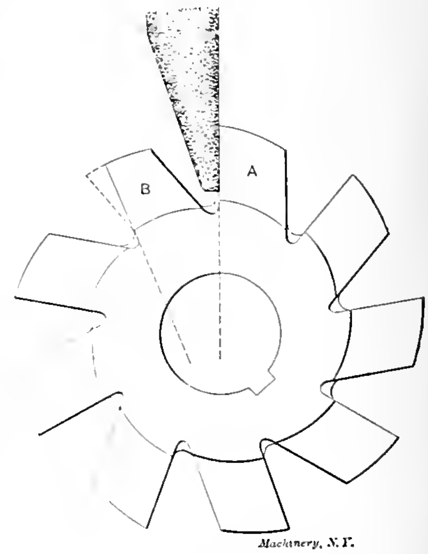


Fig. 3. Correct and Incorrect Methods of Grinding Gear-cutter Teeth.

* * *

In a recent address to a university student body in a Canadian town, Rudyard Kipling said, "*Take everything seriously and earnestly, except yourselves.*" What a wealth of meaning there is in those few words! Doubtless there is no other fault more prominent in the average college graduate than an exaggerated idea of his own importance. He confidently expects to step from his college work to a place all prepared for him, and fittingly compensated as his great ability deserves! In the language of the street, he usually has a "swelled head." The chief part of the first few years of his practical education, which we call experience, is largely learning his relative unimportance to the world at large. The engineering student learns with much disgust that many of the beautiful theories so carefully and positively expounded by his instructors apply only in the remotest degree to his actual work. He finds that engineering is nine-tenths plain hard work on common-sense matters, and that his theoretical knowledge may apply to some extent to the other one-tenth. His knowledge of theory is not nearly so important as his personality and general attitude to his fellow employes.

* With Shop Operation Sheet Supplement.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

POTTER & JOHNSTON 6-INCH AUTOMATIC CHUCKING MACHINE.

The readers of MACHINERY are familiar with the Potter & Johnston chucking machine from the very complete description we have recently given of it. (See article "The Setting Up and Operation of the Potter & Johnston Automatic Chucking Machine," in the April and May, 1908, issues, and "New Machinery and Tools" in the April, 1908, issue.) The builders of this machine have recently added to their line a smaller size which they designate as their 6-inch automatic chucking machine. This is shown in the three accompanying engravings. While it involves the same principles in its construction as used in the larger machine, the actual mechanism employed is different in a number of particulars, and is of sufficient interest to warrant the full illustration and description herewith given.

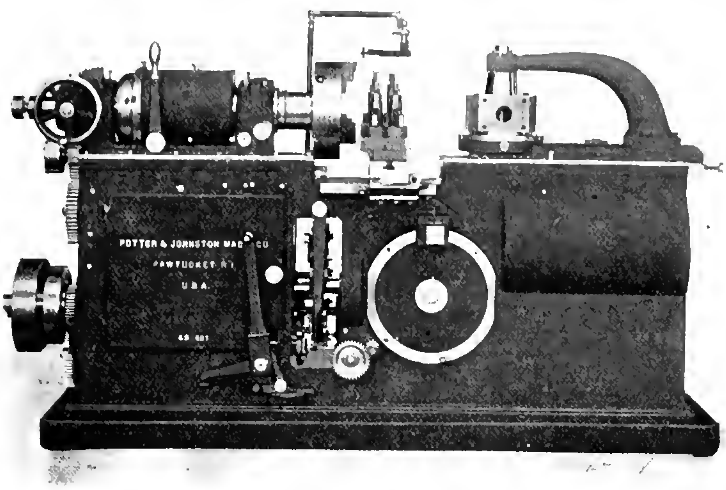


Fig. 1. A Small Size and New Design of the Potter & Johnston Automatic Chucking Lathe.

General Description of Machine.

The plan of the machine is very simple, consisting, as it does primarily, of a single bed casting with an adjustably mounted head-stock and driving mechanism on one end, and turret slide on the other, with longitudinal ways between them on which the base for the double-acting cross-slide is adjustably mounted. The cross-slide and turret-slide are operated by cylindrical cams, driven from a feed shaft at the rear of the machine, which also operates the governing disk seen in the opening in the center of the bed. This disk carries dogs and pins which control the rapid and slow movements of the feed shaft, and the spindle speed changes, of which there are three, controlled automatically. The slow or feeding movement of the feed shaft is operated from the spindle movement, and is proportional to it. The rapid movement is operated from the constant speed driving pulley, and always runs at the highest practicable speed. A large supply of gears, both for speeds and feeds, is provided, covering all ranges of work within the capacity of the machine.

A front view of the machine is shown in Fig. 1. A notable characteristic, which will at once be seen, is the completeness with which the mechanism is enclosed in the single rectangular box-shaped casting. Another feature which catches the eye is the provision made for the longitudinal adjustment of the head-stock to suit work of different lengths. This has been done in preference to making this adjustment between the cam roll and the turret slide, as it is thereby possible to make the parts with less over-hang, and so give the machine greater rigidity and greater cutting power.

Spindle Driving Mechanism.

The machine is driven from a constant speed pulley at the base of the machine, seen at *A* in Fig. 3. This pulley is keyed to shaft *B*, which runs through the head-stock end of the base, and carries a set of three gears, *C*, *D*, and *E*, of varying diameters, meshing with corresponding gears *F*, *G*, and *H*, running loosely on short shaft *J* above it. The largest of these gears, *F*, is connected with shaft *J* by a roller ratchet mechanism, so that the drive is normally through this pair of gears, *C* and *F*. The other two sets are provided with clutches, either one of which can be thrown into operation, as will be described later. When either of them is engaged, shaft *J*, thus driven at a faster rate than that given by its normal connection through gear *F*, runs away from that gear, being permitted this liberty by the roller ratchet drive. It will thus be seen that three changes of speed are provided for shaft *J* by the operation of two positive clutches.

Shaft *J* is connected by change gearing *K* and *L* with a shaft *M* above it, which extends out through the back end of the bed, where it carries gear *N*, which drives a mating gear *O*, keyed to a shaft running lengthwise of the head-stock, between the ways on which the latter is adjusted. This shaft carries a pinion which engages the driving gear of the spindle. The shaft is splined a sufficient length to give a full drive on the pinion at any adjustment of the head. The change gears *K* and *L* furnished for connecting shafts *J* and *M* in the base, provide for six rates of speed, which, with the three clutch changes available, gives eighteen changes in all.

Handle *P* on the head-stock controls a double-acting clutch which engages the spindle with either the driving gear on one side, or with a stationary brake member on the other.

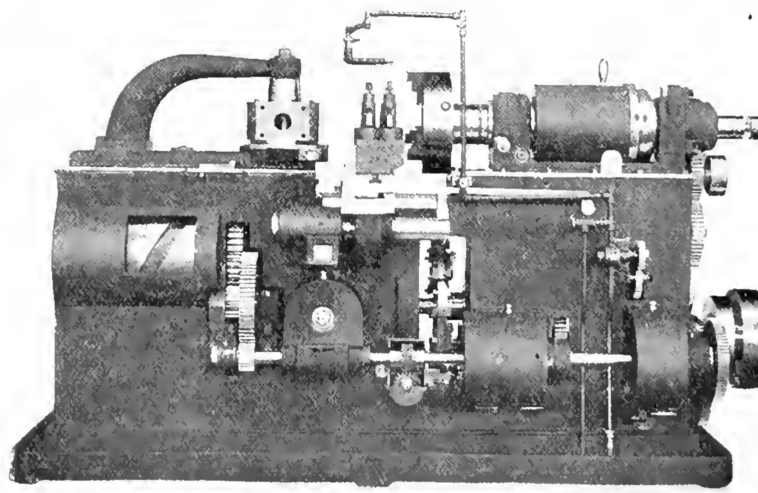


Fig. 2. Rear View showing the Feed Shaft and its Connections with the Governing Disk and Cross- and Turret-slide Cams.

This is a great convenience and a time saver as well, since it enables the operator to stop the spindle instantly for the purpose of removing and inserting work. Hand-wheel *Q* at the rear bearing of the spindle operates a rugged back facing attachment, consisting of a stiff stationary bar supported from the back end and extending the length of the spindle with a facing tool on the front, by means of which the inner hub of work held in the chuck may be conveniently finished.

Driving Connections of the Cam and Governing Mechanisms.

The feeding movement for driving the cross-slide and turret-slide cams is driven from pulley *R* at the rear end of the driving pinion shaft, so that it always revolves proportionally with the spindle, thus making all feeds proportional to the

spindle speed. The conditions are thus the same as in the lathe, where the number of revolutions per inch of feed is constant, whatever the rate may be at which the spindle revolves. Pulley *R* is belted to pulley *S*, which runs loosely on shaft *B*. Change gearing connects this pulley *S* with the feed shaft seen in Fig. 2, running along the back of the bed near the base. This feed shaft has also geared connections with constant speed driving shaft *B*, which connections are controlled by the vertical lever *T*, see Fig. 3. By means of this lever, the motion of the feed shaft may be arrested entirely, it may be given the constant speed rapid movement from shaft *B* required for the idle motions of the machine, or it may be connected with the spindle for the cutting movement through pulley *S* and the gearing just described. These changes may also be made automatically, as will be described later. The considerable reduction required for the feeding motion between the loose pulley *S* and the feed shaft at the rear, is effected by a differential gear train encircling the latter shaft, and enclosed within the casing shown at the right-hand end of the bed in Fig. 2. The casing shown just at the left of this and on the same shaft, encloses the gearing and mechanism by means of which connection is made with the rapid movement derived from the constant speed shaft *B*.

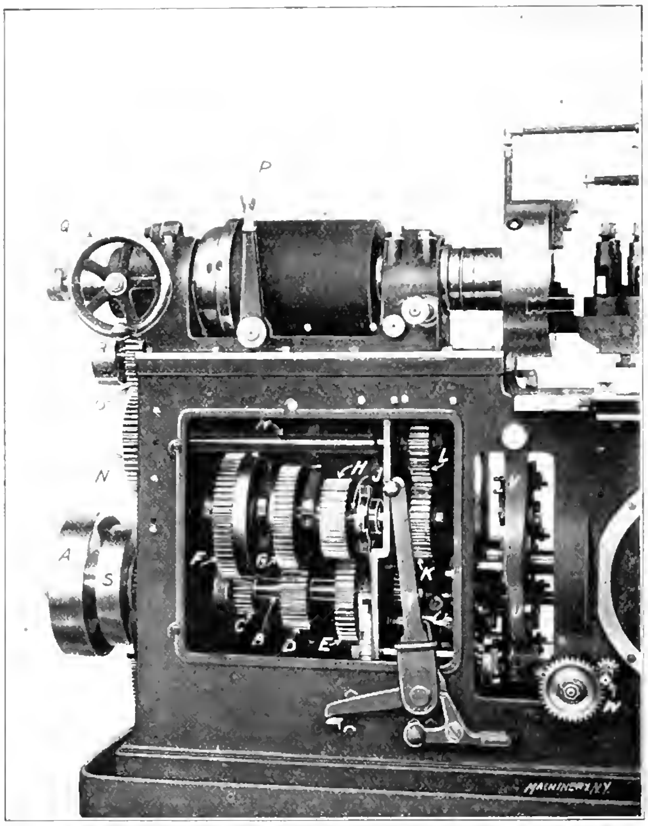


Fig. 3. Door in Base removed to show Spindle Driving Mechanism.

The Speed and Feed Governing Connection.

The feed shaft at the back of the machine, as may be seen in Fig. 2, drives three separate mechanisms. The first connection, through the spiral gearing shown and a set of worm gearing, is with the short shaft on which is mounted the governing disk, seen also in Fig. 1 and at *U* in Fig. 3. To the periphery of the disk are attached dogs which engage a pin on the end of lever *V* at the front of the machine. This lever is mounted on a rock shaft which extends through the machine and is connected in the rear with levers and a link to the mechanism for operating the speed change clutches in the base of the machine for gears *G* and *H*, as previously described. To the left side of the governing disk, in the position shown in Fig. 3, are attached dogs carrying pins which operate a ratchet mechanism, revolving a cam shaft, by means of which the feed shaft is connected with either the constant speed rapid movement, or the slow speed feeding movement operating from the spindle, as desired. The worm shaft by which this governing disk is driven is extended out to the front of the machine, where it is geared to a short stud *W* with a squared end, by means of which the movements may be manually operated when setting up the machine.

The Cross- and Turret-slide Cams and Connections.

The second member driven from the feed shaft in the rear is the cross-slide cam. This is of the cylindrical type, mounted on a shaft extending through the bed from back to front, and driven by worm gearing from the feed shaft. The circular cover plate for the chamber holding the cam may be plainly seen at the front of the machine, below and just to the right of the cross-slide in Fig. 1. This cover plate is removed for giving access to the cam drum when changing the cross-slide cams for setting up new work. The guiding surfaces of the cam operate a roll, fixed to the under side of a square bar, which extends through the machine, with bearings at the front and rear. This bar has rack teeth cut on its upper side at the rear, meshing with a pinion on a stout rock shaft, which in turn is keyed to a sliding pinion held in the cross-slide base. This latter pinion engages the teeth of a rack fast to the cross-slide. It will thus be seen that the movement derived from the cross-slide cam is transmitted through the square bar to the rock shaft, and thence to the cross-slide—a very direct and powerful connection, which still permits freedom of adjustment for the cross slide base on the bed, to suit the work being operated on. The cross-slide carries two tool-post blocks.

A third function of the feed shaft is the driving of the turret slide cam. This cam (which may be seen through the opening in the rear of the bed in Fig. 2), like that for the cross slide movement, is of the cylindrical type and is enclosed in a cylindrical chamber. It is of cast iron, with an inserted steel working face for that part of the surface where most of the wear comes, during the feeding of the tools. It will be seen that this cam is connected with the feed shaft by spur gearing, instead of by worm gearing as in the case of the cross-slide movement. The turret cam with the four-sided turret used makes four revolutions to one of the cross-slide cam, or for each piece of work completed. To avoid the necessity of a complicated automatic turret clamping mechanism, a supporting arm is provided for the turret stem, which stiffens it so as to adapt it for even the heaviest forming cuts.

It will be seen that ruggedness is a prime characteristic of this machine. The bed is one solid piece of double box section, while the turret slide and head-stock are both low and very firmly gibbed to the stiff bed. The machine is built by Potter & Johnston, Pawtucket, R. I., and, as a large proportion of the work for which their older machines are adapted is in the vicinity of 6 inches in diameter or smaller, this machine should find a large field awaiting it.

GOULD & EBERHARDT STOCKING CUTTER.

During the past decade the development of gear-cutting machinery has been rapid, and the improvements in this class of machine tools has perhaps been more radical than in almost any other class of machines. While the development of the gear-cutting machines themselves is of supreme importance, one must not lose sight of the fact that the actual methods of producing the gear tooth, by means of a rotary cutter, have also presented a field for improvement. To obtain good results, if accurate and noiseless running gearing is the object sought, it is required that a gear tooth should first be roughed out with a roughing out or stocking cutter, before the tooth is finally finished with an ordinary gear tooth cutter of the regular type.

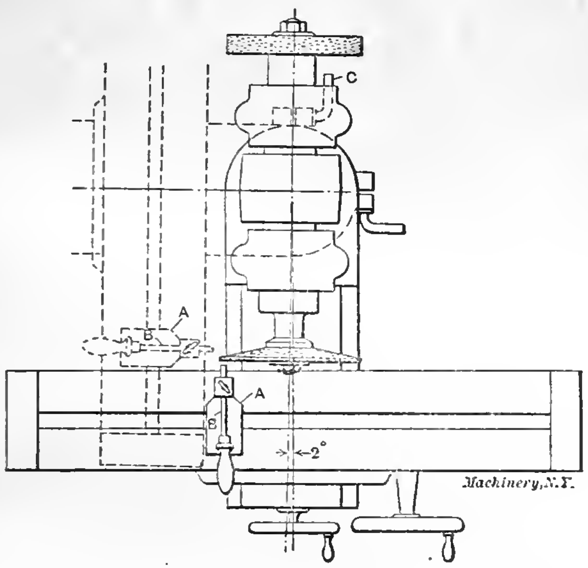
Some five or six years ago, the firm of Gould & Eberhardt, of Newark, N. J., brought out what they term their "stepped style" of stocking cutter, for roughing out the teeth of coarse pitch gearing, previous to the finishing operation with a standard gear tooth cutter. The advantages claimed for these cutters over the ordinary square saw or slotting cutter, which had previously been used most generally, was that by having steps provided in the cutter, the chips were broken up, and

Supplement to MACHINERY, July, 1908.

Operations for the Article in this number entitled "Machine Shop Practice—Grinding a Gear-cutter."

SHOP OPERATION SHEET NO. 67.

Ethan Viall. MACHINERY, July, 1908.



Grinding a Gear-cutter—Truing the Emery Wheel.

1. Be sure that there is no play in the grinder spindle, that it runs freely and is well oiled; also see that the table ways are clean and free from grit and have oil enough so that the table can be moved easily.

2. Select a free-cutting saucer-shaped emery wheel about 6 inches in diameter, of medium grade and grain, and one that will not glaze or wear too fast.

3. Place the wheel, with the concave side out, on the end of the spindle which has a right-hand thread on it, which is the end that turns to the left when facing it.

4. Bolt the diamond holder *A* near the right-hand end of the table and clamp the diamond truing tool *B* in place.

5. Swing the knee around until the table is parallel with the spindle, and in the position indicated by the dotted lines. Adjust the table vertically until the diamond point is slightly below the center of the spindle, and then tighten the clamp *C*.

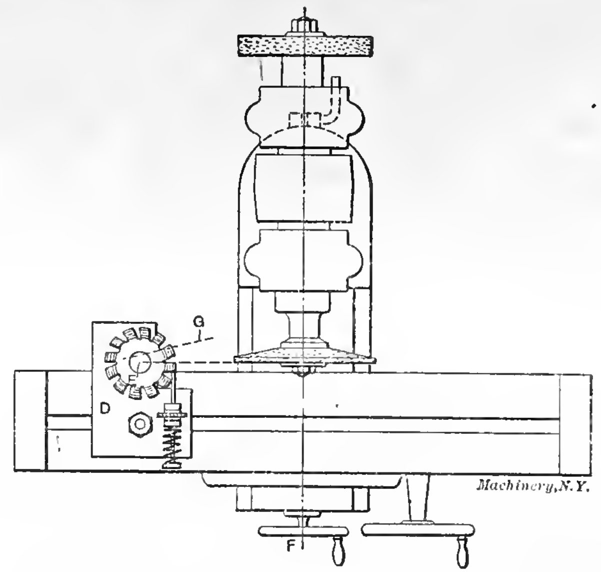
6. Start the grinder, and true up the wheel by feeding the diamond across its periphery.

7. Move the diamond truing tool and holder to the left end of the table. Loosen the clamp *C*, and swing the knee around until its center line makes an angle of 2 degrees with the axis of the spindle, as shown in the illustration, and again clamp the knee.

8. Bring the diamond truing tool into contact with the face of the wheel, and beginning at the edge, true at least a half-inch of its surface, and more if needed. Cut deep enough to remove all old glaze, and to true the wheel perfectly.

SHOP OPERATION SHEET NO. 68.

Ethan Viall. MACHINERY, July, 1908.



Grinding a Gear-cutter—Lining up Center of Cutter with Face of Wheel.

1. After truing the wheel as described in the previous operation sheet, carefully wipe off the table and clean out the slot.

2. Bolt a gear-cutter fixture *D* to the left end of the table, and place the cutter to be ground on the pin *E*, so that the teeth on that side of the cutter which is next to the wheel, will have their faces toward it. Loosen the table clamp and adjust the table vertically until the centers of the cutter teeth are the same height as the center of the grinder spindle.

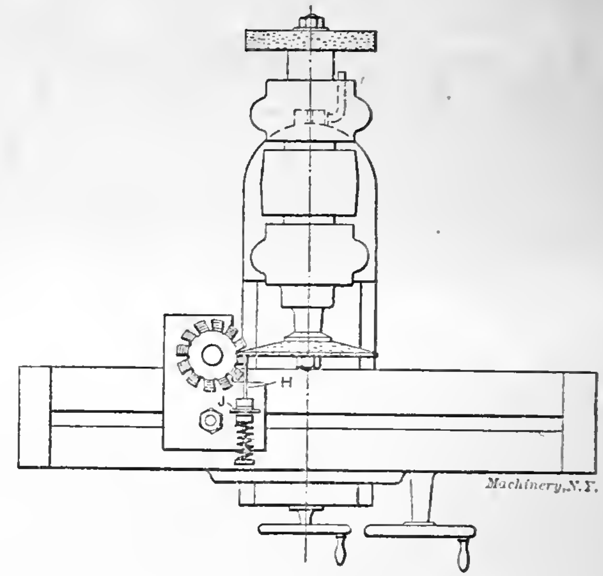
3. Carefully line up the table so that it is parallel with the face of the wheel. If there are no graduations on the machine for this purpose, set the table with the trued surface of the wheel, using a straight-edge.

4. With the jig and cutter far enough to the left to be clear of the wheel, lay a straight-edge across the face of the wheel and move the table out or in by means of the wheel *F* until the center of the pin *E* holding the gear-cutter is exactly in line with the outside face of the wheel. When the cutter is set in this way, the faces of the teeth will be radial or in line with the axis of the cutter.

NOTE.—It is important that the teeth of a gear-cutter be ground radially in order that the form of the teeth shall not be changed. If the top of a tooth is ground back faster than the base, and the face of the tooth be in the plane indicated by the line *G*, the shape of the tooth space cut is distorted, and a gear with badly shaped teeth is the result. In addition to this, the cutter works badly owing to the negative rake.

SHOP OPERATION SHEET NO. 69.

Ethan Viall. MACHINERY, July, 1908.



Grinding a Gear-cutter—Setting the Stop and Grinding.

NOTE.—It is assumed that the axis of the cutter is in line with the face of the emery wheel, and that the wheel has been trued.

1. Adjust the table longitudinally until the edge of the wheel rests against the bottom of one of the flutes between the teeth of the gear-cutter, and then tighten the table stop in the proper position to prevent the wheel from grinding the flute to a greater depth.

2. Turn the gear-cutter until a tooth rests lightly against the face of the wheel, then adjust the spring-stop *H* against the back of the tooth so that the cutter can be indexed freely, and also so that it will be held firmly against the wheel.

3. Move the cutter to the left until it is clear of the wheel and start the machine.

4. Carefully grind each tooth in turn, taking light cuts, then feed the teeth forward slightly by turning the knurled nut *J* which feeds the spring-stop *H*. Continue grinding until all cutting-edges are sharp and even.

NOTE.—When grinding cutters, light cuts must be taken to prevent the temper from being drawn from the cutting-edges, which would, of course, spoil the cutter. The face of the wheel which comes in contact with the work should be narrow, especially for dry cutter grinding, in order that the heat generated may be reduced to a minimum. If the cutter gets warm while grinding, remove it and cool in water. A moderately heavy and well-balanced wheel placed on the opposite end of the spindle will cause the grinder to run more steadily.

IX.—TABLE OF IDEAL MOMENTS.

All values may be read in hundreds or thousands of inch pounds.

Bending Moments in Inch Pounds = M_b		Torsional Moments in Inch Pounds = M_t: 50	100	150	200	250	300	400	500	600	700	800	900	1000	1200	1400	1600	1800	Bending Moment
50	T	70.71	111.8	158.1	206.2	255.0	304.1	403.1	502.5	602.1	2119	2154	2193	2236	2332	2441	2561	2691	2000
	B	120.7	161.8	208.1	256.2	305.0	354.1	453.1	552.5	652.1	4119	4154	4193	4236	4332	4441	4561	4691	
75	T	90.14	125.0	167.7	213.6	261.0	309.2	407.0	505.6	604.7	704.0	803.5	2377	2417	2506	2608	2720	2843	2200
	B	165.1	200.0	242.7	283.6	336.0	384.2	482.0	580.6	679.7	779.0	878.5	4577	4617	4706	4808	4920	5043	
100	T	111.8	141.4	180.3	223.6	269.3	316.2	412.3	509.9	608.3	707.1	806.2	2563	2600	2683	2778	2884	3000	2400
	B	211.8	241.4	280.3	323.6	369.3	416.2	512.3	609.9	708.3	807.1	906.2	4963	5000	5083	5178	5284	5400	
125	T	134.6	160.1	195.3	235.9	279.5	325.0	419.1	515.4	612.9	711.1	809.7	908.6	2736	2864	2953	3053	3162	2600
	B	259.6	285.1	320.3	360.9	404.5	450.0	544.1	640.4	737.9	836.1	934.7	1034	5386	5464	5553	5653	5762	
150	T	158.1	180.3	212.1	250.0	291.5	335.4	427.2	522.0	618.5	715.9	813.9	912.4	2973	3046	3131	3225	3329	2800
	B	308.1	330.3	362.1	400.0	441.5	485.4	577.2	672.0	768.5	865.9	963.9	1062	5773	5846	5931	6025	6129	
200	T	206.2	223.6	250.0	282.8	320.2	360.6	447.2	538.5	632.5	728.0	824.6	922.0	1020	3231	3311	3400	3499	3000
	B	406.2	423.6	450.0	482.8	520.2	560.6	647.2	738.5	832.5	928.0	1025	1122	1220	6231	6311	6400	6499	
250	T	255.0	269.3	291.5	320.2	353.6	390.5	471.7	559.0	650.0	743.3	838.2	934.1	1031	1226	3770	3848	3936	3500
	B	505.0	519.3	541.5	570.2	603.6	640.5	721.7	809.0	900.0	993.3	1088	1184	1281	1476	7270	7348	7436	
300	T	304.2	316.2	335.4	360.6	390.5	424.3	500.0	583.1	670.8	761.6	854.4	948.7	1044	1237	1432	4308	4386	4000
	B	604.2	616.2	635.4	660.6	690.5	724.3	800.0	883.1	970.8	1062	1154	1249	1344	1537	1732	8308	8386	
350	T	353.6	364.0	380.8	403.1	430.1	461.0	531.5	610.3	694.6	782.6	873.2	965.7	1059	1250	1443	1638	4847	4500
	B	703.6	714.0	730.8	753.1	780.1	811.0	881.5	960.3	1045	1133	1223	1316	1409	1600	1793	1988	9347	
400	T	403.1	412.3	427.2	447.2	471.7	500.0	565.7	640.3	721.1	806.2	894.4	984.9	1077	1265	1456	1649	1844	400
	B	803.1	812.3	827.2	847.2	871.7	900.0	965.7	1040	1121	1206	1294	1385	1477	1665	1856	2049	2244	
450	T	452.8	461.0	474.3	492.4	514.8	540.8	602.1	672.7	750.0	832.2	917.9	1006	1097	1282	1471	1662	1855	450
	B	902.8	911.0	924.3	942.4	964.8	990.8	1052	1123	1200	1282	1368	1456	1547	1732	1921	2112	2305	
500	T			522.0	538.5	559.0	583.1	640.3	707.1	781.0	860.2	943.4	1030	1118	1300	1487	1676	1868	500
	B			1022	1039	1059	1083	1140	1207	1281	1360	1443	1530	1618	1800	1987	2176	2368	
600	T			618.5	632.5	650.0	670.8	721.1	781.0	848.5	922.0	1000	1082	1166	1342	1523	1709	1897	600
	B			1219	1233	1250	1271	1321	1381	1449	1522	1600	1682	1766	1942	2123	2309	2497	
700	T				728.0	743.3	761.6	806.2	860.2	922.0	990.0	1063	1140	1221	1389	1565	1746	1931	700
	B				1428	1443	1462	1506	1560	1622	1690	1763	1840	1921	2089	2265	2446	2651	
800	T				824.6	838.2	854.4	894.4	943.3	1000	1063	1131	1204	1281	1442	1612	1789	1970	800
	B				1625	1638	1654	1694	1743	1800	1863	1931	2004	2081	2242	2412	2589	2770	
900	T					934.1	948.7	984.9	1030	1082	1140	1204	1273	1345	1500	1664	1836	2012	900
	B					1834	1849	1885	1930	1982	2040	2104	2173	2245	2400	2564	2736	2912	
1000	T					1031	1044	1077	1118	1166	1221	1281	1345	1414	1562	1720	1867	2059	1000
	B					2031	2044	2077	2118	2166	2221	2281	2345	2414	2562	2720	2887	3059	
1100	T						1140	1170	1208	1253	1304	1360	1421	1487	1628	1780	1942	2110	1100
	B						2240	2270	2308	2353	2404	2460	2521	2587	2728	2880	3042	3210	
1200	T						1237	1265	1300	1342	1389	1442	1500	1562	1697	1844	2000	2163	1200
	B						2437	2465	2500	2542	2589	2642	2700	2762	2897	3044	3200	3363	
1400	T							1456	1487	1523	1565	1612	1664	1720	1844	1980	2126	2280	1400
	B							2856	2887	2923	2965	3012	3064	3120	3244	3380	3526	3680	
1600	T							1649	1676	1709	1746	1789	1836	1887	2000	2126	2263	2608	1600
	B							3249	3276	3309	3346	3389	3436	3487	3600	3726	3863	4208	
1800	T								1868	1897	1931	1970	2012	2059	2163	2280	2408	2546	1800
	B								3668	3697	3731	3770	3812	3859	3963	4080	4208	4346	

M_t = Torsional Moment

M_b = Bending Moment

T = Ideal Torsional Moment

B = Ideal Bending Moment

$T=\sqrt{M_t^2+M_b^2}$ and $B=M_b+\sqrt{M_t^2+M_b^2}$

These ideal moments being for use with the Polar Section Modulus.

The values at right of heavy zig-zag line across upper right-hand corner are for the bending moments 2,000 to 4,500, inclusive, in right-hand column.

Contributed by John S. Myers.

X.—TABLE OF IDEAL MOMENTS.

Bending Moments in Inch Pounds = M_b		Torsional Moments in Inch Pounds = M_t: 2000	2200	2400	2800	3200	3600	4000	4400	4800	5200	5600	6000	7000	8000	9000	10000	11000	12000
600	T	2088	2280	2474	2864	3256	3650	4045	4441	4837	5235	5632	6030	7026	8023	9020	10018	11016	12015
	B	2688	2880	3074	3464	3856	4250	4645	5041	5437	5835	6232	6630	7626	8623	9620	10618	11616	12615
700	T	2119	2301	2500	2886	3276	3667	4061	4455	4851	5247	5644	6041	7035	8031	9027	10025	11022	12020
	B	2819	3001	3200	3586	3976	4367	4761	5155	5551	5947	6344	6741	7735	8731	9727	10725	11722	12720
800	T	2154	2341	2530	2912	3298	3688	4076	4472	4866	5261	5657	6053	7046	8040	9035	10032	11029	12027
	B	2954	3141	3330	3712	4098	4488	4876	5272	5666	6061	6457	6853	7846	8840	9835	10832	11829	12827
900	T	2193	2377	2563	2941	3324	3711	4100	4491	4884	5277	5672	6067	7058	8051	9045	10040	11037	12034
	B	3093	3277	3463	3841	4224	4611	5000	5391	5784	6177	6572	6967	7958	8951	9945	10940	11937	12934
1000	T	2236	2419	2600	2973	3355	3736	4123	4512	4903	5295	5689	6083	7071	8062	9055	10050	11045	12042
	B	3236	3419	3600	3973	4355	4736	5123	5512	5903	6295	6689	7083	8071	9062	10055	11050	12045	13042
1100	T	2283	2460	2640	3008	3384	3764	4149	4535	4924	5315	5707	6100	7086	8075	9067	10060	11055	12050
	B	3383	3560	3740	4108	4484	4864	5249	5635	6024	5415	6807	7100	8166	9175	10167	11160	12155	13150
1200	T	2332	2506	2683	3046	3418	3795	4176	4561	4948	5337	5764	6119	7102	8090	9080	10072	11065	12060
	B	3532	3706	3883	4246	4618	4995	5376	5761	6148	6537	6964	7319	8302	9290	10280	11272	12265	13260
1400	T	2441	2608	2778	3131	3493	3863	4238	4617	5000	5385	5772	6161	7139	8122	9108	10097	11089	12081
	B	3841	4008	4178	4531	4893	5263	5638	6017	6400	6785	7172	7561	8539	9522	10580	11497	12489	13481
1600	T	2561	2720	2884	3225	3578	3940	4308	4682	5060	5441	5824	6210	7181	8158	9141	10127	11116	12106
	B	4161	4320	4484	4825	5178	5540	5908	6282	6660	7041	7424	7810	8781	9758	10741	11727	12716	13706
1800	T	2691	2843	3000	3329	3672	4025	4386	4754	5126	5503	5882	6264	7228	8200	9178	10161	11146	12134
	B	4491	4643	4800	5129	5472	5825	6186	6554	6926	7303	7682	8064	9028	10000	10978	11961	12946	13934
2000	T	2828	2973	3124	3441	3774	4119	4472	4837	5200	5571	5946	6325	7141	8246	9220	10198	11180	12166
	B	4828	4973	5124	5441	5774	6119	6472	6837	7200	7571	7946	8325	9141	10246	11220	12198	13180	14166
2200	T	2973	3111	3256	3561	3883	4219	4565	4919	5280	5646	6019	6391	7338	8297	9265	10239	11218	12200
	B	5173	5311	5456	5761	6083	6419	6765	7119	7480	7846	8219	8591	9538	10497	11465	12439	13418	14400
2400	T	3124	3256	3394	3688	4000	4327	4665	5012	5367	5727	6093	6462	7400	8352	9315	10284	11259	12238
	B	5524	5656	5794	6088	6400	6727	7065	7412	7767	8127	8493	8862	9800	10752	11715	12684	13659	14638
2600	T	3280	3406	3538	3821	4123	4441	4771	5111	5459	5814	6174	6532	7467	8412	9368	10333	11303	12278
	B	5880	6006	6138	6421	6723	7041	7371	7711	8059	8414	8774	9132	10067	11012	11968	12933	13903	14878
2800	T	3441	3561	3688	3960	4252	4561	4883	5216	5557	5906	6261	6621	7533	8476	9426	10385	11351	12322
	B	6241	6361	6488	6760	7052	7361	7683	8016	8357	8706	9061	9421	10333	11276	12226	13185	14151	15122
3000	T	3601	3720	3842	4104	4386	4868	5000	5325	5660	6003	6353	6708	7616	8544	9487	10440	11402	12364
	B	6601	6720	6842	7104	7386	7868	8000	8325	8660	9003	9353	9708	10616	11544	12487	13440	14402	15364
3500	T	4031	4134	4244	4462	4742	5021	5315	5622	5941	6268	6604	6946	7826	8732	9657	10609	11543	12500
	B	7531	7634	7744	7982	8242	8521	8815	9122	9441	9768	10104	10446	11326	12232	13157	14109	15043	16000
4000	T	4472	4565	4665	4883	5123	5381	5657	5946	6248	6561	6882	7211	8062	8944	9849	10770	11705	12649
	B	8472	8565	8665	8883	9123	9381	9657	9946	10248	10561	10882	11211	12062	12944	13849	14770	15705	16649
4500	T	4924	5009	5100	5300	5522	5763	6021	6294	6580	6877	7184	7500	8322	9179	10062	10966	11885	12816
	B	9424	9509	9600	9800	10022	10263	10521	10794	11080	11377	11684	12000	12822	13679	14562	15466	16385	17316
5000	T	5385	5463	5546	5731	5936	6161	6403	6660	6931	7214	7507	7810	8602	9434	10296	11180	12083	13000
	B	10385	10463	10546	10731	10936	11161	11403	11660	11931	12214	12507	12810	13602	14434	15296	16180	17083	18000
5500	T	5852	5924	6001	6172	6363	6573	6801	7043	7300	7569	7849	8139	8902	9708	10548	11413	12298	13200
	B	11352	11424	11501	11672	11863	12073	12301	12543	12800	13069	13349	13639	14402	15208	16048	16913	17798	18700
6000	T	6325	6391	6462	6621	6800	6987	7211	7440	7684	7940	8201	8485	9220	10000	10817	11662	12530	13416
	B	12325	12391	12462	12621	12800	12987	13211	13440	13684	13940	14207	14485	15220	16000	16817	17662	18530	19416

Contributed by John S. Myers.

XI.—DIAMETERS OF SHAFTS FOR COMBINED TORSION AND BENDING STRESSES.

Fiber Stress in Pounds per square inch			Torsional Moments in Thousands of Inch Pounds.																		Fiber Stress in Pounds per square inch		
7500			0	3.75	7.5	11.25	15	18.75	22.5	30	37.5	45	52.5	60	67.5	75	90	105	120	135			7500
	10000		0	5	10	15	20	25	30	40	50	60	70	80	90	100	120	140	160	180		10000	
		12500	0	6.25	12.5	18.75	25	31.25	37.5	50	62.5	75	87.5	100	112.5	125	150	175	200	225	12500		
Bending Moments in Thousands of Inch Pounds.																					Bending Moments in Thousands of Inch Pounds.		
0	0	0	0	1 3/8	1 25/32	1 31/32	2 3/16	2 11/32	2 1/2	2 3/4	2 15/16	3 1/8	3 9/16	3 7/16	3 19/32	3 25/32	3 13/16	4 5/32	4 11/32	4 1/2	0	0	0
3.75	5	6.25	1 23/32	1 27/32	2 1/32	2 7/32	2 3/8	2 1/2	2 5/8	2 27/32	3 1/16	3 7/32	5 15/16	5 31/32	5 31/32	6	6 1/16	6 1/16	6 1/8	6 3/16	250	200	150
5.625	7.5	9.375	1 31/32	2 1/32	2 3/16	2 5/16	2 15/32	2 19/32	2 11/16	2 29/32	3 3/32	3 1/4	3 13/32	3 9/16	6 3/16	6 3/16	6 1/4	6 1/4	6 5/16	6 3/8	275	220	165
7.5	10	12.5	2 1/16	2 1/32	2 5/16	2 7/16	2 9/16	2 21/32	2 25/32	2 31/32	3 5/32	3 5/16	3 7/16	3 19/32	6 5/16	6 3/8	6 3/8	6 7/16	6 7/16	6 1/2	300	240	180
9.375	12.5	15.63	2 11/32	2 3/8	2 7/16	2 17/32	2 21/32	2 3/4	2 27/32	3 1/32	3 3/16	3 11/16	3 1/2	3 5/8	3 3/4	6 1/2	6 9/16	6 9/16	6 5/8	6 5/8	325	260	195
11.25	15	18.75	2 1/2	2 1/2	2 9/16	2 31/32	2 3/4	2 13/16	2 29/32	3 3/32	3 1/4	3 13/32	3 17/32	3 21/32	3 25/32	6 5/8	6 11/16	6 11/16	6 3/4	6 13/16	350	280	210
15	20	25	2 3/4	2 3/4	2 25/32	2 27/32	2 29/32	3	3 1/16	3 7/32	3 11/32	3 1/2	3 5/8	3 3/4	3 27/32	3 31/32	6 13/16	6 7/8	6 7/8	6 15/16	375	300	225
18.75	25	31.25	2 15/16	2 15/16	2 31/32	3 1/32	3 3/32	3 1/8	3 3/16	3 11/32	3 15/32	3 19/32	3 23/32	3 13/16	3 15/16	4 1/32	4 7/32	7 3/16	7 3/16	7 1/4	437.5	350	262.5
22.5	30	37.5	3 1/8	3 5/32	3 5/32	3 3/16	3 1/4	3 9/32	3 11/32	3 7/16	3 9/16	3 11/16	3 25/32	3 7/8	4	4 3/32	4 9/32	4 15/32	7 1/2	7 1/2	500	400	300
26.25	35	43.75	3 9/32	3 9/32	3 5/16	3 11/32	3 3/8	3 13/32	3 15/32	3 9/16	3 21/32	3 3/4	3 7/8	3 31/32	4 1/16	4 5/32	4 11/32	4 1/2	4 21/32	7 13/16	562.5	450	337.5
30	40	50	3 7/16			3 15/32	3 1/2	3 17/32	3 19/32	3 21/32	3 3/4	3 27/32	3 15/16	4 1/16	4 1/8	4 7/32	4 13/32	4 9/16	4 23/32	4 27/32	50	40	30
33.75	45	56.25	3 19/32				3 5/8	3 21/32	3 11/16	3 25/32	3 27/32	3 15/16	4 1/32	4 1/8	4 7/32	4 9/32	4 7/16	4 5/8	4 3/4	4 29/32	56.25	45	33.75
37.5	50	62.5	3 23/32				3 3/4	3 25/32	3 13/16	3 7/8	3 15/16	4 1/32	4 1/8	4 3/16	4 9/32	4 11/32	4 1/2	4 21/32	4 13/16	4 15/16	62.5	50	37.5
45	60	75	3 15/16				3 31/32	4	4 1/32	4 1/16	4 1/8	4 3/16	4 9/32	4 11/32	4 13/32	4 1/2	4 5/8	4 25/32	4 29/32	5 1/32	75	60	45
52.5	70	87.5	4 5/32				4 3/16	4 7/16	4 7/32	4 1/4	4 5/16	4 3/8	4 13/32	4 15/32	4 17/32	4 5/8	4 3/4	4 7/8	5	5 1/8	87.5	70	52.5
60	80	100	4 11/32					4 3/8	4 3/8	4 13/32	4 15/32	4 1/2	4 17/32	4 19/32	4 21/32	4 3/4	4 27/32	4 31/32	5 3/32	5 7/32	100	80	60
67.5	90	112.5	4 1/2						4 17/32	4 19/32	4 5/8	4 21/32	4 23/32	4 3/4	4 13/16	4 7/8	4 31/32	5 1/16	5 3/16	5 5/16	112.5	90	67.5
75	100	125	4 11/16						4 23/32	4 23/32	4 3/4	4 25/32	4 13/16	4 7/8	4 15/16	4 31/32	5 3/32	5 3/16	5 9/16	5 3/8	125	100	75
82.5	110	137.5	4 13/16						4 27/32	4 7/8	4 29/32	4 15/16	4 31/32	5	5 1/32	5 3/32	5 3/16	5 9/32	5 3/8	5 15/32	137.5	110	82.5
90	120	150	4 31/32							5	5 1/32	5 1/16	5 3/32	5 1/8	5 5/32	5 7/32	5 9/32	5 3/8	5 15/32	5 9/16	150	120	90
105	140	175	5 1/32							5 1/4	5 9/32	5 5/16	5 11/32	5 11/32	5 3/8	5 7/16	5 1/2	5 9/16	5 21/32	5 23/32	175	140	105
120	160	200	5 13/32								5 1/2	5 17/32	5 17/32	5 9/16	5 19/32	5 5/8	5 11/16	5 3/4	5 13/16	6	200	160	120
135	180	225	5 11/16								5 23/32	5 3/4	5 3/4	5 23/32	5 25/32	5 13/16	5 7/8	5 15/16	6	6 1/16	225	180	135

Values at right of heavy zig-zag line across upper right-hand corner are for the bending moments in upper part of three right-hand columns.

Contributed by John S. Myers.

XII.—DIAMETERS OF SHAFTS FOR COMBINED TORSION AND BENDING STRESSES.

Fiber Stress in Pounds per square Inch			Torsional Moments in Thousands of Inch Pounds.																		
7500			0	150	165	180	210	240	270	300	330	360	390	420	450	525	600	675	750	825	900
	10000		0	200	220	240	280	320	360	400	440	480	520	560	600	700	800	900	1000	1100	1200
		12500	0	250	275	300	350	400	450	500	550	600	650	700	750	875	1000	1125	1250	1375	1500
Bending Moments in Thousands of Inch Pounds.																					
0	0	0	0	4 11/16	4 13/16	4 31/32	5 7/32	5 15/32	5 11/16	5 7/8	6 1/16	6 1/4	6 7/16	6 9/16	6 3/4	7 1/16	7 7/16	7 11/16	8	8 1/4	8 1/2
45	60	75	3 15/16	5 5/32	5 9/32	5 3/8	5 19/32	5 13/16	6	6 3/16	6 3/8	6 1/2	6 11/16	6 13/16	6 15/16	7 5/16	7 5/8	7 7/8	8 1/8	8 3/8	8 5/8
52.5	70	87.5	4 5/32	5 1/4	5 11/32	5 15/32	5 11/16	5 7/8	6 1/16	6 1/4	6 7/16	6 9/16	6 3/4	6 7/8	7	7 5/16	7 5/8	7 15/16	8 3/16	8 7/16	8 5/8
60	80	100	4 11/32	5 5/16	5 7/16	5 17/32	5 3/4	5 15/16	6 1/8	6 5/16	6 7/16	6 5/8	6 3/4	6 7/8	7 1/16	7 3/8	7 11/16	7 15/16	8 3/16	8 7/16	8 11/16
67.5	90	112.5	4 1/2	5 13/32	5 1/2	5 5/8	5 13/16	6	6 3/16	6 5/16	6 1/2	6 5/8	6 13/16	6 15/16	7 1/16	7 3/8	7 11/16	8	8 1/4	8 1/2	8 11/16
75	100	125	4 11/16	5 15/32	5 19/32	5 11/16	5 7/8	6 1/16	6 1/4	6 3/8	6 9/16	6 11/16	6 7/8	7	7 1/8	7 7/16	7 3/4	8	8 1/4	8 1/2	8 3/4
82.5	110	137.5	4 15/16	5 9/16	5 21/32	5 3/4	5 15/16	6 1/8	6 5/16	6 7/16	6 5/8	6 3/4	6 7/8	7	7 1/8	7 1/2	7 3/4	8 1/16	8 5/16	8 1/2	8 3/4
90	120	150	4 31/32	5 21/32	5 3/4	5 27/32	6	6 3/16	6 3/8	6 1/2	6 5/8	6 3/4	6 13/16	7 1/16	7 3/16	7 1/2	7 13/16	8 1/16	8 5/16	8 9/16	8 3/4
105	140	175	5 7/32	5 13/16	5 7/8	5 31/32	6 1/8	6 5/16	6 7/16	6 5/8	6 3/4	6 7/8	7	7 1/8	7 1/4	7 9/16	7 7/8	8 1/8	8 3/8	8 5/8	8 13/16
120	160	200	5 15/32	5 31/32	6 1/16	6 1/8	6 5/16	6 7/16	6 9/16	6 11/16	6 7/8	7	7 1/8	7 1/4	7 3/8	7 5/8	7 15/16	8 3/16	8 7/16	8 11/16	8 7/8
135	180	225	5 11/16	6 1/8	6 3/16	6 1/4	6 3/8	6 9/16	6 11/16	6 13/16	6 15/16	7 1/16	7 3/16	7 5/16	7 7/16	7 11/16	8	8 1/4	8 1/2	8 11/16	8 15/16
150	200	250	5 7/8	6 1/4	6 5/16	6 3/8	6 1/2	6 5/8	6 13/16	6 15/16	7 1/16	7 3/16	7 1/4	7 3/8	7 1/2	7 3/4	8 1/16	8 5/16	8 9/16	8 3/4	8 15/16
165	220	275	6 1/16	6 7/16	6 1/2	6 9/16	6 5/8	6 3/4	6 15/16	7	7 1/8	7 1/4	7 3/8	7 1/2	7 9/16	7 7/8	8 1/8	8 3/8	8 9/16	8 13/16	9
180	240	300	6 1/4	6 9/16	6 5/8	6 11/16	6 3/4	6 7/8	7	7 1/8	7 1/4	7 5/16	7 7/16	7 9/16	7 11/16	7 15/16	8 3/16	8 7/16	8 5/8	8 7/8	9 1/16
195	260	325	6 7/16	6 11/16	6 3/4	6 13/16	6 7/8	7	7 1/8	7 3/16	7 5/16	7 7/16	7 9/16	7 5/8	7 3/4	8	8 1/4	8 1/2	8 11/16	8 15/16	9 1/8
210	280	350	6 9/16	6 13/16	6 7/8	6 15/16	7	7 1/8	7 3/16	7 5/16	7 7/16	7 1/2	7 5/8	7 3/4	7 13/16	8 1/16	8 5/16	8 9/16	8 3/4	8 15/16	9 3/16
225	300	375	6 3/4	6 15/16	7	7 1/16	7 1/8	7 1/4	7 3/8	7 7/16	7 1/2	7 5/8	7 11/16	7 13/16	7 15/16	8 1/8	8 3/8	8 5/8	8 13/16	9	9 1/4
262.5	350	437.5	7 1/16	7 1/4	7 5/16	7 3/8	7 7/16	7 1/2	7 9/16	7 5/8	7 3/4	7 13/16	7 15/16	8	8 1/8	8 5/16	8 9/16	8 3/4	8 15/16	9 1/8	9 3/8
300	400	500	7 7/16	7 9/16	7 9/16	7 5/8	7 11/16	7 3/4	7 13/16	7 7/8	8	8 1/16	8 1/8	8 3/16	8 5/16	8 1/2	8 11/16	8 7/8	9 1/8	9 5/16	9 7/16
337.5	450	562.5	7 11/16	7 13/16	7 7/8	7 7/8	7 15/16	8	8 1/16	8 1/8	8 3/16	8 1/4	8 5/16	8 7/16	8 1/2	8 11/16	8 7/8	9 1/16	9 1/4	9 7/16	9 5/8
375	500	625	8	8 1/16	8 1/8	8 1/8	8 3/16	8 1/4	8 5/16	8 3/8	8 7/16	8 1/2	8 9/16	8 5/8	8 11/16	8 7/8	9	9 3/16	9 3/8	9 9/16	9 3/4
412.5	550	687.5	8 1/4	8 5/16	8 3/8	8 3/8	8 7/16	8 7/16	8 1/2	8 9/16	8 5/8	8 11/16	8 3/4	8 13/16	8 7/8	9	9 3/16	9 3/8	9 1/2	9 11/16	9 7/8
450	600	750	8 1/2	8 9/16	8 9/16	8 5/8	8 5/8	8 11/16	8 3/4	8 3/4	8 13/16	8 7/8	8 15/16	9	9 1/16	9 3/16	9 3/8	9 1/2	9 5/8	9 13/16	10

Contributed by John S. Myers.

consequently less power was consumed by the operation, and the strain on the machine and parts was not as great. At the same time, the lower step of the cutter removed the wide flare of the gear tooth space between the top of the teeth which the square stocking or slotting cutter did not do, and in this way left a more nearly uniform amount of metal all around the tooth outline to be removed by the finishing cutter.

Fig. 1. Gould & Eberhardt Improved Stocking Cutter for Gear Work.

While this idea was not new at the time, it was the first time that cutters of that kind were manufactured for the trade. Since then the firm has still further improved this class of cutter, and has recently brought out and patented a new stepped style of stocking cutter, shown in the accompanying illustration, Fig. 1. The improvement embodied in the new form will be most readily seen by comparing the new and the old style as shown in the accompanying line engraving, Fig. 2, where the new style is shown to the left, and the old style to the right. It will be seen that the new stocking cutter finishes the bottom of the tooth space, thereby relieving the finishing cutter of this duty, and saving the latter where it usually wears out first. It also approaches the finished outline at the top of the tooth more closely than did the old style. The essential feature of improvement, however, is the recessing of the tops of the cutting teeth, as shown most plainly in the half-tone illustration, Fig. 1, so that each tooth practically cuts out about half as much as formerly. This permits a maximum amount of stock to be removed with a minimum amount of power consumption, because the cutting edges, being staggered, will be more thoroughly lubricated while cutting. As com-

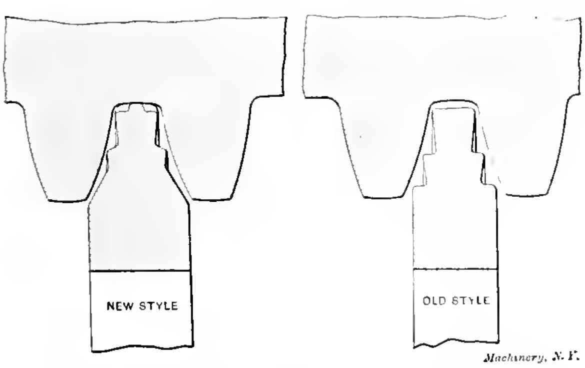


Fig. 2. Comparison between New and Old Form of Stocking Cutter, Indicating Improvement embodied in New Design.

pared with the ordinary saw stocking cutters, the superiority of the new design needs, of course, no demonstration. The large corners left by saw stocking cutters are entirely removed by the present design, and the cutters can be made considerable wider at the hubs, thus lessening the liability for the keys to shear off; in consequence of all this, faster speeds and feeds are permissible without the strains on the machine itself being increased, but rather lessened.

MOTOR DRIVE FOR THE FOX LIGHT MILLER—UNIVERSAL DIVIDING HEAD.

The Fox Machine Co., 815-825 North Front Street, Grand Rapids, Michigan, has been for a number of years building small hand and power milling machines for light manufacturing, having originally become interested in this line from filling the requirements of the Fox Typewriter Co., an allied corporation. The company has recently designed a belt-connected motor drive for its line of small millers which is interesting in the simplicity of its adaptation to machines of standard type, as well as in its effectiveness. The machine to which this drive is applied in Fig. 1 is a No. 3½ hand and power feed milling machine of the builder's standard design, which was furnished to the Charleston navy yard and built to meet the requirements of the government's standard specifications for motor-driven machines.

As shown, the miller is mounted on a supplementary floor base, which is also provided with suitable connections for supporting the motor. The latter, as may be seen, is hinged at the left-hand side to this base, and is supported on the right by the short end of a foot lever, whose outer end is connected with a treadle and a foot-operated catch, by means of which the motor may be raised about its hinge or allowed to fall by gravity, at the will of the operator. A counter-shaft carrying a cone pulley and a driving pulley is supported over

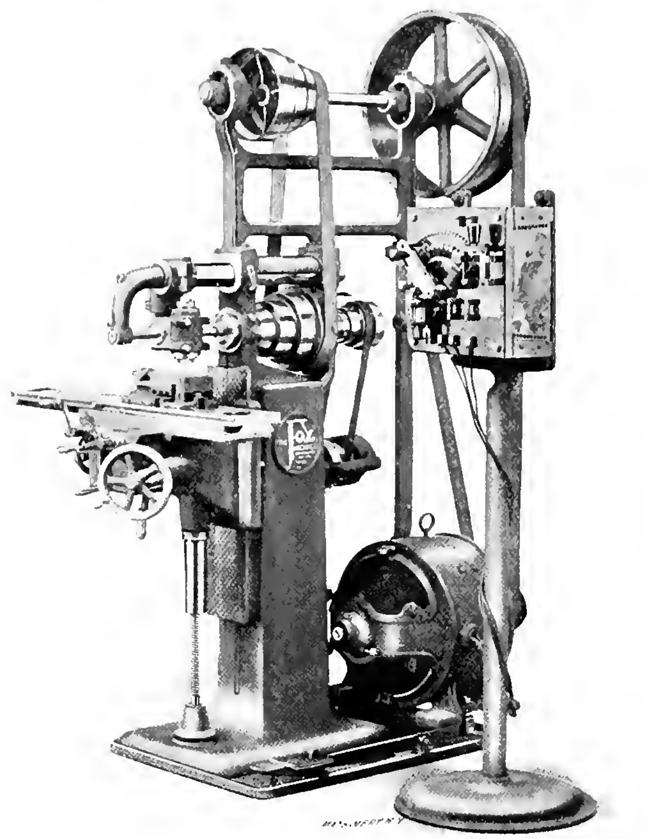


Fig. 1. The No. 3 1-2 Fox Light Miller, arranged for Motor Drive.

the machine by a cast framework, attached to the top of the milling machine column and to the motor base. The driving pulley on this counter-shaft, which has two diameters and is flanged, is belted to the double flanged pulley on the armature shaft. The hinged connection of the motor and the foot lever operated movement provided for it, are employed for starting and stopping the machine. The raising of the motor slackens the belt and thus stops the counter-shaft, while the dropping of it tightens the belt so that the whole power of the motor may be transmitted. It will be noted that the arrangement permits the use of a cemented or "endless' driving belt.

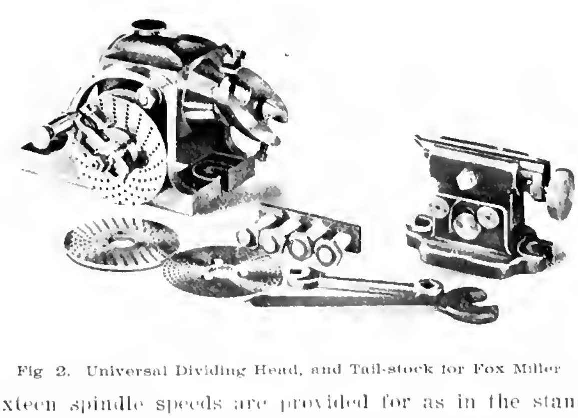


Fig. 2. Universal Dividing Head, and Tail-stock for Fox Miller

Sixteen spindle speeds are provided for as in the standard belt-driven machine with double friction counter-shaft. This number of speeds is obtained from the two-step armature and counter-shaft pulleys, the four-step driving cones and the back gearing of the machine. In the particular case shown, a variable speed motor is used, still further increasing the num-

ber of speed changes. The starting switches and controller are mounted on a pedestal, as shown, which may be set in any position convenient for the operator.

Among the accessories with which these machines are provided may be mentioned the vertical milling attachment shown in place on the machine, and the dividing head shown in Fig. 2. The former is provided with an angular adjustment which may be swiveled through an arc of 90 degrees from the vertical to the horizontal. By reversing it, it will cover this range in the other direction, giving a full movement of 180 degrees. It may be adjusted transversely of the spindle as well from any convenient distance from the base of the column.

The universal dividing head- and tail-stock shown in Fig. 2 are new and are especially designed for the No. 3½ miller, though they may be used on other sizes of the builder's machine for small work. The spindle is held in a long taper bearing and may be securely locked by the knurled thumbscrew shown at the top. The spindle may be elevated to any angle from the horizontal up to the vertical, and when in the latter position is especially stable, the height of the work above the table being reduced to a minimum. The tail center may be raised or lowered or tilted for taper work. The index plates furnished are drilled on a special automatic machine having a master worm gear 18 inches in diameter, thus insuring great accuracy. They give all divisions from 2 to 50, and the principal divisions up to 360. The device will be found useful for cutting small gears, milling squares, hexagons, etc., fluting taps and reamers, and doing a large variety of other work of this class.

BARNES SLIDING EXTENSION GAP LATHE.

The Barnes Drill Co., Inc., 602 South Main St., Rockford, Ill., is building the extension gap lathe shown in the two accompanying half-tones. The advantages of this form of gap lathe are well-known and indisputable. Essentially, the idea consists of mounting the bed of the lathe on a base on which it may be adjusted longitudinally close up against the head-stock, or as far away from it as may be necessary to suit the width of any work of such diameter as to require the use of the gap. Fig. 1 shows the lathe with the gap closed for ordinary work, while Fig. 2 shows it extended, with the large swing face-plate in use. This design has an advantage over the lathe of fixed gap in that the width of the opening between the shears and head-stock may be made as little or as much as is required to swing the work, thus making it possible to bring the carriage and tool close up to the surface being turned. It obviates the necessity also for a filling-in piece, such as is sometimes used for extending the ways across the gap to support the carriage on ordinary work, for cuts close to the live center.

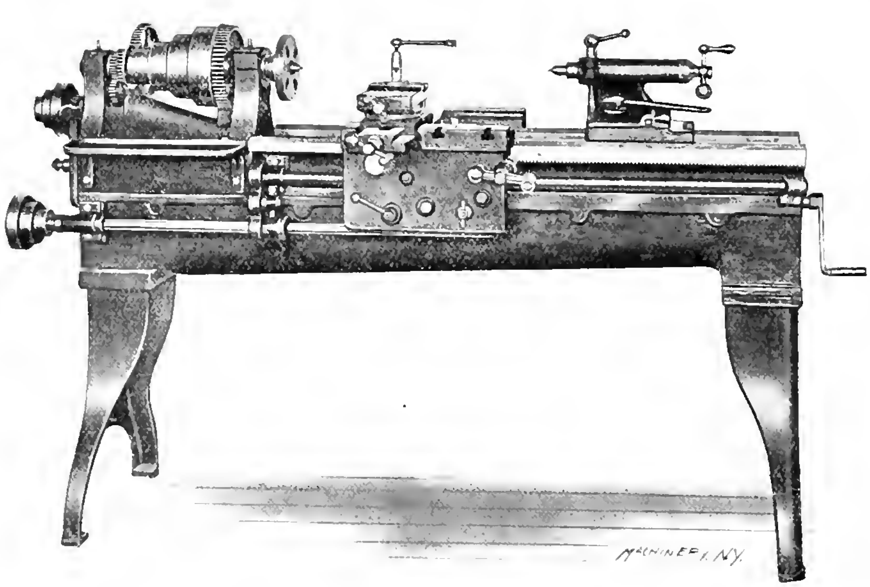


Fig. 1. The Barnes Sliding Extension Gap Lathe.

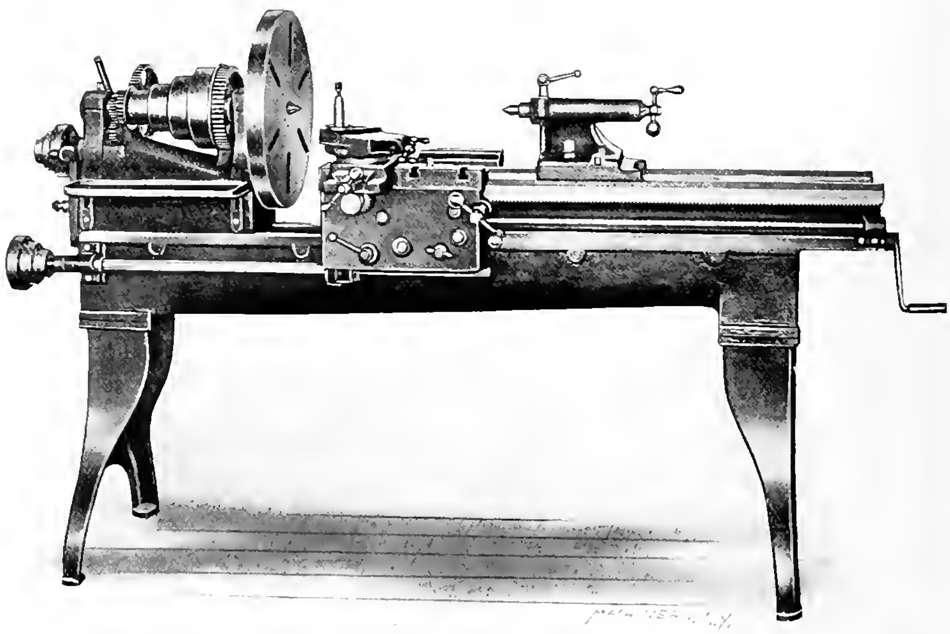


Fig. 2. Lathe with Supplementary Bed shifted, opening Gap for Full Swing.

The upper bed is adjusted on the base by means of a screw operated by a crank, shown at the rear end. The two beds are fitted together by dove-tail construction which permits them to be firmly clamped together at any adjustment by means of clamp bolts passing transversely through the main bed. The carriage has the cross-slide bridge located to the left, so as to bring the tool close to the work. For large diameter cuts, the cross-slide ways are extended in front to make provision for facing up to the full diameter without overhanging the tool or the tool-holder. Power cross feed and a compound rest are provided. The carriage is fitted to the bed with a V-bearing in front and a flat bearing at the rear. It is gibbed at the rear and may be clamped for cross-slide work. It is also fitted with T-slots for holding work for boring, etc.

The lathe is arranged for screw cutting as well as for turning. The splined feed-screw is carried well up under the ways, as in the lathes of standard construction, but is connected by gearing to a splined driving shaft, which is carried down below the gap so as not to interfere with work of the full diameter. The three-step cone pulleys may be used for the feeds, or they may be removed and the connections made with change gears for positive turning feeds or screw cutting.

The head-stock gearing gives the necessary power for turning full diameter of the gap. The head-stock casting is heavy and strong. The spindle is hollow, made from a good grade of steel, accurately ground and running in bronze bearings, carefully scraped and fitted. The cone pulley has four steps and is back geared, giving eight changes of speed in all. A push pin connection is used for locking the gear with the cone, so that a wrench is not required when throwing the back gears in or out.

The lathe is furnished with a friction counter-shaft, change gears, center rest, large and small face-plates, and the necessary wrenches. The swing over the carriage is 8½ inches; over the bed, 13 inches; and over the gap, 22½ inches. A

lathe with a 5½-foot bed takes 36 inches between the centers when used as an ordinary lathe, and 54 inches when extended; the gap opens 18 inches wide. It will be seen that the extension feature of the bed is useful in increasing the distance between centers, as well as in giving greater swing. The arrangement is such that when used as a simple lathe it has all the conveniences expected in machines of its type, the gap feature being obtained without any sacrifice of utility of ordinary work. The machine should be especially useful for garages and repair shops.

A REMARKABLE BROACHING MACHINE AND ITS WORK.

We show in the accompanying half-tones a Lapointe broaching machine provided with special cutting tools, and engaged on what is, without much doubt, the heaviest broaching operation ever undertaken. The size of the hole to be broached is approximately 8 inches square, though the hole is not really square, being of the special shape shown in Fig. 2. Not only is the work remarkable on account of its size, but also in the fact that the surfaces had to be broached on a taper, the outer end of the hole being ½ inch further across than at the bottom, while the work is rendered still more difficult from the fact that the opening is closed at the small end. Thus the only way of broaching is to commence at the bottom and work outward. A recess 3 inches long and about

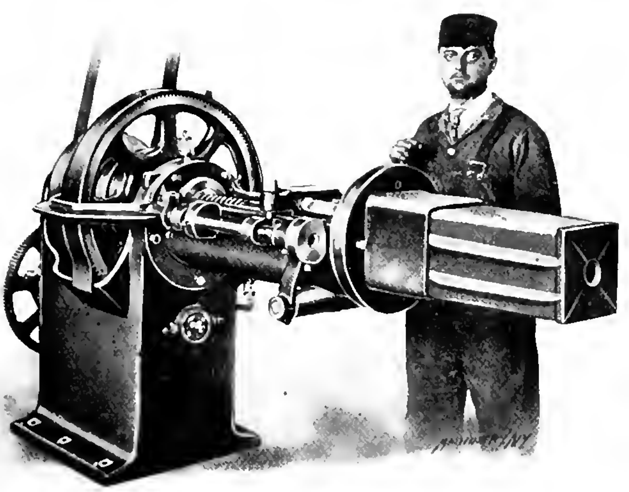


Fig. 1. The Machine with the Work in Place.

¼ inch deep is furnished at the bottom, however, to allow the starting of the broach. The stock to be removed on each of the finished surfaces of the work is about 1/16 inch thick; the total area to be broached is 14 inches long, with a developed width of 24 inches. In the center of each face of the hole, it will be noticed that there is a half-round recess; no broaching is done in this part. This piece of work is a steel casting.

The machine used is the largest of the line of broaching machines made by the builder, the Lapointe Machine Tool Co., of Hudson, Mass. The construction of these machines has been previously described. (See New Machinery and Tools, in the July, 1907, and May, 1908, issues of MACHINERY.) The mechanism consists primarily of a threaded draw bar or ram, operated by a revolving nut, driven by suitable gearing and reversing mechanism, this mechanism being operated by dogs and adjustable stops to give the required length of operating and return strokes. Practically the only special feature of the equipment is the special broaching head and broaches used. These are of such unusual size and ingenious construction as to be of decided interest.

Fig. 2. The Hole which is to be Broached.

The construction of the broaching head is perhaps most plainly shown in Fig. 3. It consists essentially of a central square mandrel, tapered to the taper of the hole to be finished in the work, and provided with ways in which slide four separate broaches, one for each corner of the work. These broaches are connected with the head of the ram of the

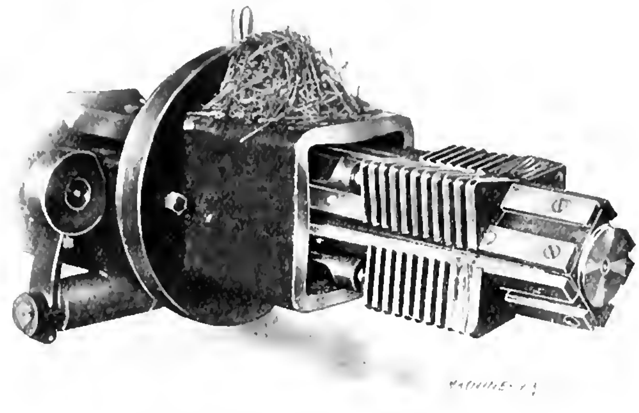


Fig. 3. The Taper Broach and the Chips it produces; note the Flexible Pulling Rods.

machine by bars, which are milled down to such a thinness as to have sufficient flexibility to permit the broaches to spread apart as they approach the inner end of the stroke, and come together again as they return to the starting position on the outer end of the mandrel. Each of the broaches is made of a solid piece of tool steel, with a series of 13 teeth of suitable shape milled in it.

In operation the ram is first extended to the outer limit of its stroke, with the broaches at the outer and smaller end of the square central mandrel. The work is then placed over the mandrel as shown in Fig. 1, in which position the broaches nearly touch the closed bottom of the hole. The outer teeth in this position are in the recess. The machine is then started up, and the revolving nut, and threaded ram pull the broaches up on the tapered guides of the square mandrel, by means of the flexible pulling rods. As the broaches are thus drawn inward on a gradually expanding form, they cut the required shape in the interior of the steel casting. The broaches first are tapered, so that the outer end is 1/32 inch larger than the end to which the pulling rods are connected, this being the amount which is to be removed from the work in each operation.

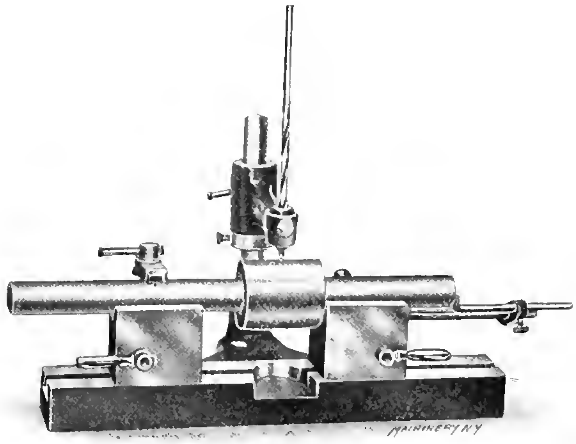
As is shown in the engraving, a special abutment or base is provided for taking the thrust of the work as it resists the action of the cutters. Piled up on this special base, in Fig. 3, will be seen the chips produced at one stroke of the machine. It will be noted from their character that a cutting action of the most desirable kind is effected by the broaching blades, indicating that the work is done in a very superior way. The approximate pulling strain on the four rods operating the broaches is estimated by the builders to be from 75 to 100 tons.

ADJUSTABLE DRILL JIG.

The Cleveland Specialty and Mfg. Co., 3001 Searsdale Avenue S. W., Cleveland, Ohio, has brought out an interesting adjustable drill jig, as illustrated in the accompanying halftone. This jig is intended to eliminate the laying out of certain classes of work for drilling, and is intended particularly for circular pieces of work which can be placed in the V-blocks shown. It is, of course, especially valuable when drilling duplicate pieces of this character. A great deal of time is spent in laying out simple work for drilling, hunting for V-blocks and clamping devices, and placing the work on the drill press; and, finally, when the piece is drilled, it is often found that the hole has not been correctly located, on account of defective lay-out or setting up, or because the drill has run out.

Difficulties of this kind will be eliminated by the use of this adjustable jig. The design is very simple. The base of the device is finished at the bottom, where it rests on the drill press table, and on the top, where two V-blocks slide back and forth. The blocks are provided with dovetails to fit a corre-

sponding dove-tail slot in the base. The levers shown at the front of the V-blocks serve the purpose of clamping them in place wherever desired. A clamping device for fastening the work in the V-groove is provided, as indicated in the engraving, and at the right-hand end an adjustable stop is arranged for. This can be extended out to any length required for long pieces, or pushed in close to the V-block for short pieces. The stop and the clamp may be used on either block, and when



Cleveland Specialty Co.'s Adjustable Drill Jig for Cylindrical Work.

short pieces are being drilled, one V-block only may be employed. In the middle of the base-block at the back of the device is a boss which supports a steel stem on which the arm holding the drill guide bushing is mounted. This arm can be adjusted up and down on the stem to suit the work, and it can also be swung to one side if it is required that a larger drill or reamer should follow the first drill, so the drill bushing does not have to be removed for this purpose.

As a great deal of the drilling work in most machine shops consists of drilling and reaming pin-holes in shafts, holes to be tapped for set-screws in collars or levers, spotting of shafts for set-screws, etc., and, as it is seldom considered profitable to build special jigs for these purposes, a universal appliance like the one shown, will undoubtedly prove of value in nearly every machine shop where there is a premium placed on the accuracy and rapidity of the operations performed.

KELLY ADJUSTABLE REAMERS.

The accompanying half-tone illustration and line engraving show the appearance and application of a new type of reamer and boring tool, placed on the market by the Kelly Tool Co., Cleveland, Ohio. As will be seen from the half-tone, which shows a front view of the tool, it consists of a rectangular holder into which are inserted two cutters, one on each side of the holder, and inclined at an angle of 45 degrees. These

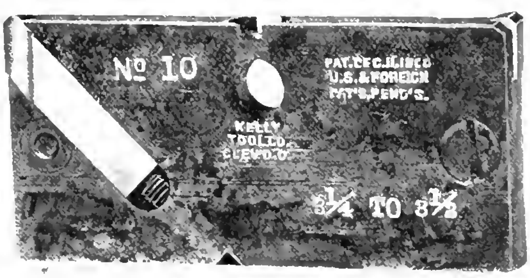


Fig. 1. The Kelly Adjustable Reamer and Boring Tool.

cutters constitute the cutting edges of the reamer, and are adjustable, so that each size of reamer covers a range of ¼ inch, the reamers being made in seventeen sizes, from 1 inch up to 5¼ inches. The tool may be used as a boring tool, as well as a reamer, the cutters being held absolutely rigid in position by the binding screws, the head of one of which is shown near the right-hand edge in the half-tone illustration. The reamer holder, as shown in Fig. 1, is in turn held in a bar, as indicated in Figs. 2, 3 and 4. In Fig. 2 is shown a bar used either for "floating" or rigid work, a pointed screw being used to hold the holder in place when it is not desired to have it floating. Fig. 3 shows the arrangement used when the tool is used for work where it is required that the cutters finish a hole clear down to the bottom. It will be seen that the holder is held by a plate on the end of the bar, fastened in place by four screws, and also by a screw passing through the tapered hole on its center line. Finally, in Fig. 4, the tool is shown placed in a boring-bar, and used as a double boring cutter, permitting the use of the front end of the bar as a guide or pilot.

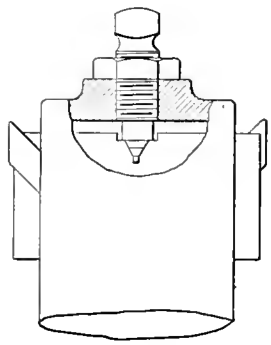


Fig. 2

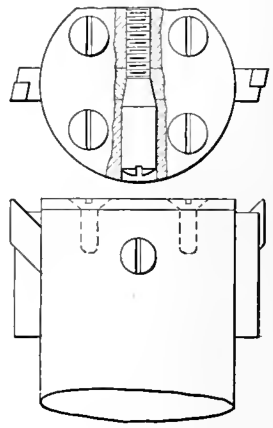


Fig. 3

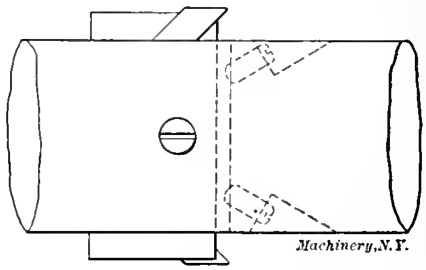


Fig. 4

Figs. 2, 3, and 4. Different Applications of the Kelly Adjustable Reamer.

The simple construction of this tool, including the adjustable features, the comparatively small number of tools necessary for the complete set, the ease of setting and adjustment, all tend to make it valuable in machine tool work, and its application to any kind of turret machine, lathe, boring mill or drill press, makes it as universal a tool as can well be conceived of.

LUCAS HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

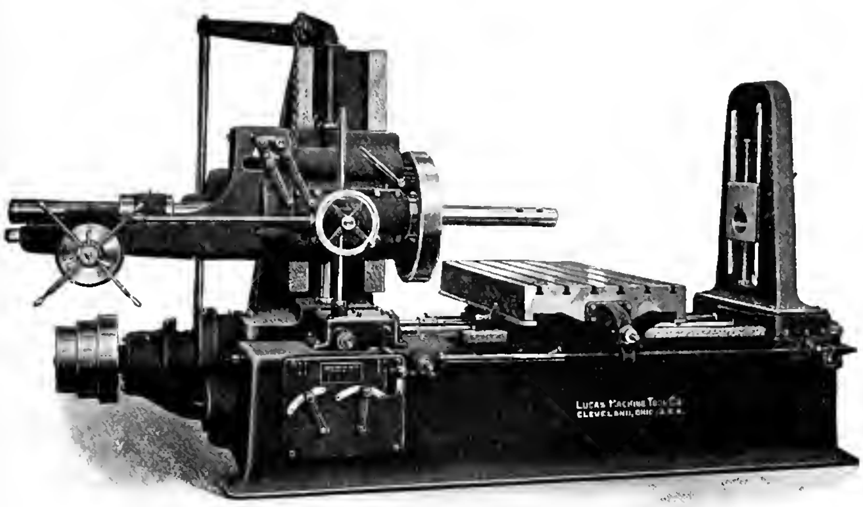
The machine illustrated in the accompanying half-tone is quite extensively used in railway shops on account of its adaptability to a wide range of work. Special attention has been given in the design and construction of this machine to the production of a high-grade manufacturing machine, equally useful for tool-room work requiring great accuracy and for general manufacturing where power and rigidity are the principal essentials. A good example of the work which is being done on it in railroad shops is a tumbling shaft in which the holes may be bored, and the hubs faced parallel and true with the holes by milling, at one setting; also, air pump cylinders, which may be bored, and both ends faced by milling, at one setting.

The principal feature of this machine is the raising and lowering of the spindle head, which is a constant weight, instead of raising and lowering the platen with its load, which is widely variable. This construction allows the use of a deep box bed of great stiffness, which gives a solid foundation to the other members of the machine, and keeps them in accurate relation to each other in all positions and eliminates the necessity of building a foundation under the machine. As a foundation is not necessary, the location of the machine is not confined to the ground floor.

The advantages offered by this machine are, in short, that work can be bored, drilled, and milled at one setting, and all the work done accurately without any measuring, trying or

"papering up," all of which the precision screws and the graduated dials make unnecessary. Further, this construction allows the addition to the machine of a vertical power feed for milling purposes, which is a most valuable feature for many classes of work.

The spindle is made of un-annealed hammered crucible steel, and is accurately ground its entire length, and has a long bearing in the sleeve. It is forged and rough turned at least six months before it is finished, and is allowed to season between every operation. The front of the driving gear forms a face-plate to which the facing head or face milling cutters or other large tools may be attached.



Lucas No. 3 Precision, Horizontal Boring, Drilling, and Milling Machine.

Milling feeds to platen and head (which includes the outer support for the boring-bar) make the machine universal and capable of finishing at one setting many kinds of pieces which would otherwise require resetting and finishing in other machines, and the addition of a graduated revolving table allows holes to be bored and drilled and surfaces to be milled at various angles. A power cross-feed is provided for the platen to make the machine complete for milling purposes. This greatly increases the usefulness of the machine and makes it easy to do many jobs which would otherwise be difficult. It may be mentioned that the length of the cross-feed to the platen is sufficient so that one job of boring may be made ready on one end of it while the machine is boring another piece on the other end.

The yoke is adjusted along the bed with a wrench, and as there is a geared connection between the two screws that respectively adjust the spindle head and the outer support for boring-bar, which is in the yoke, the outer support is kept in automatic alignment with the spindle, and cannot be thrown out by chips getting under the yoke, because it is fitted to the bed. The yoke may be altogether removed and then put back in its original position without destroying the alignment of the outer support for the boring-bar with the spindle, which is a valuable feature where it is required to do work on pieces which are longer than the nominal capacity of the machine. The outer support for the boring-bar is bored out after the machine is assembled, which insures its perfect alignment with the spindle.

The driving gears in the speed box are made of steel and are controlled by two levers on top, giving nine changes of speed. The two levers on the head of the machine, which are interlocking, multiply these speeds by two, giving a total of 18 changes of speed in geometrical progression. At each spindle speed, only such gears are in mesh as are used to obtain that speed, and there is therefore no friction loss due to the revolving of idle gears. The driving pulley runs on a stationary bushing. The main driving clutch is operated by a lever at the front end of the machine, within easy reach of the operator, and when the machine is stopped, only the driving pulley continues in motion. A direct connected motor drive can be applied if desired.

The feed motion is taken from one of the driving shafts which runs at a higher speed than the spindle. This makes it possible to obtain coarse feeds without gearing up, thus avoiding excessive strain on the feed gears and bearings. The fine feeds are obtained by reduction gearing. Another point of advantage of the arrangement is that it gives two series of feeds, a coarse series with the back gears in and a fine series with the back gears out. This gives a greater total range of feeds without excessive increments. There are 18 variations of feed, 9 for either position of the spindle back gears from 0.005 inch to 0.537 inch per revolution of spindle. The rate of feed is the same for every part to which it is applied.

The adjustments of the spindle head, the outer support for the boring-bar and the platen are made by precision screws. The screws are provided with dials graduated to read thousandths of an inch, thus allowing holes to be bored or drilled, and surfaces to be milled an exact distance apart, making it possible to produce interchangeable work without the use of jigs, or jigs may be originated on the machine more quickly and accurately than by any other method. The platen is of extra size and thickness and has six finished T-slots. It will be noticed that it is especially deep, the aim being to make it so stiff that with ordinary care, there will be no appreciable springing when work is clamped upon it.

The machine is regularly supplied with automatic feed to the spindle, automatic cross-feed to the platen and vertical feed to the head. The head and outer support for the boring-bar may be quickly moved by power, and may also be moved by hand from both the front and end of the machine.

This machine is at present the largest of the various sizes made and sold by the Lucas Machine Tool Co., Cleveland, O., and has a spindle 4 inches in diameter with 60 inches total traverse; the greatest distance between the face-plate and outer support for the boring-bar is 6 feet; the greatest distance from the top of the platen to the center of the spindle is 26 inches; and the platen, which is 30 inches wide and 48 inches long, has a cross-feed of 36 inches.

THE LANDIS CORRUGATED GRINDING WHEELS.

An interesting departure in the making of grinding wheels is illustrated in the half-tone below, which represents the construction of the Landis corrugated grinding wheels, invented and placed on the market by Ezra F. Landis, Waynesboro, Pa. It will be noticed that the corrugations in both of the two styles of wheels shown extend from the sides of the wheel to the center, and leave no continuous or unbroken cutting surface on the periphery of the wheel. This construction insures a much greater positive cutting action of the wheel, the principle of cutting being similar to that of a milling cutter. Comparative tests, undertaken with two 8-inch carborundum wheels, one of the ordinary plain

Corrugated Grinding Wheels for Rapid Grinding.

type, and the other of the corrugated type illustrated, on a plain grinder, using a lever with a weight to press the work against the wheel, indicated that with this construction of wheel it is possible to cut nearly four times as much as with a plain wheel, both wheels being of the same grit and grain. The increased wear on the corrugated wheel was only 25 per cent, in spite of the increased efficiency, and this amount of wear can be reduced by using a much harder wheel when corrugated. The advantages claimed for this construction, however, are not only that it will increase the cutting capacity, but that a wheel made on the corrugated principle will cut all kinds of stock, aluminum, hard and soft steel, wrought or malleable iron, bronze, brass, copper, hard rubber, wood fiber, leather, bone, ivory, marble, granite, and in fact anything grindable, with a great deal less liability to glazing of the wheel. These wheels are made either of carborundum, emery or corundum, and by either the vitrified or silicate process.

CLIMAX CHAIN BLOCKS.

The Climax Hoist Co., 1753-55 North Howard Street, Philadelphia, Pa., has designed and constructed a line of hand-operated chain hoists which are believed by their builders to combine a great number of points of excellence. The purpose of the designer (an engineer of long experience in hoist and crane work) has been to produce a high degree of efficiency, simplicity and durability, with a low manufacturing cost, in such a way as to give great value for comparatively little money.

The exterior of the hoist is shown in Fig. 1, while the construction may be followed from the line engraving, Fig. 2. Its simplicity will be at once appreciated. The hand-wheel *A* is threaded to the hub of the friction plate *B*, the latter being fast to the driving shaft *C*. To the other end of *C* is fastened the driving pinion *D*, which meshes with the internal gear *E*, mounted on a stationary stud supported by the cover *F*. The

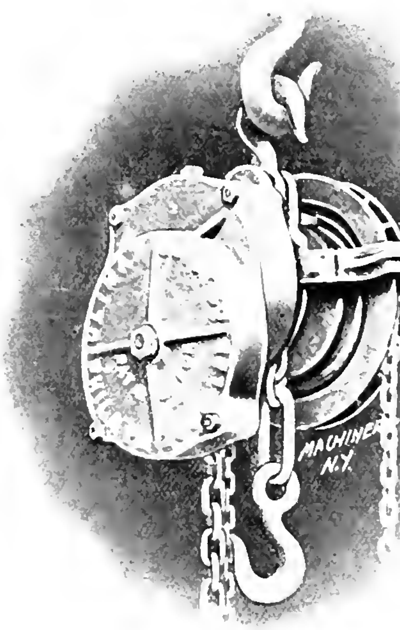


Fig. 1 The Climax Hoist

teeth of the pinion formed on the hub of *E* engage the internal teeth of the load gear *G*, on whose extended hub is keyed the load chain sprocket *H*. The long hub on *G* is supported by roller bearings at *J* and *J* in the main frame *K*; this hub also serves as the bearing for driving shaft *C*. Gears *G* and *E* run submerged in oil in casing *F*.

It was stated that sprocket wheel *A* was threaded to the hub of friction plate *B*. This is required by the automatic brake mechanism, which is provided to keep the hoist from running backwards under a heavy load when the workman releases the hand chain *L*. In lifting work by the hand chain, the sprocket wheel is turned in a clock-wise direction, as indicated in the sectional view, Fig. 2. In doing this it is screwed inward on the hub of *B* until it clamps between the flange on *B* and its own web, friction washers *O* and ratchet plate *P*, thus making *A*, *O*, *P*, *O*, and *B* revolve as a solid unit, raising the work through the medium of the gearing previously described. If the hand chain is released, the load tends to revolve shaft *C* and friction plate *B* backwards. This, however, is prevented by the ratchet teeth on *P* which engage with the pawl *Q*, which is fast to the casing of the hoist. By this means the rotation of *C* is prevented and the work remains safely suspended.

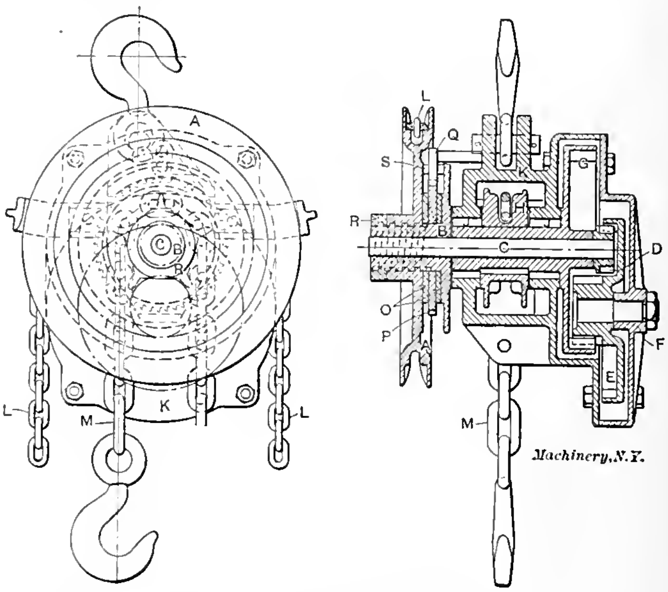


Fig. 2. Elevation and Section showing Gearing and Automatic Brake.

When the operator desires to lower the load, the left-hand side of the chain *L* in Fig. 2 is pulled, revolving the sprocket in a counter clock-wise direction. This unscrews sprocket *A* on the hub of *B* from contact with friction washers *O* and ratchet *P*, leaving *B* and drive shaft *C* free to be revolved by the load, which is thus allowed to descend. If the load has been removed so that there is not enough weight to cause the mechanism to run back by its own weight, the continued pulling of the left-hand chain screws the sprocket wheel against collar *R* on the hub of *B*, which is thus positively revolved in the proper direction to lower the hook.

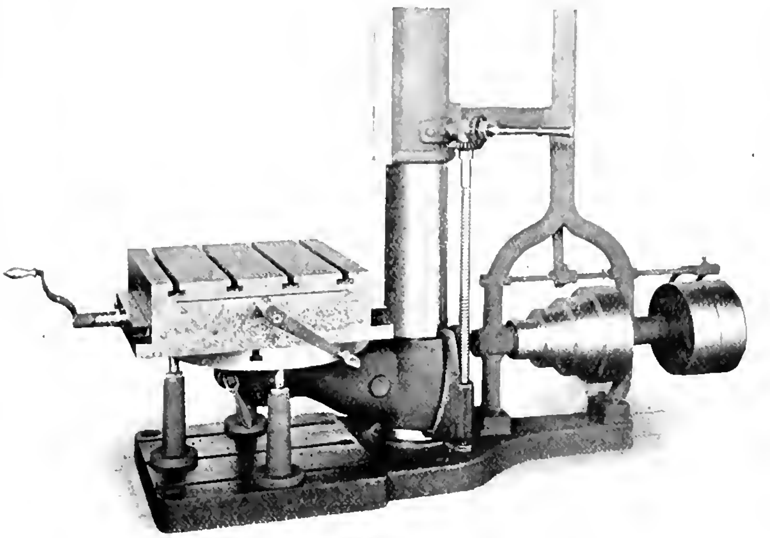
On the other hand, if the workman has been lowering the load, as previously described, and he removes his hand from the chain, the mechanism is positively braked as follows: The turning of the hand-wheel by the operator in a clock-wise direction having ceased, this latter is quickly brought to a stop by the action of friction plug *S* in pawl *Q*. This friction plug serves the double purpose of arresting the movement of sprocket-wheel *A*, and of keeping the pawl in contact with ratchet plate *P* when required. The plug is forced against the web of *A* and the flange on *B* by a spring in its interior. Wheel *A* thus being arrested and the motion of *B* continuing under the weight of the descending load, *A* is immediately screwed inward on the threaded hub of *B*, clamping friction washers *O* and plate *P*, thus arresting the movement of all of these parts against pawl *Q*. When the wheel is being revolved in the opposite direction friction plug *S* raises pawl *Q* so that there is no disagreeable clicking sound, as would be the case if it were held in contact with the ratchet by a spring. As soon as the wheel starts to revolve in the other direction, however, this same plug brings it quickly into contact with the ratchet.

The points of superiority claimed for this design of hoist are—low cost, due to the few parts and simple construction; high efficiency, also resulting from the simple construction, from the use of roller bearings for supporting the load, and from the fact that the gears are enclosed and run in oil; and durability. The parts are all interchangeable so that superior construction is attained at low cost, and repairs are easily effected.

This hoist is arranged with different load chain connections, in seven sizes, to lift from 1,000 to 10,000 pounds.

COMPOUND TABLE FOR UPRIGHT DRILL PRESS.

The illustration shows a compound table for upright drilling machines made by the Mechanics Machine Co., Wyman and Mill Sts., Rockford, Ill. It can be applied to the machines built by this company or to any other drill press. The table is of the European type generally used abroad, being made with two slides at right angles. Combinations of the two movements bring any part of the work directly beneath the drill spindle. The top of the table is provided with four T-slots for bolting down work. The dimensions are 18 x 20 inches, and the



The Mechanics Machine Co.'s Compound Drill Press Table.

sliding movements are 13 and 16 inches. A compound table is a useful adjunct to the drilling machine for work other than drilling, it being practicable with it to use a well-built machine for a variety of milling and profiling operations.

KEARNEY & TRECKER THREE-SPINDLE ATTACHMENT FOR MILLING SPIRAL GEARS.

The arrangement shown in the accompanying half-tone and line engraving was built by the Kearney & Trecker Co., of Milwaukee, Wis., for a manufacturer of cream separators, to be used in cutting the halves of the herringbone pinions which form a part of the drive for the separator bowl. Since these were to be made in great quantities, it was considered worth while to plan out quite carefully the problem of manufacturing them as cheaply as possible. The very satisfactory result of this planning will be appreciated from a study of the device as built.

The arrangement consists essentially of an adjustable attachment fastened to the face of the column for supporting and driving a long spindle carrying three cutters; and of corresponding means for indexing and supporting three work arbors, holding as many gangs of pinion blanks. The cutter arbor, which is in reality an auxiliary spindle, has bronze bearings adjustable for wear. It is carried in a frame, which supports it at right angles to the main spindle, and is connected by spur gearing at the upper end with the short secondary shaft, which is, in turn, connected with the main spindle though a pair of bevel gears. The spur gearing runs in an enclosed box, submerged in oil, the same oil being used to lubricate the bearings. This drive permits the spindle of the attachment to be set to any angle, so that it is unnecessary to swivel the table, as is the practice when cutting the spirals in a universal milling machine. The machine used in this case is one of the builders' No. 2A manufacturing milling machines, which is not furnished with table swivelling adjustment. Of the three cutters carried by the spindle, two are supported between the main and outer bearings, and the third on the overhanging end of the arbor. In these positions they are centered with the three work arbors provided.

The dividing head is provided with means for rotating the work for the spiral cutting, and for indexing for the number of teeth, all three work arbors being connected and operated simultaneously for these movements. The construction of the head will be best understood from the line drawing, Fig. 2. The feed-screw *A* of the milling machine table is connected with the worm-shaft *B* of the head, through simple change gearing. This is done to avoid complication as much as possible. It is often possible to use simple in the place of compound gearing for obtaining spirals of given lead, if the calculations are carefully made. Idlers between the table feed-screw *A* and worm-shaft *B* are used for changing from right-hand to left-hand spiral, or *vice versa*.

The connection between the last gear, *C*, of the change gear train and the worm-shaft *B*, as shown, is effected through the index plate *D*, and the index crank and pin *P*. The plate provided has as many holes as there are to be teeth in the gear, being specially made in this way so as to avoid all possibility of error in dividing.

Worm-shaft *B* and the worm formed on it drive worm-wheel *E*, which is keyed to a short shaft, on the outer end of which is fastened bevel gear *F*. This bevel gear meshes with two others, *G* and *H*, the former keyed to the central spindle *J*, and the latter revolving loosely upon it, but pinned to the hub of spur pinion *K*. *K* meshes with pinions L_1 and L_2, keyed respectively to spindles J_1 and J_2. It will thus be seen that spindle *J*, driven by bevel gear *G*, rotates in the same direction as spindle J_1 and J_2, driven by bevel gear *H* and spur gears *K*, L_1 and L_2.

The whole mechanism of the head is enclosed, and is provided with means for thorough lubrication. The spindles have the same provision for holding and forcing out the taper shanks of the work arbors as are used in the regular milling machines. It will be seen that great care is necessary in the construction of the gearing in the head-stock to prevent back lash in the small bevel and spur gears. The accurate results which have been obtained in the practical use of the device are an evidence of the good workmanship which was put into the construction of these parts.

At the tail-stock end an angle plate is used, clamped to the top of the table and provided with suitable holes for holding tail-stock centers of ordinary construction. These holders are provided with studs which pass through holes in the knee and are clamped by nuts on the other side. The tail-center for

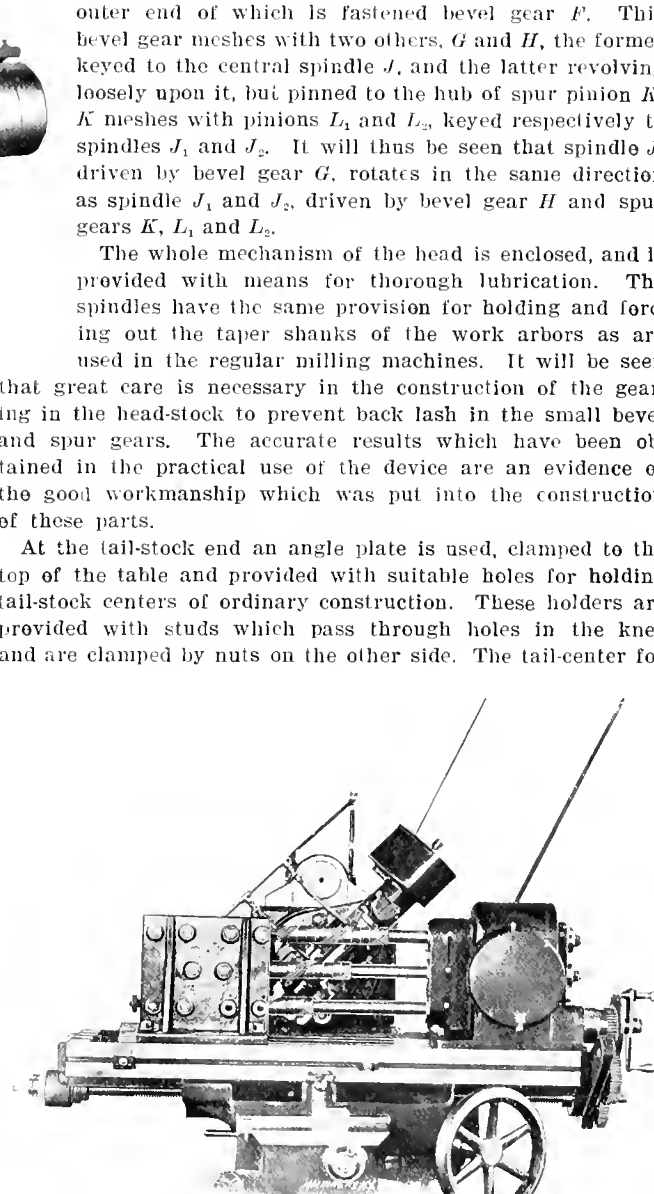


Fig. 1. Adjustable Angular Cutter Spindle and Triple Spiral Head Attachments used on Milwaukee Plain Miller.

the central work arbor is fixed in position, while those for the upper and lower tail-centers may be shifted to positions to accommodate the different lengths of work arbors. In the case shown, the upper work arbor is short and the lower one long, necessitating corresponding positions of the centers. The three arbors are made of these different lengths to provide for the setting of the spindle on the angle. When so set, with the arbor arranged as shown, it will be seen that all three cutters start their work at once and finish at the same time on the three stacks of pinions, each of which is of the

same length. For cutting right-hand pinions with the spindle head reversed to the same angle on the other side, the upper and lower work arbors are interchanged in the spindles in the dividing head, requiring the upper dead center to be moved outward and the lower one inward to correspond.

Cutting oil is supplied to each of the cutters by a system of piping, leading from the regular oil supply equipment of the Milwaukee miller. The final arrangement was somewhat different from that shown, permitting the head to be swung over to the other angle for cutting right-hand gears, without necessitating disconnecting the piping.

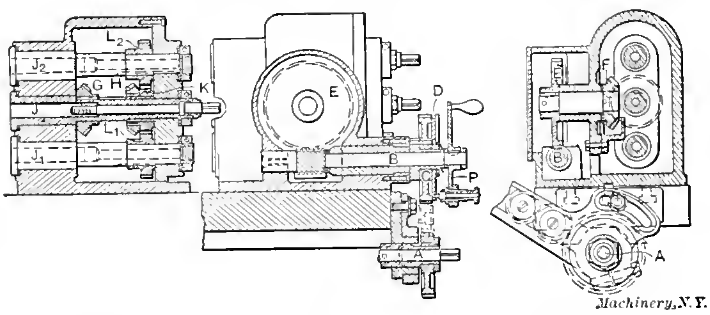
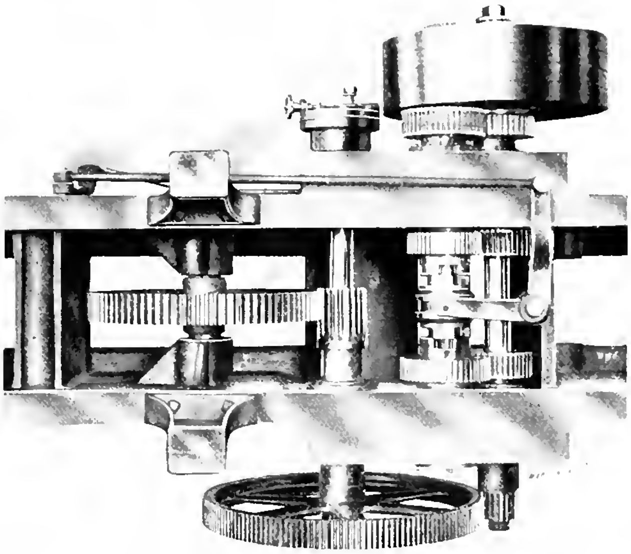


Fig 2. Elevation and Sections of Triple Spiral Cutting Attachment

It is interesting to note that the manufacturers for whom this device was furnished have gear hobbing machines in this device was furnished have gear-hobbing machines in being their experience that more accurate work is possible with this method than in the hobbing process. The gear is run at such high speed that defects soon show themselves. No figures are given as to the comparative cost of the two methods of cutting gears.

VARIABLE SPEED DRIVE FOR THE WOODWARD & POWELL PLANER.

The accompanying illustration shows an underneath or a "worm's eye" view of the arrangement of a new two-speed driving mechanism, which has been applied by the Woodward & Powell Planer Co., Worcester, Mass., to its planers. The device is particularly interesting from the simplicity with which it provides two cutting speeds, instantly obtainable, leaving the return speed constant.



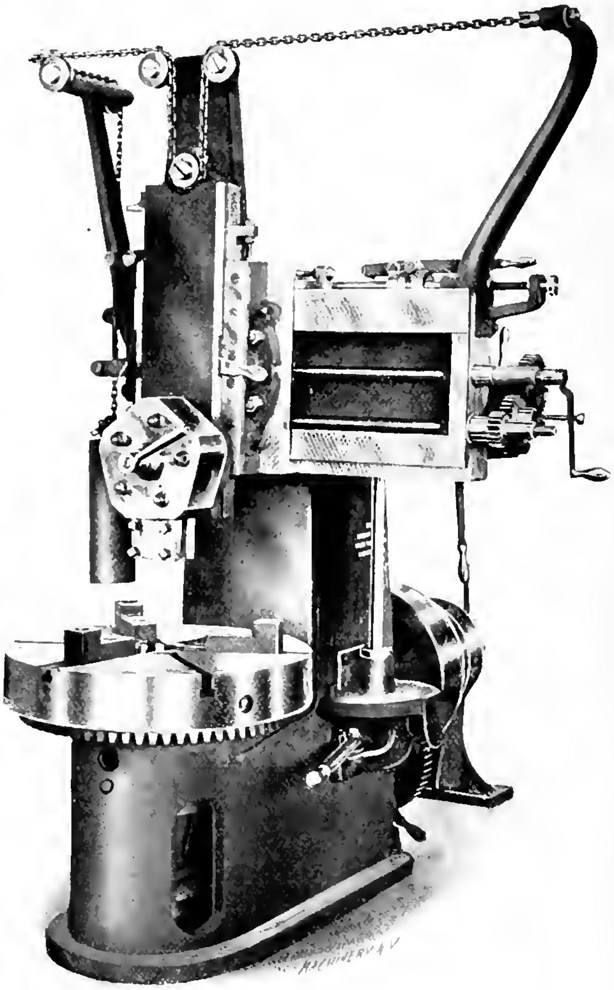
View, from Underneath, of a Planer Drive which gives Two Forward Speeds with Constant Reverse.

The tight and loose pulleys for the return speed are mounted on the driving shaft as usual. The tight pulley for the forward speed runs loosely on the driving shaft, and has a long hub on which the loose pulley for the same belt freely revolves, and to which is keyed a driving pinion, meshing with a raw-hide gear on an intermediate shaft. This intermediate shaft has keyed to it, inside the frame of the planer, a double-ended jaw clutch, adapted to engage corresponding jaws in the hubs of two gears of different diameters, which are loosely mounted on it. These gears engage, in turn, raw-hide mating gears, fast to the driving shaft. The double-jawed clutch is connected by a horizontal bent lever and a reach rod to a vertical shifting lever at the side of the machine, within convenient reach of the operator. The two loose clutch gears on the intermediate shaft are self-oiling and together with the clutch, are of massive construction, and so designed that there is no danger of the teeth slipping out of engagement, except when forced out by the lever.

The arrangement is simple and easily understood. When driving forward, the power is transmitted to the pinion on the hub of the driving pulley, thence to the raw-hide gear, driving the intermediate shaft, and from there to that one of the two gears in the bed which is engaged by the clutch to the intermediate shaft. From that gear the power is transmitted through the driving shaft, and thence through the usual gearing to the table. On the return stroke, the belt drives a pulley fast to the driving shaft, which operates the planer table in the ordinary way, at the same time driving freely the intermediate shaft, which is connected through the gearing with the other driving pulley. The ordinary variation obtained is in the ratio of $1\frac{1}{2}$ to 1.

NILES-BEMENT-POND 30-INCH TURNING AND BORING MILL.

The advantages of the horizontal revolving table of the boring mill over the face-plate of the lathe for chucking heavy pieces are well known. The work does not need to be elevated so high in the boring mill, and it rests on the table by its own weight while it is being centered and clamped. These considerations give the boring mill a great advantage in the



Niles-Bement-Pond 30-inch Vertical Boring Mill.

rapid production of heavy duplicate parts which require chucking operations. To take advantage of these good qualities, the Niles-Bement-Pond Co., Trinity Building, 111 Broadway, New York, has brought out the boring mill shown in the accompanying engraving.

The base and upright are cast in one piece, strongly ribbed to insure stiffness under the heaviest cuts. All bearings are of liberal size, and particular care has been taken to make

the machine run smoothly, and easy to handle. The cross rail is of sufficient depth to insure a minimum of deflection under the strain of the cut, and has a wide face offering a broad bearing to the saddle.

The table is 30 inches in diameter, corresponding with the rating of the machine. It is supported on a spindle of ample proportions running on a step bearing submerged in oil, and it is supported laterally by a long split sleeve, adjustable for wear and having a conical bearing on the bed. This preserves the alignment permanently, and insures a true running table. The working surface of the table, as regularly built, has a 3-jaw combination chuck, capable of holding work from 4 to 25 inches in diameter. In addition to the jaw slides, there are three radial T-slots for bolting on work. The jaw slides are of steel, built into the table. The chuck jaws are reversible and may be readily removed, leaving the surface of the table entirely clear for irregular work requiring special clamping fixtures.

The table is driven by an accurately cut bevel gear which, as may be seen in the illustration, is nearly the full diameter of the swing. The machine is driven by a 4-step cone provided with back-gears giving eight speeds; this number is doubled by the use of the 2-step counter-shaft provided. Thus a range of 16 speeds covers the work for which the machine is adapted by small gradations, insuring the proper speed for each case. The total gearing ratio of 27 to 1 insures a maximum cutting power on large diameters. The turret slide is supported in a saddle which slides on the permanently located cross rail. Either the vertical movement of the turret slide in the saddle, or the horizontal movement of the saddle on the cross rail, may be effected positively through the feed motion provided. There are 16 changes of feed driven by positive gearing, thus making many of them available for screw cutting. The gears regularly furnished with the machine give 16 pitches from 4 to 48 threads per inch. Additional gears may be furnished at a slight extra cost so that the machine may be used for cutting threads of any desired pitch. All the feed changes, including the reversing of the feed motion, which is effected by the lever at the base of the vertical feed shaft, may be effected from the operating side of the machine, thus making the manipulation simple and rapid, and increasing the output of the tool. The turret has five large holes for tool-holder shanks which are securely held in position by large bolts and binder plugs. The flat sides with which the turret is provided give a broad bearing to the back faces of the tool-holders, thus preventing lateral deflection under heavy cuts.

It will be seen that the machine besides being stiff and powerful, is simple in construction and convenient in operation, thus adapting it especially to manufacturing purposes.

BAUSH VERTICAL AND HORIZONTAL MULTI-SPINDLE DRILLING MACHINES FOR STRUCTURAL WORK.

The two multiple spindle drilling machines illustrated in Figs. 1 and 2 have been designed by the Baush Machine Tool Co., 200 Wason Avenue, Springfield, Mass., especially for the Bethlehem Steel Co. for drilling structural steel made in the "Bethlehem" sections, and manufactured by the Grey process. The equipment installed by the Bethlehem Works consists of eight double-head horizontal machines of the type shown in Fig. 1, and four single-head vertical machines as shown in Fig. 2. The vertical machines are arranged in a line, every other machine being placed on a sliding base so as to accommodate the drilling of various lengths when required. The horizontal machines are intended for drilling the flanges of the rolled sections, and the vertical machines are designed for drilling the web. In the case of the horizontal machines, each head takes the thrust of the drilling pressure of the opposite head.

The design of these drills is very plainly shown in the half-tones. The horizontal machines in particular, embody an entirely new departure in multiple drill design, so far as the arrangement of the details is concerned. These are made in two sizes. The capacity of the heads of the larger size is 12 x 48 inches—that is, the adjustable drill spindles will cover any

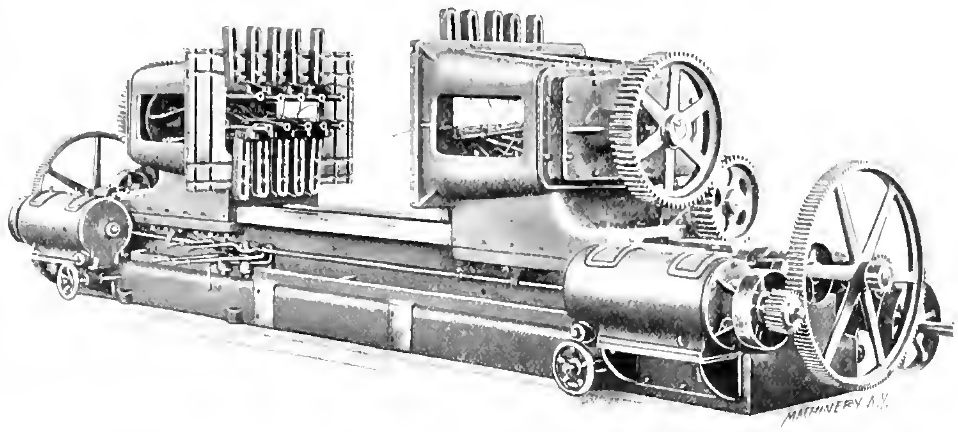


Fig. 1. Double-head, Ten-spindle Baush Horizontal Drilling Machine.

large lay-out within a rectangle 12 inches high by 48 inches wide, eighteen spindles being provided in each head. The smaller size horizontal machine carries heads of a capacity of 12 x 24 inches, each head being provided with ten spindles. This size is the one illustrated in Fig. 1. Both heads on the horizontal machine are operated independently or together, as required. All spindles are provided with No. 3 Morse taper sockets, and the machines are designed for drilling one-inch holes in soft steel, at a speed of 55 feet per minute at the periphery of the drill, with feeds ranging up to 0.01 inch per revolution of spindle. Each head is equipped with an oil pump, pan, reservoir and connections to each spindle, to allow oiling each drill independently.

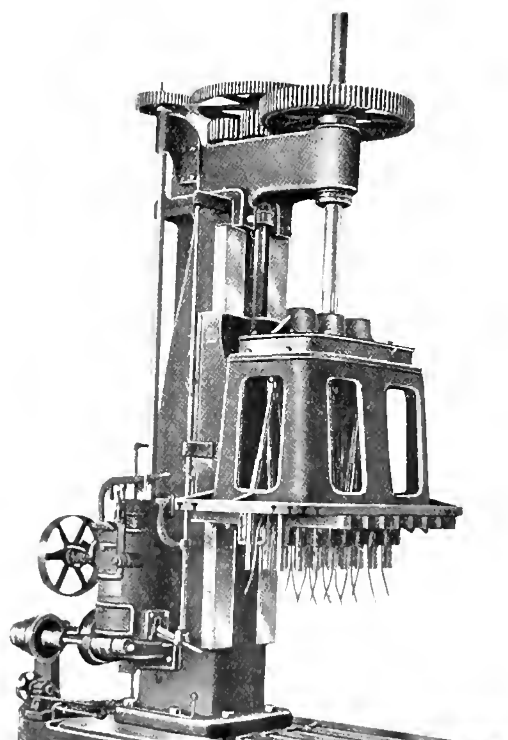


Fig. 2. Sixteen spindle Baush Vertical Drilling Machine.

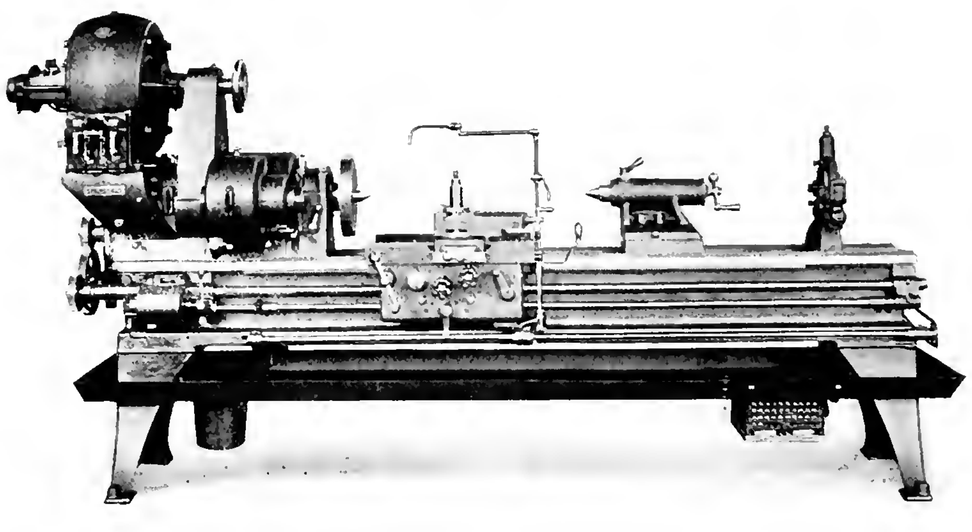
The vertical machines are also built in two sizes, the larger size carrying sixteen drill spindles, and having a capacity of 12 x 36 inches. This is the size illustrated in Fig. 2. The

smaller size carries ten spindles, and has a working capacity of 12 x 24 inches. The spindles in these machines are also provided with No. 3 Morse taper sockets, and designed for drilling holes of the same size at the same speed and feeds as the horizontal machines. The oil pump and oiling arrangement are also of the same character as already mentioned in connection with the machine shown in Fig. 1.

In both styles, the machines are motor-driven, the eighteen spindle-heads being driven by a 25 horse-power motor, and the sixteen spindle-heads by a 20 horse-power motor, while the ten spindle-heads are driven by a 15 horse-power motor. The drills are all provided with a two-speed quick return. The vertical machines weigh about 11,000 pounds, and the double-head horizontal machines about 25,000 pounds, without the motors.

SPRINGFIELD HIGH-POWER MOTOR-DRIVEN LATHE.

The motor-driven lathe shown in the accompanying illustration is built by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O., and is known as the company's No. 3 high-power rapid-reduction lathe of 19 inches capacity. One of the most noteworthy features of departure from previous designs is the system of drive employed. On this type of lathe the power is transmitted by means of a silent chain drive, instead of by a train of gears. A heavy, cumbersome construction is thereby avoided, and a neater and more compact appearance given to the machine.



Springfield No. 3 High-power Rapid-reduction Lathe.

The motor is a 7½ H.P. variable speed motor, the speed variations being within the limits of 500 and 1,000 revolutions. The fast speeds of the spindle are obtained by direct drive through the silent chain mentioned, from the motor to the spindle. The next series of slower speeds are obtained through a train of gears consisting of one set of spur gears and one set of helical gears. The smooth action of the helical gears eliminates any chatter marks when taking fine cuts in finishing work. The slowest series of speeds are obtained by a double set of back gears. By the arrangement outlined spindle speeds from 10 to 285 R.P.M are obtainable. The clutches used throughout the geared head are positive steel clutches, but so arranged that the machine does not have to come to a dead stop before changes can be made. A belt-driven model of this lathe is also built, which has ten speed changes for the lathe head itself, which, with a two-speed counter-shaft, gives twenty different speeds. This machine is designed to give a constant cutting speed of 80 feet pr minute for all diameters, from 1½ inch to 18½ inches. When motor-driven, if a constant speed instead of a variable speed motor is used, eight mechanical speeds are obtainable.

The operating lever for the control is placed on the right side of the apron, where it is out of the way of the operator, and yet very convenient of access. The cross-feed screw and compound rest screw have micrometer dials, permitting accurate adjustments. The friction knobs for throwing in and out the gears and longitudinal feeds are made with a series of small ridges around the outer circumference, so that the operator can readily get a good grip. The lathe is equipped with a rapid feed change gear box, which gives six feeds in geometrical progression. The machine shown in the illustration is also equipped with a modification of the change gear system generally in use, but the lathe may also be equipped with the "Ideal" rapid change gear system, used on the lathes of the Springfield Machine Tool Co. Using either system of change gearing, the lathe is equipped with automatic stop and reverse. The latter can be controlled either from the head or apron as desired by the operator.

The machine is of an exceptionally heavy design throughout. The head is heavily ribbed; the spindle runs in large journals, which are oiled by means of babbitt rings of triangular shape, carrying a profuse stream of oil, and thereby preventing any possibility of heating the boxes. The back-gear shaft is oiled in the same manner. In actual tests this lathe has proved itself capable of taking cuts with a feed of 5/32 inch and a cutting speed of 60 feet per minute, with a cut ¾ inch deep in 60-point carbon steel.

BESLY PISTON RING DISK GRINDER.

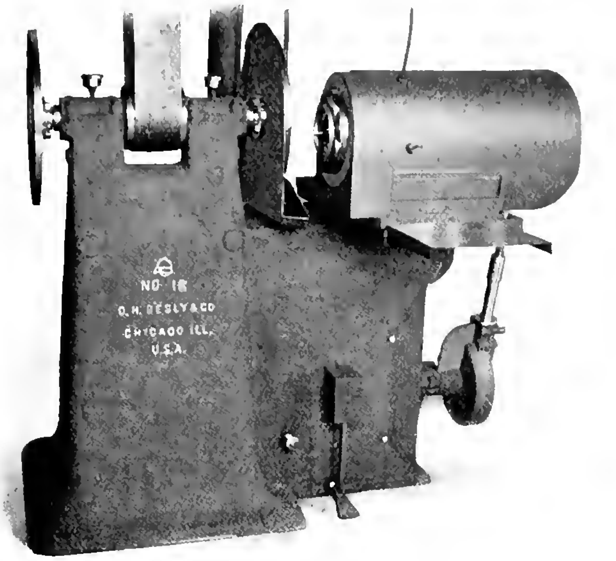
The accompanying half-tone illustrates a new type of grinding machine built by Charles H. Besly & Co., 15-17-19-21 South Clinton Street, Chicago, Ill. This machine has been designed especially for grinding the sides of piston rings rapidly and accurately to size. The novel feature of the machine is that the grinding is done on a steel disk wheel which has its sides covered with Helmet spiral abrasive disks, made by the builders. The machine will grind rings from the smallest diameter up to 10 inches diameter.

The machine as shown carries 18-inch disk wheels. The spindle is 1¾ inch in diameter, and is made from the crucible steel The bearing bushings are each 8 inches long and are carefully fitted into bored holes in the base casting, thus assuring perfect alignment, as well as making it easy to replace them when worn out. The bushings are split, have removable caps, which are fitted over the bushings, making it easy to remove the spindle if necessary. The end adjustment of the spindle is accomplished by means of a threaded collar, which is mounted on the spindle just under the flange of the spindle pulley. The end thrust is taken on hardened and ground steel thrust collars of large area. The bearings are well protected from dirt and grit, and particular attention is given the lubricating of all bearing parts. The spindle pulley is 7 inches diameter by 6¼ inches face.

On the right-hand side of this machine and secured to the bed, is a dove-tailed bed plate. On this bed plate is mounted a platen or carriage, which has a reciprocating motion, and is moved back and forth parallel to the face of the disk wheel. This motion is attained through a gear and rack underneath the bed, the gear receiving its movement through a crank and lever, the crank being attached to a lower shaft, which is driven by a spur gear meshing with a gear on the worm-gear shaft. This shaft, in turn, projects on the rear side of the machine, and is driven direct from the counter-shaft by a quarter turn belt. On the worm-gear shaft is mounted a clutch, which, upon being thrown in, lets this shaft make four revolutions, and then releases automatically, the four revolutions of this shaft moving the platen ahead and back to its original starting point.

Upon the platen is mounted a compound slide, also having a reciprocating motion, this motion being to and from the face of the disk wheel. The slide receives its motion from a cam which is secured to the outer edge of the bed

plate. Upon this slide is mounted the head or bearings of the spindle which carries the chuck for holding the work to be ground. This head can be moved back and forth at will by means of a screw and hand-wheel, the screw being equipped with a micrometer dial graduated to read in thousandths of an inch. The chuck is of the magnetic rotating type, and receives its rotary motion through bevel and spur gears from the lower shaft in the base of the machine. A sliding gear is provided in the base of the machine, by means of which a rapid or slow motion can be obtained across the face of the disk.



Besly Piston Ring Grinder.

The action of the machine is as follows: The work is placed on the chuck and the lever tripped, the platen moves forward, and the chuck carrying the work moves towards the face of the grinding disk, the work rotating and its entire surface coming in contact with the grinding disk. Thus, instead of grinding in one place only, the whole face is ground at once. As soon as the platen gets to its full forward stroke it recedes, and near the end of the stroke the chuck carrying the work also recedes from the face of the grinding disk. As soon as a full backward stroke is reached, the platen and chuck stop automatically. The principal dimensions are as follows: height from floor to center of spindle, 42 inches; space occupied by base on floor, 30 x 48 inches; weight of machine complete, 3,000 pounds.

GARDNER DOUBLE DISK GRINDER.

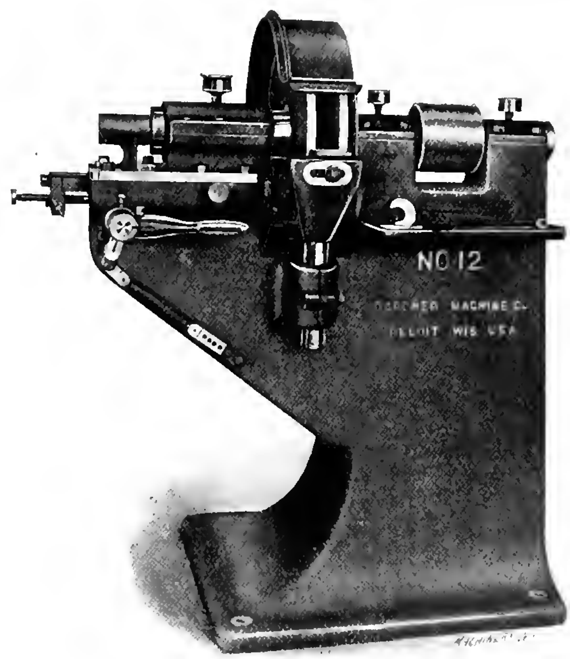
The double disk grinder shown herewith, made by the Gardner Machine Co., Beloit, Wis., embodies what is, so far as we know, a distinctly original idea in its construction—namely, that of having both wheels driven by one pulley and one belt. To accomplish this, the outer disk is carried on a sleeve supported in the adjustable bearing, and is driven by a drive shaft, forming an extension of the spindle on which the other disk and driving pulley are mounted, the sleeve being splined to the drive shaft.

This arrangement, it will be seen, makes possible a very neat design of frame, it being in the form of a column for carrying the fixed spindle, and provided with a knee extending outward to furnish a bearing surface for the slide of the adjustable spindle. The sliding head is equipped with micrometer stop screws and a back stop. The importance of the back stop is not always realized by the purchaser. It comes into play in finishing very thin work, say from 1/8 inch down to 1/32 inch in thickness. It is adjusted so as to allow the disks to be separated just enough to introduce the work, and not enough to allow room for the work to be caught between the work rest and the wheel. The sliding head is operated by means of a hand lever which is directly connected with a steel cut pinion meshing with a steel cut rack fastened to the under side of the sliding head.

To remove the disk from the machine, the driving shaft of the left-hand head is uncoupled from the main spindle. The end of this drive shaft is made with a left-hand thread and a taper shank, the main spindle being bored and threaded to receive it. When this has been removed, the sliding head can be taken off for re-covering the wheels, or the main spindle disk may be used with the machine in this condition, with special work table and fixtures for ordinary flat surface grinding. The disk wheels are fastened to the spindles by the usual countersunk screws.

The machine, as may be seen from the engraving, is rigidly constructed throughout, and great care has been taken in providing lubrication and excluding dust from the wearing surfaces, the hollow spindle being provided with dust-proof collars for this purpose, as well as the main bearings. Disk wheels of either 15 or 18 inches diameter may be used. The maximum distance between the wheels is 4¼ inches, which is enough for the great majority of cases, though this may be increased to suit special work. The weight of the machine in the condition shown in the engraving is 1,000 pounds, and when crated for domestic shipment weighs 1,800 pounds. It is furnished with all the necessary accessories, such as setting-up press for the disks, counter-shaft, wrenches, and other supplies.

This machine will be furnished in two other forms besides that shown. In one case, provided with an additional single disk at the right-hand end of the main spindle, having the usual tilting table and standard work holding arrangements. This machine will be known as the "No. 12 combination" grinder. The other style, the "No. 12 duplex," will have the same form of double disks, sliding heads, etc., duplicated on the right-hand side of the column, the whole machine being driven by one belt. This arrangement can be used either as a roughing and finishing machine, or, if desired, two men may be employed on the same or different work.



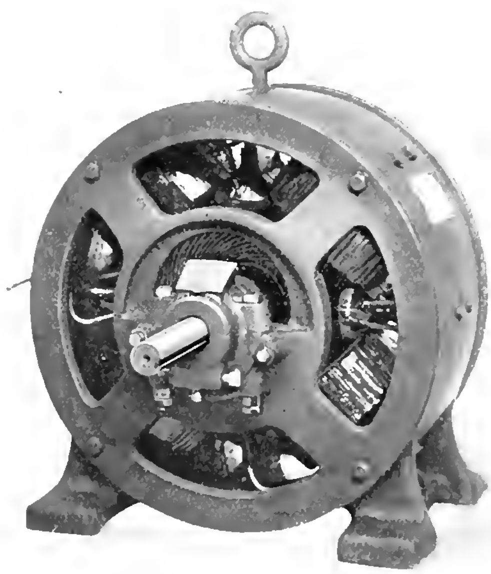
Double Disk Grinder driven from Single Pulley.

WESTINGHOUSE TYPE "SA" MACHINE TOOL MOTORS.

In order to operate a machine tool with the greatest economy, the speed must be adjusted in each case for the work in hand. The new type SA motor, brought out by the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., permits a quick, easy and accurate speed adjustment, and the advantage of the motor drive in this respect as compared with the slow and cumbersome method of shifting belts is apparent. The controller and the motor can be mounted convenient for the operator, and the desired speed can be obtained without stopping the work. It is stated that in one large American manufacturing establishment, where this type of motor was substituted for the older form of power, tests made before and after installing the motors indicated a saving in favor

of the motor of 30 per cent of the cost, as well as considerable improvement in the quality of the product. The speed of these motors can be adjusted within wide limits, simply by moving the controller handle, and the speed, once adjusted, remains practically constant at all loads until further adjustment is made. The number of different speeds obtainable between the minimum and maximum is limited only by the number of notches on the controller. The standard type of SA motors is built in capacities of from ½ to 23 H.P. for speed ratios of 1 to 4, and in capacities of from 1½ to 50 H.P., for speed ratios of 1 to 3.

In all type SA motors, the coils on the auxiliary poles are in series with the armature circuit, so that the strength of these poles depends on the load of the motor, and is always proportional to the armature reaction. This is true no matter which way the armature is rotating. The result is that under the brushes is a fixed magnetic field of exactly the right strength to cause sparkless commutation at all loads and at all speeds within the limits of the motor rating, and heavy



Westinghouse Type SA Machine Tool Motor.

overloads can be carried for short periods. The open type SA motor will carry its full rated load at any rated speed for 12 hours or 2 hours, according to its rated time of operation, with a temperature rise not exceeding 72 degrees F. It will carry an overload of 25 per cent for one hour or of 50 per cent momentarily without injurious heating or sparking. The two-hour ratings are satisfactory for intermittent machine tool service, and will give excellent results when applied for such purposes.

WALCOTT & WOOD 20-INCH CRANK SHAPER.

The crank shaper shown in the accompanying half-tones and line engravings is the first of a new line brought out by the Walcott & Wood Machine Tool Co., Jackson, Mich. The details of this line of shapers have been worked out along original lines throughout, and differ in many points from the standard construction with which most shaper users are familiar. The changes are quite largely along the line of increased stiffness and durability, and give evidence of careful attention to small details.

Driving Mechanism.

The machine is of the crank type with the quick return obtained by elliptical gearing. Except for the difficulty of making accurate gearing of this kind, this movement is especially adapted for the quick return motion of a shaper. The action is simple and direct, requiring very few parts, and is exceedingly durable. The methods of manufacture developed by the makers for these gears insure accurate work at reasonable cost, so that the only objection to their use is in a measure removed. The driving connections will best be understood by referring to Figs. 3 and 4 in connection with the half-tone engravings. The 4-step driving cone is mounted on the sleeve *A* which takes the pull of the belt. It drives shaft *B* which has mounted on it double sliding gears which may be made to engage at will, by the operation of lever *C*, with either of gears *D* and *E*. By this means the four speeds given by the cone pulley are doubled, giving

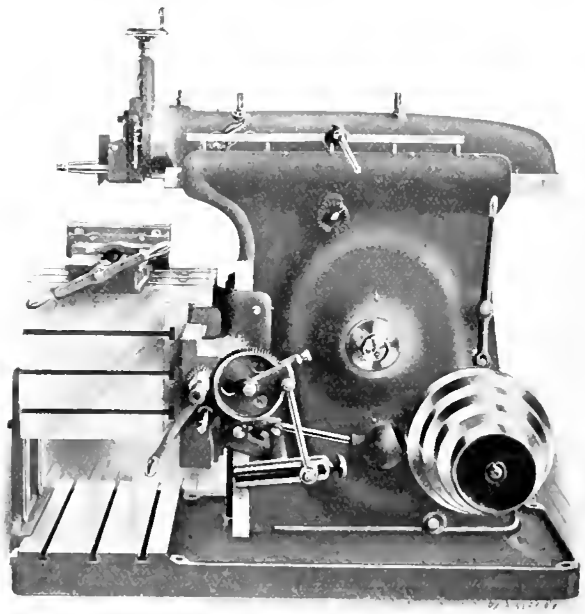


Fig. 1. Walcott & Wood 20-inch Crank Shaper.

eight in all. Pinion teeth are cut in the sleeve on which gears *D* and *E* are mounted, meshing with the bull-wheel *F*. This is keyed to a shaft, the other end of which carries one of the elliptical gears *G* whose mate *H* is attached to and drives the crank *U*.

The slotted link *J* which drives the ram *K* is of unusual length, as may be seen, being pivoted near the base of the machine to link *L*. The upper end is pivoted to block *M*,

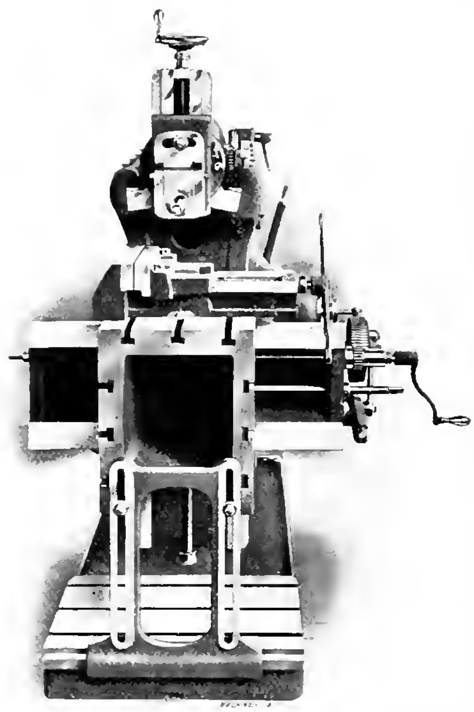


Fig. 2. Front View of Walcott & Wood 20-inch Crank Shaper.

which is supported on ways on the inside of the ram on which it is adjusted by screw *N* which is connected by bevel gearing with squared shaft *O*, by means of which the position of the ram is adjusted. The handle *P* operates a stud with a pinion on the lower end meshing with a rack having a wedge surface which tightens a binding lever, bringing the loose section of the adjusting block *M* simultaneously up against the under side of the ways on the ram and against the adjusting screw, clamping them all tightly. The length of

stroke is adjusted by squared shaft Q which is connected by spur and bevel gearing with screw R which shifts the position of a crank-pin in the slotted crank. The length of stroke is read from a dial S whose pointer is connected by spur gearing and rocks with the ram.

Tool Head and Down Feed.

The tool head is, in the main, of familiar construction, although a number of conveniences and improvements have been made in details. It swivels to any angle through an arc of 90 degrees, and its feed-screw has an adjustably graduated collar reading to thousandths of an inch. A graduated scale and adjustable pointer are provided for indicating the depth of the cut. A strap tool-post is used. The clapper box is strengthened by a tie-rib which connects the two sides, materially strengthening it against side thrust.

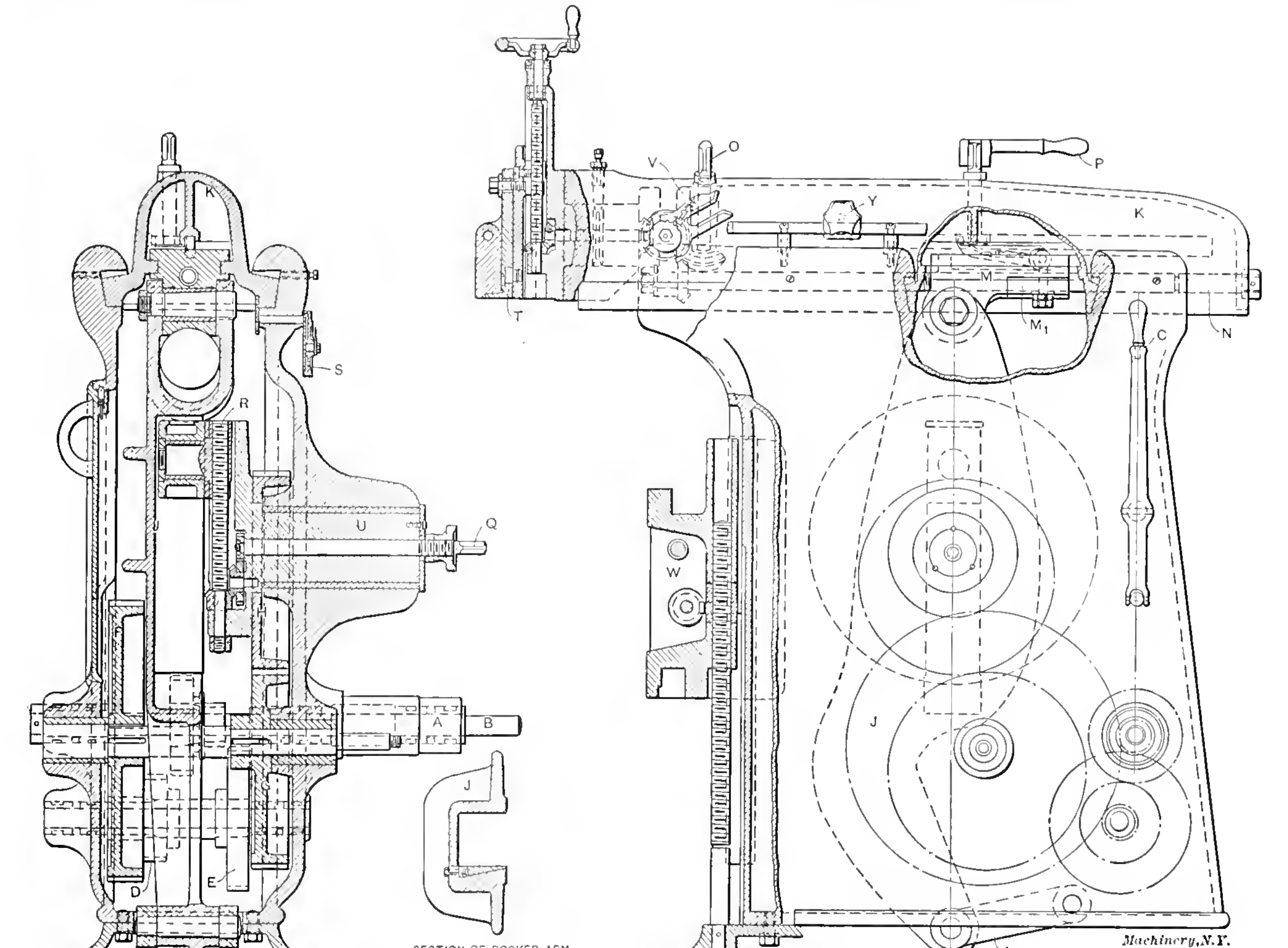
The power down feed is accomplished by positive mechanism acting without the use of springs. It is operated by an adjustable dog Y supported on a rail mounted on top of the column. This dog enters the slotted arm V at the end of the back stroke, rocking it forward and bringing it back again as the ram reverses. This rocking movement, by means of a ratchet and pawl, is transmitted, through the bevel gearing shown, to the down feed screw. The ratchet is used for connecting or disconnecting the motion. The amount of feed is varied by altering the position of Y.

Construction of the Sliding Bearings.

A particular feature of this machine is the method of gibbing used throughout. This is best seen in the case of the ram in Fig. 3. Instead of the ordinary square form of ram bearing with caps screwed on to hold the ram to its work, the construction shown is used, in which the bearing practically surrounds the ram slide on three sides with the solid metal of the column. The ram has flat bearings underneath and a flat wide side bearing tapering slightly outward and upward. The wide top bearing is tapered slightly upward and inward. The lower and side bearings fit the ram surfaces, being planed and scraped to receive them. The space between the tapered upper bearing surface of the ram and the over-hanging lip of the column is filled on each side with a tapered wedge gib set up by screws acting on its edge, thus adjusting them in the direction of their greatest stiffness, producing a uniform contact instead of localizing it under the points of the set-screws as is the case with the usual form of flat gib.

In order to insure the permanent maintenance of the sidewise alignment of the ram, the side bearing, so the builders claim, is 60 per cent greater on this machine than on any other regularly manufactured. The ratio of the lower bearing to the side bearing is calculated to be such that the ram will wear outward so that the wear will be continually taken up on the sides without requiring special provisions for this. By making the upward bearing substantially flat, the wedging tendency that results from the use of 45-degree top bearings, as sometimes used, is eliminated, while the abolishing of screwing on caps goes far toward removing the possibility of the "fan-tail" cut which results from the give of such caps under heavy cuts.

The same principle, so far as possible, is carried out in other bearings. In the case of the rocker arm J, a detailed cross-section of which is shown at the right of Fig. 3, a taper gib of the same type has been produced provided with screws for both forcing it out and drawing it in, so that its position can be accurately located. This, in combination with the slight angular displacement of the ram, resulting from its unusual length, as previously described, reduces the wear of the block and the slot to a minimum, and makes it possible to take up whatever wear may occur. The pin about which the arm is pivoted to the adjusting block of the ram, is tapered so that this may be adjusted for wear. The journal of the hub of the slotted crank U in the main frame is



Figs. 3 and 4. Section and Elevation showing Design of Shaper.

unusually long, and its bearing is cast solid with the column. All of this tends to make a strong and durable driving mechanism.

Cross-Rail and Table.

The cross-rail W, Fig. 5, is of box form designed to withstand the strain of heavy cuts. The bearings on the front of the column are made with the outside surfaces at a slight angle to provide means for automatically taking up wear in

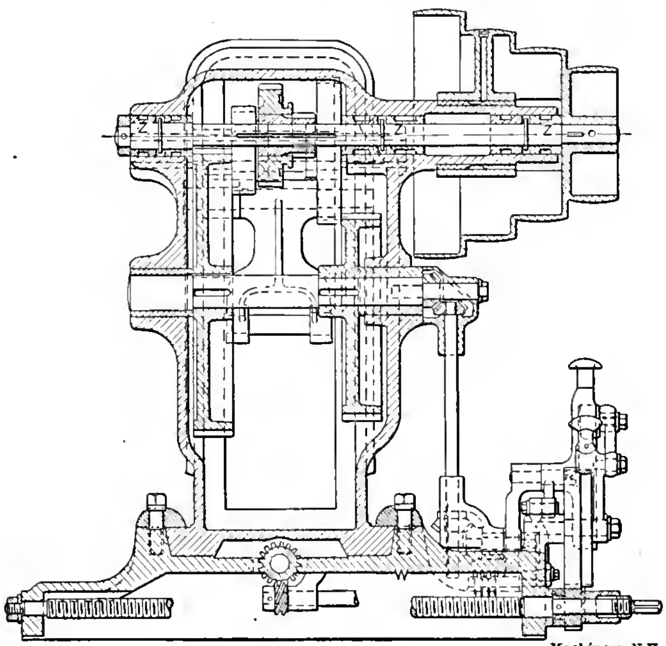


Fig. 5. Transverse Section through Apron, and Column of Shaper.

the same way as is done with the ram bearings. This makes it unnecessary to rely on the pressure of a few gib screws to maintain the alignment. The apron is provided with a gib of the same kind as used in the ram and rocker arm, for taking up the wear. The table is of box form, and can be readily detached. It is locked to the apron in a simple and effective way. An outer support of the practical form shown in Figs. 1 and 2 is supplied with the machine.

Feed Mechanism.

To avoid the necessity for adjusting the feed for various heights of the table, an original feed mechanism has been employed. At the right side of the cross-rail is mounted a bracket which contains a crank connected by bevel gearing and telescopic shaft with the bull-wheel shaft. The crank is connected with a slotted link which is thus vibrated in the proper relation with the ram for the feeding movement. An adjusting screw and knob shifts the position of a trunnion nut in this slotted link to vary the rate and the diameter of the feed. The trunnion nut is connected by a link with the ratchet arm of the feed gear wheel, which, in turn, meshes with the pinion on the cross-feed shaft in the usual way. The pinion driving the cross-feed screw is connected to it by clutch teeth kept in engagement by a spring. This furnishes a safety device so that if the table is accidentally fed to the extreme end of its travel, the resistance of this movement stopping the screw will cause the clutch teeth to be forced out against the pressure of the spring, thus stopping the feed and preventing the breaking of any part.

Details of Construction and Equipment.

In describing the means for adjusting the position of the ram by means of crank-shaft O, screw N and clamping handle P, mention should have been made of the reason for following this plan in place of the usual one in which M is clamped by a bolt through a vertical slot in the ram with a handle similar to P at the top. The arrangement here used does away with this elongated slot, and thus allows the ram to be ribbed through from side to side above block M throughout its whole length. This greatly increases the stiffness of the ram, and its capability for doing heavy and accurate work.

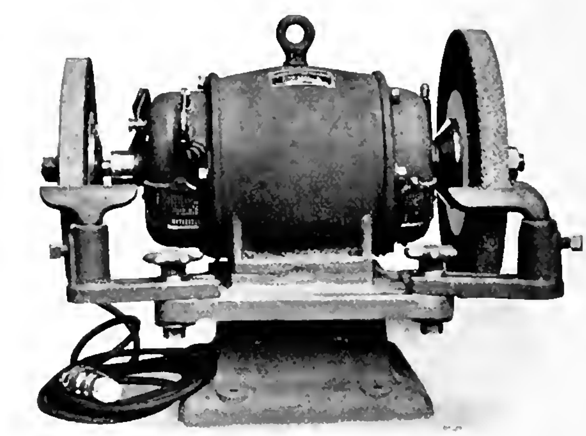
As to the general character of the design and workmanship of the machine, aside from what has already been explained, it may be mentioned that all bearings are bushed with bronze, and all rapid running bearings are provided with ring oilers. The ring oilers for the driving shaft are seen plainly in Fig. 5 at Z, Z, Z. The driving cone is provided with bushings with an oil chamber between, arranged so that a splasher attached to the pulley throws the oil over the stem and keeps the bearings thoroughly lubricated. Suitable oiling facilities are provided for all the other running and sliding bearings.

The vise, as shown in the half-tone, is designed to lie down flat on top of the table, giving it a rigid support. It is graduated and provided with a swivel base. All the shafting is of the best quality steel ground to size. The gears are all cut from the solid, and are of coarse pitch and wide face, driven by steel pinions. The maximum stroke of the machine is 20 inches; the horizontal travel, 27 inches; the length of the ram bearing in the column, 36 inches; the down feed of the head, 7 inches. The width of the belt used is 3 inches. The counter-shaft is run at about 350 revolutions per minute. The maximum ratio of the gearing is 32 to 1. The net weight of the machine and counter-shaft is 4,100 pounds.

The line of shapers to which this 20-inch belongs will later include a 16-inch and a 24-inch size, as well, with probably is 4,100 pounds.

U. S. ELECTRICAL TOOL CO.'S BENCH GRINDER.

The electric bench grinder illustrated in the accompanying half-tone is manufactured by the United States Electrical Tool Co., Cincinnati, Ohio. The motor of this bench grinder is of the air-cooled type of 2 H.P. capacity, and made for 110 or 220 volts direct current. It is operated by connecting it directly to an ordinary incandescent lamp socket. The



Bench Grinder built by the United States Electrical Tool Company.

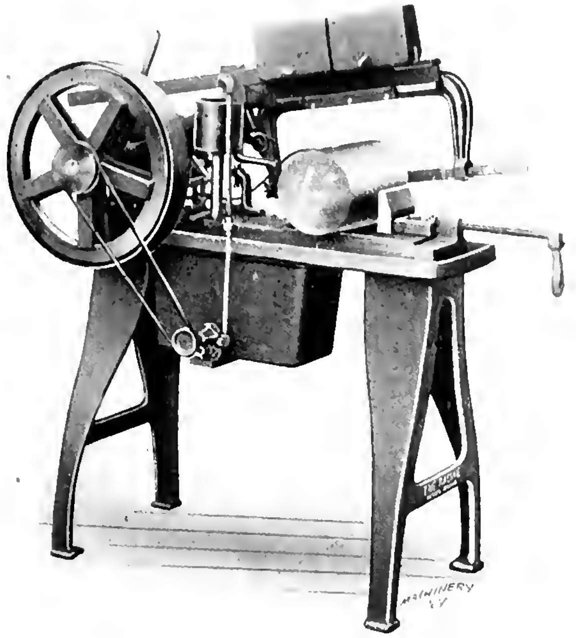
emery wheels used are 12 x 1¼ inch and 10 x 1 inch, respectively. The bearings are conical, dust-proof, and adjustable for wear. The tool rests are adjustable and can be taken off, if required, or swung out of the way. Besides being used for regular grinding work, this grinder is also suitable for buffing or polishing work.

RACINE HIGH-SPEED AUTOMATIC HACK-SAW MACHINE.

The hack-saw manufactured by the Racine Gas Engine Co., Racine Junction, Wis., which was described in "New Machinery and Tools" department in the January, 1908, issue of MACHINERY, has been brought out in an improved form, as shown in the accompanying engraving. As will be remembered, an important feature of the machine is the means provided for positively arresting the saw from contact with the work on the back stroke, thus lengthening the life of the saw, increasing the rapidity of the cutting, and squaring off the end of the work more accurately.

The improved design shown herewith has been especially planned for increasing the rate of production. With this end in view, a tank and pump for a lubricant has been pro-

vided. A cutting compound costing less than 2 cents per gallon is recommended, which is pumped from the tank through a pipe into a reservoir, and thence onto the work, whence it falls into the trough provided around the base of the machine, and then returns to the tank again to be used over continuously as in screw machines and other machine tools.



Racine High-speed Automatic Hack-saw Machine.

The raising of the saw on the return has proved to be of great value in increasing the rate of production. It is also impossible to break the saw by applying too much pressure to it. As much as 80 pounds pressure has been used for a saw blade 14 inches long, 1 inch wide, and 0.032 inch thick, without injury, a 6-inch round bar having been cut off under these conditions in 32 minutes. It is possible, also, to use a thin blade, thus effecting a saving of material.

The use of the cutting compound has made possible a doubling of the speed on a machine of this type, while the length of time that a saw blade can be used is increased from 10 to 40 per cent. according to the size and kind of material to be cut. The blade is also less liable to break.

ANGLE MEASURING INSTRUMENT MADE BY SCHELLENBACH-HUNT TOOL CO.

The Schellenbach-Hunt Tool Co., Cincinnati, Ohio, is making the unique angle measuring device shown herewith in Figs. 1 and 2. This instrument is arranged with suitable multiplying gearing to indicate the position of an adjustable

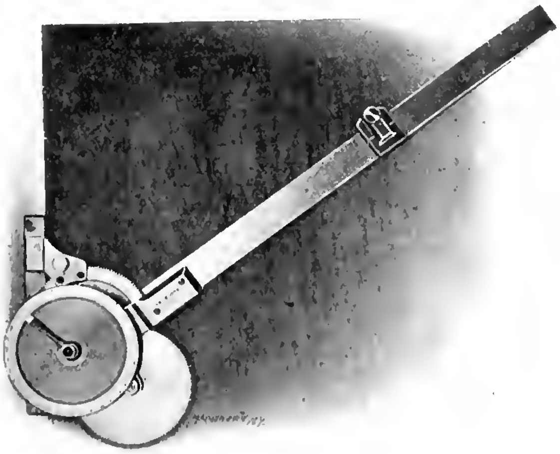


Fig. 1. Schellenbach-Hunt Angle Measuring Device used on the Drawing Board

straight-edge sector to within one minute in easily read graduations. It may be used for accurate work on the drawing board or for laying out angles for templets on sheet metal and similar work.

The device when used on the drawing board is arranged as shown in Fig. 1. To the straight-edge at the left, which lines the device with the edge of the drawing board, is fastened a stationary gear of 144 teeth about whose center is pivoted the radial arm used for taking off or scribing the angles. The working edge of this arm passes through the center of the pivot. The plate to which this arm is fastened carries a pinion of 18 teeth meshing with a stationary gear and attached to the end of the spindle of a large revolving gear of 135 teeth shown at the right. This gear, in turn, meshes with a pinion of 18 teeth on the spindle which carries the pointer shown, which thus makes 60 revolutions for each full revolution of the arm. The stationary dial around which the pointer travels, is, accordingly, graduated into 360 degrees, each degree corresponding with a minute of movement of the arm. Arranged thus, the arm can be swung around through a half circle.

In the position shown in Fig. 2, the guiding straight-edge has been removed from the fixed gear, and the latter is held to the drawing board by thumb tacks passing through holes in the web of the gear provided for the purpose. In this position the blade is free to move around the whole circle. A sliding block for a scriber or pencil is shown attached to the blade. This can be locked in any desired position on the blade as a stop for the graduations produced. The indicating hand can be set to any desired position in relation to the

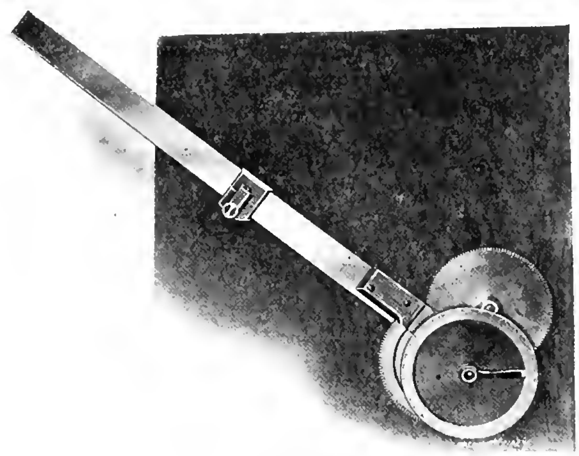


Fig. 2. The Instrument so arranged that the Straight-edge can be moved through 360 Degrees.

dial, and is clamped by means of the knurled thumb-screw shown. It may easily be seen that the device can be used for dividing circles into minutes or in even multiples of minutes. For odd spacing, a vernier is provided which reads to 5 seconds. With this, odd spacings can be effected. For an uneven number, such as 47, for instance, the fractional parts of the minute would be estimated on the dial. The blade of the instrument is 12 inches long. The screws are made of German silver, and the spindles and bearings are of steel, hardened and ground. The weight of the instrument complete, as shown in Fig. 1, is 20 ounces.

KEMPSMITH HORIZONTAL CIRCULAR MILLING AND INDEXING ATTACHMENT.

The Kempsmith Mfg. Co., Milwaukee, Wis., is building a circular milling attachment of the type shown in operation, Figs. 1 and 2. The operations for which it is adapted include circular milling of all kinds, indexing, cutting the teeth of gears, etc., and other operations in which successive portions of the periphery of a piece of work have to be presented to a milling cutter. It should be especially useful in connection with a vertical milling attachment.

The device consists of a circular table, either 11 or 18 inches in diameter as required by the customer, mounted on a base on which it has a solid bearing for almost its whole area. The table may be rotated on its base by means of a worm and worm-wheel, being set at the desired locations either by means of the graduations for degrees marked on its periphery, or by means of the index plate and crank shown in Fig. 2. The plate and crank are the same as used with the regular

spiral head furnished with the universal milling machine, which may be taken off and used with this attachment. Since the ratio of the worm and gearing is the same as that in the spiral head, the index tables are the same for each case. For continuous power rotation, feed connection is made with

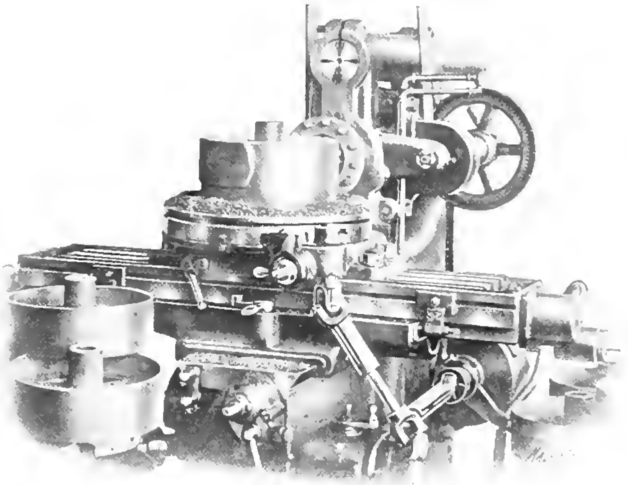


Fig. 1. Kempsmith Horizontal Circular Milling and Indexing Attachment being used for Pulley Crowning.

the feed box on the knee by the telescopic shaft and gearing shown in Fig. 1. A special bevel gear connection encased in a suitable containing bracket is provided for driving the telescopic shaft from the gear box. A clutch provided with an automatic throw-out is used for disconnecting this power feed when required.

The application of the device shown in Fig. 1 relates to the milling of a crowned pulley face. This is done, as shown, by using a round cutter head with inserted blades in its face to finish the face of the pulley, setting the latter with its center slightly off from the center line of the machine spindle. This produces the desired crowning effect which may be varied by altering the longitudinal adjustment of the table. In this case, of course, the power circular feed is employed. In Fig. 2 this power feed is disconnected, and the index plate and crank are being used for dividing a large spur gear. This is of a diameter much too great to be swung on the usual index centers of the machine. Of course, the centers could be mounted on blocks high enough to swing the work, but in that case the cut would be taken so far from the bearing sur-

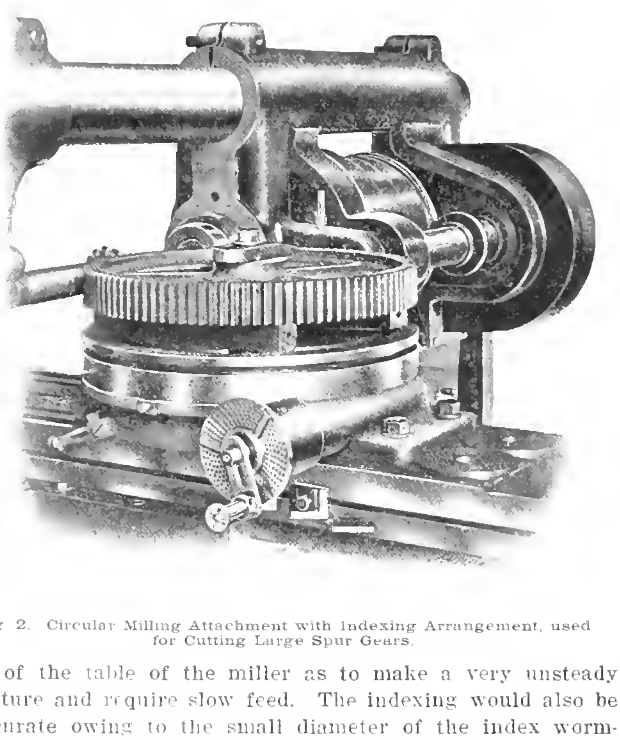


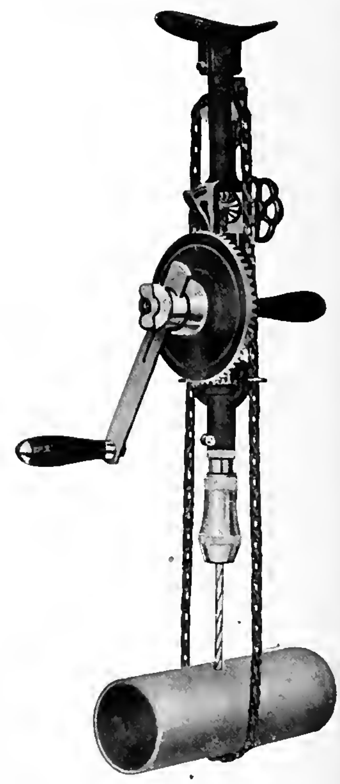
Fig 2. Circular Milling Attachment with Indexing Arrangement, used for Cutting Large Spur Gears.

face of the table of the miller as to make a very unsteady structure and require slow feed. The indexing would also be inaccurate owing to the small diameter of the index worm-wheel as compared with the diameter of the work. In the present case the index wheel nearly approaches the work in diameter. The automatic vertical feed of the machine is used in this case. It will be seen that the strain of cutting is taken vertically downward against the knee which is well able to resist the stress, so that a heavy cut may be taken without chatter or vibration. The gear in this case was 6 pitch, 18 inches in diameter.

The attachment, as stated, is built in two sizes, giving either a 14-inch or 18-inch table. The table can be clamped at any angle throughout the full circle by a patent clamping ring, such as used on the universal millers. The table, if desired, can be released from the worm-wheel for quick adjustment.

UNIVERSAL BREAST DRILL MADE BY THE LANCASTER MACHINE & KNIFE WORKS.

The Lancaster Machine & Knife Works, of Lancaster, N. Y., is placing on the market the breast drill shown herewith which combines a number of useful features. It will be noted that it has a chain feed attachment. This attachment, which is automatic in its operation, and is operated by the supporting handle, allows pipes, beams and similar articles to be drilled with the greatest ease, it not being necessary for the workman to force the tool in by main strength. The machine can be adjusted to any angle, making it useful in working between girders and ceiling joists, and in the interior of machinery where space is limited. Where there is not enough room for a full turn of the handle, the ratchet attachment provided may be used. The tool is provided with two speeds for drills of different sizes, and the radius of the handle is also adjustable. The gears are machine cut. The head and socket have ball bearings, and the handles are cocobolo. The chuck is fitted with four steel alligator jaws which will firmly hold both round and square shank drills. If desired, however, the drill will be fitted with a 3-jaw chuck.



Universal Breast Drill made by the Lancaster Machine and Knife Works.

ECLIPSE POWER HACK-SAW.

The accompanying half-tone engraving, Fig. 1, illustrates a new power hack-saw brought out by the Eclipse Machine Co., Elmira, New York, and known as the Eclipse power hack-saw. An inspection of the general design of the machine plainly indicates that it is a radical departure in its field. The design of the machine makes it possible to cut off stock with greater accuracy than is usually possible with a power hack-saw, it being possible to cut off stock within limits of variation of not more than 0.002 inch for a 4-inch bar; at the same time the machine permits unusually rapid operation. The particular value of the accuracy obtainable is evident, as it saves expense in truing up the faces of the stock, which is usually necessary when stock has been cut off by a hack-saw.

As will be noticed in the half-tone, Fig. 1, the machine is provided with a stop device for setting the stock at any length desired to be cut off. This stop is automatic in its action, and requires a minimum amount of attention. An ordinary 20-inch hack-saw blade is used in the machine, and the stock is turned so as to always present to the saw an easy cutting surface, whereby the saw is saved, and therefore lasts longer than is ordinarily the case. In the line engraving, Fig. 2, the construction of the patented chuck

used in this machine for holding the material is illustrated. It is constructed on a rather novel principle, and will hold any size of round steel from ⅜ inch up to 6 inches in diameter, and square stock up to 4 inches in size. It is quickly operated with a single screw actuating device.

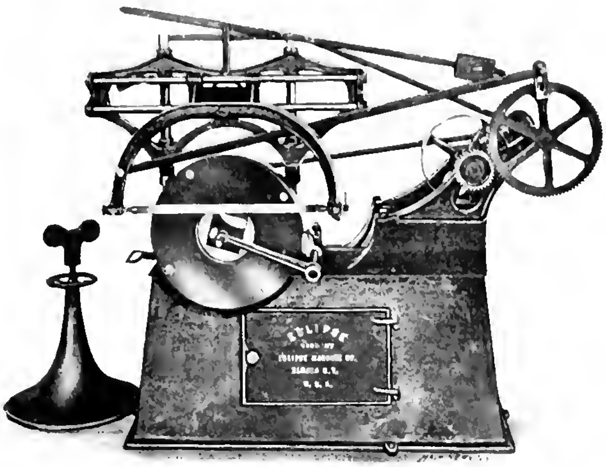


Fig. 1. The Eclipse Mechine Co.'s Power Hack-saw.

The power required to run this machine does not exceed one-half H.P. The weight of the machine is 650 pounds, and the floor space required is 4 x 2 feet. The selling agents are Manning, Maxwell & Moore, Inc., 85-87-89 Liberty St., New York.

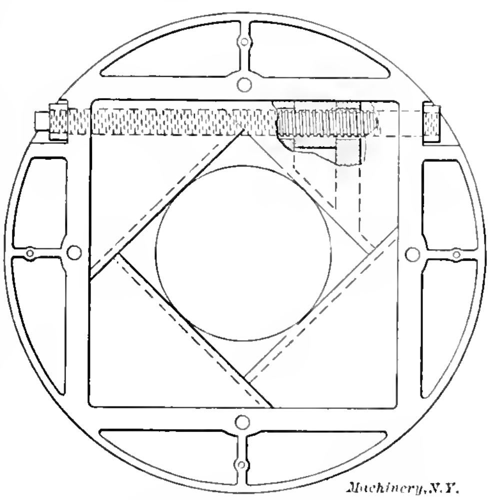


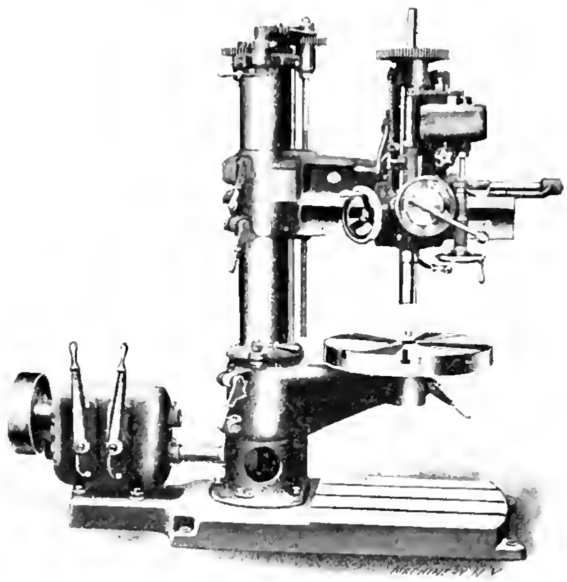
Fig. 2. Chuck of Simple and Ingenious Design used in the Eclipse Power Hack-saw.

AMERICAN TOOL WORKS 2-FOOT RADIAL DRILL.

The American Tool Works Co., 300-350 Culvert St., Cincinnati, Ohio, is building the 2-foot radial drill shown herewith. This neat looking tool is an evidence of the inherent adaptability of the radial drill press, which is evidently proving itself useful in sizes which nearly come into competition with the old standard form of upright drill press. Of course, it goes without saying that any tool of this kind placed on the market in these days is designed with special reference to the use of high-speed steel tools. This would be plainly seen in the weight and massiveness of the parts even if no special mention were made of the fact.

The base is strongly ribbed at the point where the column is attached to it. This latter part is of the double tubular form. The sleeve or outer column revolves on conical roller bearings, hardened and ground, and may be clamped in any position by the builders' patented clamping ring which may be moved by the column to suit the convenience of the operator. The clamping of this makes the outer column practically integral with the inner one, which latter extends almost to the top of the outer column, having full bearings both at top and bottom. The arm is of combined parabolic beam and tube sections, giving greatest resistance to both bending and torsional strains. This design leaves the lower line parallel with the base, and thus permits work being operated on in close proximity to the column without the necessity of an extreme reach of spindle. The arm is raised and lowered rapidly by a double thread coarse pitch screw controlled by a conveniently placed lever. Arrow points provided, located on the column cap, indicate the direction of the movements obtained.

The spindle has 16 changes of speed obtained from a 2-speed counter-shaft, a 4-speed gear box, and a back-geared head. These changes being instantly obtainable and in small increments, give the workman the fullest facilities for driving his tool, whether a drill, tap, or counterbore, at the proper speed. The gear box is very powerful, of the geared friction type. The four speeds provided are instantly available through the operation of the two levers shown. This form of box makes it possible to change the speed with absolutely no shock, even under the most severe conditions. The back-gears are located on the head so that all the connecting shafting and gearing between the driving belt and the head operate at high speed and low torque. These gears may also be engaged and disengaged without shock while the machine is in operation, by a lever convenient to the operator, the high-speed movement being engaged by a friction clutch.



American Tool Works 2-foot Radial Drill.

TWO-FOOT ARM BACK-GEARED HIGH-SPEED RADIAL DRILLING TEST IN CAST IRON TWO INCHES THICK.

Size-Drill.	Speeds.		Feeds		Back Gears				
	Revolutions.	Cutting Speed.	Per Revolution	Inches per min.	Ratio.	Position.	Actual H. P.	Amperes.	Volts.
¾" H.S.	290	56.9	.015"	4.35	1.5	Top	2.78	9	230
¾" H.S.	406	79.7	.020"	8.12	1.5	Top	6.18	20	230
1 3/32" H.S.	290	83.	.020"	5.8	1.5	Top	6.18	20	230
1 3/32" H.S.	406	116 2	.020"	8.12	1.5	Top	9 9	32	230
1 15/32" H.S.	290	111.4	.015"	4.35	1.5	Top	9 25	30	230
1 15/32" H.S.	290	111.4	.020"	5 8	1.5	Top	12.4	40	230
1 15/32" H.S.	207	79 5	.007"	1.4	1.5	Top	5.25	17	230
1 15/32" H.S.	207	79.5	.020"	4.14	1.5	Top	12 4	40	230

The head is adjusted on the arm by a hand-wheel through an angular rack and spiral pinion. It may be clamped to the arm in any position. The feeding mechanism in the head provides for four distinct rates in geometrical progression, carefully chosen, ranging from 0.007 to 0.020 inch. They are obtained by turning the knob shown just below the feed box until the feed desired, on the dial, comes opposite a fixed pointer. This obviates the necessity of referring to index plates in connection with the handling of levers. Positive-geared feeds of this type insure greatly increased productive

capacity, especially when using drills which can be pushed as hard as those made of modern high-speed steel. A friction member is provided in the drive, which allows the drill to be crowded to its limit without danger of breaking any of the mechanism. The feeds can be automatically tripped at any position of the spindle by an adjustable dog. Depth graduations are provided on the spindle, and all depths can be read from a datum point. The safety stop acts automatically at the full depth of the cut in preventing breakage of the feed mechanism. The tapping mechanism is carried on the head between the back-gears and the speed box, thus giving the friction clutches, though powerful in themselves, the added benefit of the back-gear ratio. This makes unusually heavy tapping operations possible, and also permits taps to be backed out at an accelerated speed. A lever for starting, stopping and reversing the spindle is controlled from the head at the front of the machine.

TWO-FOOT ARM BACK-GEARED HIGH-SPEED RADIAL DRILLING TEST IN STEEL THREE INCHES THICK.

Size Drill.	Speeds. Revolutions.	Speeds. Cutting Speed.	Feeds. Per Revolution.	Feeds. Inches per min.	Back Gears. Ratio.	Back Gears. Position.	Actual H. P.	Amperes.	Volts.
3/4" H.S.	406	79.7	.007"	2.84	1.5	Top	5.25	17	230
3/4" H.S.	406	79.7	.011"	4.46	1.5	Top	12.4	40	230
3/4" H.S.	290	56.9	.020"	5.8	1.5	Top	5.9	20	220
1 1/32" H.S.	290	78.3	.011"	3.2	1.5	Top	5.9	20	220
1 23/32" H.S.	106.5	47.9	.011"	1.17	5.72	Btm	8.3	28	220
1 27/32" H.S.	76	36.6	.011"	.84	5.72	Btm.	5.3	18	220
1 27/32" H.S.	76	36.6	.015"	1.14	5.72	Btm.	6.2	21	220
1 27/32" H.S.	76	36.6	.020"	1.52	5.72	Btm.	8.3	28	220

The accompanying tables give the results of tests made on one of these machines. The builders believe that these records are quite remarkable in the amount of power the machine will permit from the drive to the point of the tool.

TWO-FOOT ARM BACK-GEARED HIGH-SPEED RADIAL TAPPING TEST WITH PIPE TAPS IN CAST STEEL ONE AND ONE-EIGHTH INCH THICK.

Diameter Tap.	Speeds. Revolutions.	Speeds. Cutting Speed.	Feeds. Per Revolution.	Feeds. Inches per min.	Back Gears. Ratio.	Back Gears. Position.	Actual H. P.	Amperes.	Volts.
2 1/2"	38.5	28.9	1/8"	4.8	5.72	Btm.	9.14	31	220
3"	38.5	35.2	1/8"	4.8	5.72	Btm.	9.7	33	220
TEST IN CAST IRON ONE AND ONE-EIGHTH INCH THICK.									
2"	40	24.8	1/11.5"	3.4"	5.72	Btm.	4.24	14	226
2 1/2"	40	30.1	1/8"	5"	5.72	Btm.	5.15	17	226
3"	40	36.6	1/8"	5"	5.72	Btm.	5.75	19	226

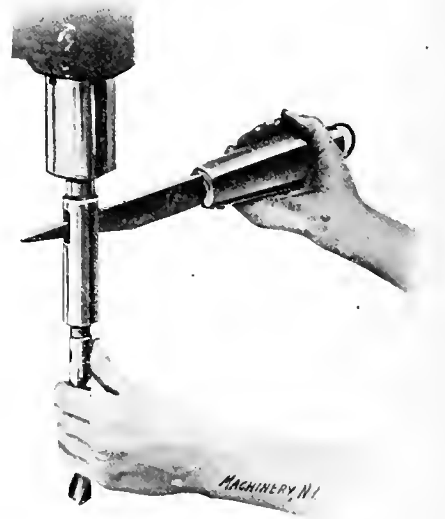
They call especial attention to the rate at which the 3-inch tap was operated in steet and cast iron, which was at the rate of 35.2 and 36.6 feet per minute, respectively.

Although the machine is shown arranged for single pulley drive through a speed box, it will also be provided with a cone pulley, if desired by the purchaser. The speed box arrangement is easily adapted to direct motor connection which may be made in a number of ways, though the builders recommend that the motor be mounted on the base beside the speed box and be connected to it by gearing.

AUTOMATIC DRILL DRIFT.

The drill drift illustrated in the accompanying half-tone is a practical appliance which undoubtedly will be appreciated in modernly equipped machine shops. It is known as the "automatic drill drift," and is manufactured and marketed by the Automatic Drill Drift Co., of Springfield, Ill. When in operation, the drift or blade is inserted in the slot in the drill socket and the drill is removed simply by sliding the heavy handle over the blade, until the base of the blade strikes against the bottom of its socket in the handle, this impact being sufficient to remove any drill. The tool consists of a hardened, polished steel blade, mounted in the heavy handle, as shown, in combination with a low tension coil spring placed behind the base of the blade in the handle. This spring serves to keep the blade permanently in its extended position, excepting when in operation.

The most pronounced advantage of the tool is that the drift and the driving mechanism are self-contained, requiring only one hand to operate the device, the other being free to hold the drill and prevent it from falling, as it invariably does when the operator is compelled to use one hand to hold the drift, while he drives it home with the other hand, by means of any object in sight. The size of the tool makes it practically universal for all ordinary purposes, as it will fit Morse sockets from No. 1 to No. 3 inclusive. A ring is provided at the end of the handle, by which it may be attached by a chain to the drill press, so as to always keep it in place, handy and ready for use. This tool, being so simple and inexpensive, should prove very useful in the machine shop, where it should cure the practice of driving drills out of their sockets by unsuitable appliances.



A Tool which combines Drill Drift and Hammer.

ARMSTRONG-BLUM MFG. CO., 113 N. Francisco Ave., Chicago, Ill. Hack-saw designed so that a drawing cut is produced, thereby doing away with the common tendency of buckling the saw blades. The blade is automatically raised on the return stroke by the action of a spring, which latter is so placed as to give the required pressure on the cutting stroke.

FERRACUTE MACHINE CO., Bridgeton, N. J. Foot press provided with a gang of one hundred 5/8-inch punches and dies for cutting paper blanks. The punches are hollow, each punch containing an ejector pushing the blanks through the lower die into brass tubes provided for their reception. The stroke of the press is 4 inches, and the total weight of press and dies, 2,750 pounds.

TECHNICAL SUPPLY CO., New York City. Duplex blue-printing machine for the continuous printing of blue-print, VanDyke, or other papers. Two Cooper-Hewitt lamps are used and two strips may be printed at once, at speeds varying from a very slow rate for black process papers, up to 4 or 5 feet per minute for fast printing papers. The rate of printing for the two sides of the machine is independent.

BUFFALO SPECIALTY CO., Buffalo, N. Y. Tandem hack-saw of original design, providing for two complete hack-saws in one frame, the object being to use the minimum amount of power, one saw cutting while the other saw is reversing. The saws are held out of contact with the work on the return stroke. Each saw has a capacity for cutting 5x5-inch stock with a stroke of 6 inches. The saws run at from 85 to 110 strokes per minute.

BUFFALO FOUNDRY & MACHINE CO., Buffalo, N. Y. Steam hammer, differing from the usual construction in that the anvil block is cast solid with the main frame, enabling the hammer to be used for small drop forging as well as for ordinary steam hammer forging work. The hammers are rated by the

actual scale weight of the falling parts, without counting the force of the blow from the pressure, and run from 100 to 300 pounds. The hammers can be run either by steam or compressed air without change.

Westinghouse Electric & Manufacturing Co., E. Pittsburg, Pa., after consulting prominent steel engineers, has placed on the market a motor especially designed for rolling mill service. It is thoroughly protected against dust, is provided with ample wearing surfaces, with plenty of clearance between the running and stationary parts, so that the machine will run indefinitely before they come in contact. The insulation used throughout is strictly incombustible, and will stand very high operating temperatures without deterioration.

Strong, Carlisle & Hammond Co., Cleveland, Ohio—Oil tempering furnace constructed so that the path of the flames strike the baffle wall under the oil tank, and are then deflected to the outer walls of the combustion chamber and to the sides of the oil tank. The furnace is equipped with a thermometer registering up to 760 degrees F., and with a chain hoist for raising and lowering the material which is contained in a heavy iron basket. The gas consumption per hour is 70 cubic feet; the floor space occupied is 36 x 37 inches; the capacity of the basket is 200 pounds.

Corbin Church Co., Plainville, Conn., is building a manufacturer's drill of single or multiple spindle type for drills up to ¾ inch diameter. The feed is 4½ inches. Each spindle has an automatic feed control which disconnects the feed when the drill has reached the proper depth, and returns the spindle, again re-engaging it when the operator is ready with a new piece of work, thus saving time in duplicate manufacturing. Combined with this feature is a device for automatically disengaging the feed when the drill point strikes a hard spot or other obstruction to its normal progress.

C. J. Toerring Co., 2121 Toronto Street, Philadelphia, Pa.—Machine for drying blue-prints. The machine consists of a series of small rollers revolved by friction contact with a larger heat roller revolving around a heat coil. The prints pass through a washing tank on the end of which the machine is mounted, and are fed into the dryer directly from the tank. This machine enables from 1,000 to 1,500 blue-prints of ordinary size to be handled in a day. It is run by a 1/20 H. P. motor; it runs at a speed of approximately 8 feet per minute, and requires 1½ K. W. per hour for heating.

G. W. Fleming Co., Bradford, Pa. A sensitive drill press of which the most original feature is a provision by which the spindle speed is changed by the lever for feeding the drill. Swinging this lever downward around the horizontal axis feeds the drill, as with the usual construction. Swinging the lever sideways shifts the friction roll in or out across the face of the driven disk on the spindle, changing the spindle speed. The speed can thus be altered while drilling is in progress, if it is found that a change is necessary, without removing the hands from the feed lever or the work.

Edwin Harrington, Son & Co., Inc., Philadelphia, Pa. Four-spindle locomotive frame drill built specially for the American Locomotive Works. Each of the heads is independently driven by a 6-horse-power variable speed motor. The minimum center distance between the drills is 28 inches, and the maximum center distance between the two outside drill heads is 34 feet 8 inches. The spindles can be brought within 16 inches of the top of the table, the maximum distance being 36 inches. The speed range is from 50 to 120 revolutions with, and from 100 to 300 without, the back gears. The feeds vary from 0.005 to 0.015 inch per revolution. The machine has a capacity of drilling four 2¼-inch holes simultaneously in steel, and weighs 46,600 pounds.

* * *

Our present educational system requires that a boy or girl leave school to learn to make a living.—*Common Sense.*

AN AMERICAN MECHANIC IN EUROPE—4.

THE FOURTH OF A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

Paris, France, June 17, 1908.

During the time which has elapsed since my last letter from Turin, Italy, the writer has visited the western part of Germany, following the Rhine Valley from Mülhausen, Elsass, to Düsseldorf, and has had an opportunity to meet most of the prominent machine tool builders and a large number of dealers in the cities along this route. It is difficult to give an exact statement of the present conditions of business. Dealers who have a large territory, and who sell a great variety of machinery and tools, and who, therefore, ought to be the ones best informed, say that the machine tool trade is dull throughout the country and that no improvement worth mentioning has taken place. Many dealers carrying on a smaller business, however, are reporting a fair amount of trade, and also that some improvement is noticeable. The machine tool shops are working with full, or nearly full, force and on full time, in this part of Germany. Some machinery, especially of the common types and sizes, is made for stock, but not to any large extent. Messrs. de Fries & Co., Düsseldorf, who are prominent both as dealers and manufacturers of machine tools, said that business is not good, but that there is no real cause for complaint. In their shops, where they usually employ about 800 men, the force was reduced about ten per cent, but the men remaining worked full time.

The railroad equipment shops here have, at the present time, large orders on hand from the various German state railways. This, of course, influences the machine industry throughout the country. In general, it can be said that Germany is carrying the industrial depression with less effect than America. The different business methods in vogue, the longer time of delivery for machines ordered, etc., are, of course, important factors; but one factor which greatly influences trade conditions is the German policy of government ownership of railroads. The state railways do not take into consideration a temporary industrial depression in ordering the material needed. Private roads, on the other hand, when a country is afflicted with a trade depression, refuse to buy and to equip themselves for future demands, and wait until times become better. This, of course, makes a trade depression still more pronounced, at the same time as it makes the crowded business in good times still more crowded. The machine tool industry, which depends to so great an extent directly or indirectly on the demands of the railroads, is thus benefited by the public ownership of the German railroads.

Wages in Germany.

In the letter in the June issue, the writer gave some figures relating to the wages paid in the machine tool industry in Italy and Switzerland. In Germany the wages paid depend upon the location of the shop, differing with the cost of living, the highest wages being paid in Berlin and its vicinity. In the northern part of Germany wages are generally higher than farther south. The Locomotivefabrik Krauss & Co., Munich, gave the following figures representing the average earnings of the men employed in their shops: Boiler makers, M. 5.50 ($1.32); blacksmiths, M. 5.70 ($1.37); machinists, M. 5.00 ($1.20); and unskilled laborers, M. 3.80 ($0.91), all based on a ten-hour day. Generally speaking, the wages in Saxony and along the Rhine are about 10 to 15 per cent higher than those quoted, and in Berlin from 20 to 40 per cent higher.

In a letter from the firm of R. Wolf, Magdeburg-Buckau, received recently in reply to an inquiry on this subject, the following information as to wages was given: Skilled machinists, 60 pfennigs (14.4 cents) per hour; pattern makers, 58 pfennigs (13.9 cents); unskilled laborers, 35 to 42 pfennigs (8.4 to 10.1 cents). Shop foremen receive on an average M. 200 ($48.00) per month, and draftsmen who have no technical school training, M. 150 ($36.00) per month. The workingmen in the shop are kept until the age of about sixty to sixty-five years, and old-age pensions are paid, amounting to from one-third to one-half of the wages of the last year in service, according to the length of time the employe has been in the firm's employ. This firm has a regularly installed apprentice-

ship system, the time of serving the apprenticeship being four years. The apprentices get, during these years small pay, increasing from year to year. There is no special trade school in this factory, but the apprentices are bound by contract to attend the artisans' and manual training schools of the city. Besides, the apprentices, like all boys without high-school education, attend the public evening schools up to the age of 17.

As remarked in a previous letter, the European wages are, when directly compared with those paid in America, very low; but it is not proper to make a direct comparison, because there are some other factors which count, besides the one of 4.17, the ratio between the American dollar and the German mark. These other factors must be taken into consideration in order to get a fair comparison. Living expenses here are somewhat cheaper, the work is more steady, and the workman who is carrying out his duties faithfully, does not live in such a fear of being laid off or thrown out of work as soon as business becomes ever so little "slack," which is so common in America; neither does he fear being laid off because of old age as early as is the case in America. The most important of all the factors to be considered, however, is the old-age pension paid by most—probably all—the State governments in Germany, and in some instances by the manufacturing concerns themselves. Two-thirds of the premium for the state pension is paid by the employer, and one-third by the employe himself. Having his old age thus reasonably well cared for, the working man can afford to expend a larger percentage of his earnings on his current living expenses.

Some Things Seen in the Shops.

When visiting the shops of Messrs. de Fries & Co., Düsseldorf, the writer took special interest in their screw-cutting practice. According to the works manager, screws of all descriptions—with few exceptions—are milled. For executing the common screw-cutting work by milling, ordinary screw-cutting lathes are rigged up with a milling attachment, which takes the place of the tool-post. The milling attachment is driven by belt or rope from an overhead drum. It is provided with a graduated scale by means of which the depth of the thread can easily be read off and adjusted. The rotative speed of the cone pulley is, of course, very much slower than that used for cutting the screws in the ordinary way. It is claimed that the greatest advantage of this practice of milling screws, over that of cutting them in the regular way is that unskilled labor can be employed, and that time is saved by this method because of the fact that one man is able to run more than one machine, the machine practically taking care of itself as soon as it is well started and the milling cutter is fed to the proper depth of thread.

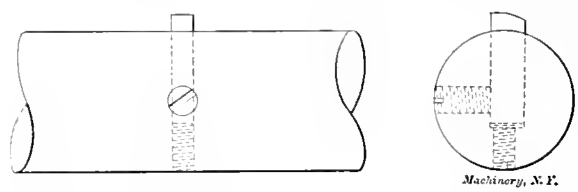
Because the lead of a screw being cut always depends upon the lead of a thread that has been previously cut, any incorrectness in the master thread (as in a lathe, in the thread of the lead-screw) will be reproduced in the screw. For ordinary purposes, the errors in the lead of lead-screws of lathes of good manufacture is insignificant, but occasions arise when these errors must be taken into consideration. In order to avoid the duplication of errors of this character, Messrs. de Fries & Co. have designed a new screw-cutting lathe, working on the principle of producing a thread independently of a previously cut lead-screw. The lathe employed for this purpose is of common design, the feature of extraordinary interest being the arrangement for feeding the carriage; a flexible steel band is used for this purpose instead of the lead-screw. This band is located centrally between the two ways of the bed, and one end of the band is fastened to the front end of the carriage, while the other end extends under the head-stock and is fastened to a drum, turned accurately to a definite diameter. When this drum is revolving, the steel band is wound up on it, and thus feeds the carriage. The drum, of course, must be large enough so that the steel band when winding up does not reach fully one complete turn around the drum, because if it reached more than one turn around, the band in winding up on itself, would be wound up on a larger diameter than that of the drum, thus causing incorrect results. The drum is driven from the cone pulley by means of a worm and worm-wheel.

For the return, another steel band is fastened to the rear end of the carriage, this band extending to the rear end of the lathe, and running over an idle pulley. A counterweight is suspended from this band heavy enough to pull the carriage back, when released from the pull at its front end. This lathe is not used for cutting the whole screw from start to finish, but simply for finishing the thread. The arrangement is by its construction too weak to stand up for the heavy cuts necessary for rough threading. The thread is therefore cut in an ordinary screw-cutting lathe, somewhat over size, and then placed in this special lathe mentioned, and there finished. The inventor of the device, the works manager of the company, claimed that by this machine it was possible to cut the most correct thread as yet produced for commercial purposes.

Threading Large Holes in Cast Iron Press Stands.

While visiting the shops of the firm of L. Schuler, Goeppingen, Germany, the writer took some interest in the method employed for threading large holes in the stands for the presses made by this company for sheet metal work. These presses are friction- and screw-driven, and a hole located at the top of the stand has to be threaded to take the screw which is to execute the whole actual pressing action, this screw varying for different sizes of presses from about 3 to 5 inches in diameter. As no inserted bushing is used, the thread is cut into the stand itself.

For the carrying out of this operation the stand of the press is put up in a heavy lathe, so that the center of the hole comes in line with the lathe centers. A heavy boring-bar is then used, one end of which is clamped in a chuck, mounted on the lathe spindle, and the other end extending on the other side of the hole to be threaded, supported only by a heavy steady-rest. The thread to be cut is of square cross section, and the cutting tool used is shown in the accompanying engraving. A square thread cutting tool is inserted in the boring-bar, being clamped on one side by a small headless set-screw, and fed into the work from the other side by a screw



Section of Boring-bar with Inserted Square Threading Tool.

at the rear end of the tool. In order to save the edge of the tool, it is taken out each time after passing through the work, before the work is returned to the original position; then the tool is inserted again at the front end of the hole, the tool being, at the same time, fed forward by means of the screw at the rear end of the tool, and a new cut started. A complete set of different sized boring-bars and tools for different diameters is, of course, necessary to meet the different requirements of the different sizes of holes to be threaded.

Machining Change Gears.

"Racquet's" article of the above title, in the April issue of MACHINERY, reminded me of a way of finishing change gears which I saw used in another German machine tool building shop. The first operation was to bore the hole in the blank. This was done in a vertical boring mill, and in this machine, also, both ends of the boss were finished by an ordinary facing tool. When the blank was finished so far, it was put on an arbor in a vertical milling machine, and the three surfaces on the rim, that is, the two sides and the outside cylindrical surface were here milled to the finished size in one cut by a gang milling cutter, consisting of one cylindrical cutter for the cylindrical surface of the blank, and two side milling cutters for milling the sides of the blank.

In another German shop the outside cylindrical surface of a gear blank was not finished at all by turning, only the sides of the rim being finished. In order to finish the cylindrical surface, the cutters for milling the teeth were so made that the teeth were finished on the top at the same time that the flanks and bottoms of the teeth were milled and finished. It seems as if this method would represent some saving in the cost of manufacturing the change gears, al-

though it might, to some extent, be done at the cost of the accuracy of the product obtained. The increased cost of milling cutters must also not be lost sight of.

Pickling Castings.

Great attention is paid to the proper pickling of castings. It is fully realized that the pickling process is not merely of advantage as a cleaning process, but that the greatest advantage of it is to be found in the softening effect upon the scale or skin of the castings, the tool not becoming dull as soon as if the casting had not been subjected to a proper pickling process. The most common solution used in Germany appears to be one of 20 per cent sulphuric acid, diluted in water. The solution is applied to the castings, not merely by putting the castings in the solution, but by forcing the solution against the castings through a large jet.

Cutting Metals by Oxygen.

In my letter in the May issue of MACHINERY reference was made to some work done by the oxy-hydrogen, or, more correctly, perhaps, the oxygen blow-pipe method of cutting iron at the Borsig Works, at Tegel, near Berlin. Some more detailed information about the use of this method may be of interest. As is well known, the principle involved in this method of cutting iron is the use made of the oxidizing effect on the metal, or, in other words, the iron is burned away. In order, however, to cause rapid combustion of the iron when the oxygen is applied to it, it must be heated to a temperature of 1,300 to 1,500 degrees F. before applying the oxygen. This pre-heating of the iron is accomplished by a burning jet of hydrogen and oxygen. The apparatus for cutting the iron consists of two nozzles, arranged to follow each other, the first nozzle pre-heating the iron, and followed by the second nozzle for the application of the oxygen, this causing combustion of the iron, and executing the cutting. The two nozzles are arranged so that the oxygen will always strike exactly the same spot which has been pre-heated by the preceding flame. It is important that the cutting nozzles be moved at a certain correct speed. If the cutting nozzles are moved too slowly, the continuous cutting will be interrupted, because the iron will get time to cool off before being struck by the stream of oxygen from the second jet. If, again, the nozzles are moved too quickly, the oxidizing effect will not be complete, and the cutting will not reach through the piece to be cut. With some practice, however, it is not difficult to learn by experience the correct speed for any particular work. When properly done, a cut made by this method is very smooth and equals a sheared cut.

It might be assumed that the material would be severely attacked on the surface by the influence of the oxygen, but this, however, is claimed not to be the case. With the exception of a layer of 0.01 inch, at the most, next to the cutting edge, the material keeps its original chemical composition, and the physical qualities remain the same. It is claimed that pieces of iron up to a thickness of twelve inches may be cut by this process. Of course, the exactness of the cut changes with the different thicknesses. At a thickness up to 2 inches, the process may be carried out within limits of 3/64 inch, while at thicknesses of from 2 to 4 inches, the limit attainable is 3/32 inch, and above 4 inches it is still less. The width of the cut, of course, also increases with the thickness of the material.

The blow-pipes are connected with flexible piping to the tanks filled with the respective gases. As the pressure in the tanks is high, being about 150 atmospheres when filled, the gas passes through a pressure reducing valve before being used. The pressure of the oxygen, when used for cutting, varies, depending upon the thickness of the material, from about 1½ to 5 atmospheres.

As a matter of curiosity, some work done by the assistance of the hydro-oxygen jet may be mentioned: when visiting the Deutsche Oxhydric Co., the writer saw a large bunch of grapes with leaves and branch of the vine, which, by the aid of the hydro-oxygen flame had been made from ordinary thin sheet iron. The imitation was good and, although the piece was of iron, it was very light. There was also a branch of a pear tree, with a large, nice-looking pear, and two leaves, and also a lily of the valley made in the same way. As a souvenir, the writer received a cup made, during his visit, from welded pipe, by the aid of the same process. The pipe was chucked in a lathe and then heated by the gas jet, and at the same time pressed to shape by hand by a plane tool.

The Geared Head vs. the Cone Pulley Drive.

The following interview with Mr. Louis Montigny of the Werkstätte für Maschinenbau, Mülhausen, is interesting because of illustrating European views on this important subject. Mr. Louis Montigny is an expert on the design of machine tools, and has been employed as such in several shops both in England and Germany, and his views are therefore not only important as giving his personal opinions, but also because they, in a measure, embody the general opinions in this regard abroad.

"During the last few years," says Mr. Montigny, "it has been quite the fashion here in Europe to equip lathes with geared head drives, but it doesn't seem to be the fashion quite as much now as it has been, and we are now again building a great many lathes with cone pulley drives."

When asked whether he considered the geared head drive preferable for modern lathes, Mr. Montigny replied: "That depends on several conditions. The advantage of the geared head, as compared with the cone pulley drive, is, of course, the easier control of the speed changing device. By means of the levers provided it is much easier to change the speed, according to the size and the material of the work to be done than is possible to do with belts on cone pulleys. If an experienced man is running the lathe, the geared head is preferable, but if an inexperienced and unskilled man is working at the machine, it is likely to cause trouble, because of breaking the teeth in the gears or by otherwise getting out of order. A mistake with a change lever may cause considerable damage, and the machine has to be laid up for repairs for at least a few hours. This, however, won't happen as easily with machines driven from cone pulleys, because there are not as many parts to break, and besides the belt will slip easier and act as a safety device. The greatest advantage of the geared head is to be found when the lathe is used for heavy duty work, as for instance, when taking a heavy roughing cut. With the geared head the belt speed is usually higher, and therefore more power can be transmitted without the liability of the belt slipping. This also means more power at the cutting point, and consequently a heavier cut. For very smooth finish turning, however, it is my opinion that as good results are not obtainable by the geared head lathe as with one having a cone pulley drive, because, for this kind of work, it is of advantage to have the belt drive the work directly. Transmitting the power through a long train of gears, as is the case in the geared head drive, always means, with the ordinary accuracy obtainable in commercial gear-cutting, some little jars and jerks, caused by the play of the teeth between the gears, and the consequence of this jarring will be noticeable on the turned surface."

Trade Conditions in Belgium.

The machine tool industry, as well as the machine industry in general, seems to be in a less prosperous state in Belgium than in Germany. Some of the machine tool works are running with the force reduced 30 to 40 per cent. Times are, however, reported to be improving, and manufacturers are optimistic in their views of the future. Belgium, being a small country, and consequently having a more limited home market, has not got any large machine tool works, the largest shops for manufacturing machine tools being equipped for about 150 to 175 men. It is interesting, however, to notice to what an extent some of these concerns are specializing their manufacture. There are two concerns making lathes as a specialty, the Ateliers Demoor, Brussels, and Le Progres Industriel, Société Anonym, Loth, near Brussels, both employing about 150 to 175 men. These shops are equipped throughout in a modern manner for manufacturing lathes. The machines are usually built in lots of ten to twenty. The detailed parts, after each operation, are brought into the inspection department and inspected so as to prevent any further working on a piece that has been spoiled.

The system of paying is according to the straight piece-work system, but the manager of the Ateliers Demoor seemed

to think a great deal of the bonus or premium system, and he is, at this time, working on the future application of this in the works. In fact, he already had this system applied in the erecting department, and stated that it had worked out so favorably as to save 30 per cent of the labor cost.

Another interesting shop in Brussels is that of the firm of Despaigne, a concern employing about eighty men. The specialties manufactured are bolt, nut, and thread rolling machines, and kindred kinds of machinery. The strong feature of this concern is some of their original designs, and of specially great interest is an automatic thread rolling machine in which a remarkably high speed is used.

Extended Use of Limit Gages.

It has been said about the German machine manufacturers that they have not as yet learned the extensive use of fine measuring instruments of which America boasts, especially of the micrometer. This is true, to a certain extent, but instead of going into the question itself regarding this, the writer wants to point out some interesting practice noticed in some shops on the European continent, and, in particular, in the two concerns in Belgium just referred to, who specialize in the manufacture of lathes. Generally speaking, the concerns in Europe have not as yet learned the full importance of specializing, but where this principle has been applied, the methods of manufacture are also modernized.

The two firms mentioned do not employ micrometers in their manufacturing to any large extent. For roughing work they use an ordinary pair of calipers. For the finishing work they use limit gages, not only for inspecting, but directly in the shop work. This, of course, is possible only when there is a specialization on a certain class of machines which are built in large numbers. The limit gages are of the double-ended type, where one end will pass over, while the other end must not pass over the work. For internal diameters limit gages of the double-ended plug gage type are used. These limit gages are all made in duplicates, and one is used in the shop and one in the inspection department, so that the machinist and the inspector are always working with exactly the same kind of an instrument. Any opportunity for disputes, differences, or misunderstandings, is thus entirely precluded. For all work made in large quantities, all the measuring instruments are kept in sets, and are used for this particular work only, so that mistakes because of using wrong gages are eliminated. It is claimed by these firms that the constant use of limit gages in the shop is superior to that of using micrometers. It is also cheaper, because the cost of the gages, is, in the long run, not as high as the time lost by setting and adjusting micrometers. There is also a great advantage in the fact that the machinist always knows the limits of accuracy required on the piece of work he is finishing, and no time is wasted on finishing the work to closer size than necessary.

Machine Tool Business in France.

The conditions in the machine tool trade in France are improving, and dealers and manufacturers alike are optimistic about the future. This is partly due to the improvement in the automobile trade. The automobile factories in the vicinity of Paris, which the writer has visited, have a fairly large amount of work on hand, and the machine tool factories are also busy. The machine tool industry in France has not as yet, as far as the quantity is concerned, reached the same height as in Germany. Comparatively few machine tools are made here, and France is, to a large extent, depending upon American, English, and German imports for supplying the demand. Regarding the quality of the machine tools made in France, however, judging from the products of a few concerns, this can be put on a level with the German makers' products. One of the most important machine tool factories in the country is the firm of H. Ernault, Paris, employing about three hundred men. This factory is equipped with high-class machine tools, among which is a large number of the best American makes, especially in the gear-cutting department; the firm specializes in lathes, milling machines, and gear-cutting machines.

The Société Francaise de Machines-Outils, about which considerable has been written, occupies at present only a small plant employing about one hundred men. The building of the main works has progressed so far that some machines are being put in, and a few are already running there. The buildings are fully up to date in construction, and are to be equipped with several electric traveling cranes with a railroad track running through the building. Among the machines in operation were several American, English, French and German, all of high class. Mr. Nardin, the manager, is a very capable engineer, and said they intended to employ about seven hundred men when everything was running. All the castings are made outside, as they do not have any foundry of their own, and all the power running the machines and for lighting is brought from a large electric central station. At present the company is making lathes of a few types only, a gear head and cone head, and a turret lathe which they claim is an improvement over the Potter & Johnston machine; an automatic dowel pin machine, and a spur gear planer of Mr. Nardin's own design; but they intend also to take up the making of planers and vertical boring and turning mills.

American Manufacturers must Keep in Close Touch with the Foreign Trade.

In Germany the criticism in connection with American machine tools was more or less limited to the criticism of a few points of the design and the workmanship, although something was said, especially in Berlin, in criticism of the way in which the American machinery in general is introduced abroad. This point of criticism is put forth with much more force and emphasis in Paris. Because of the competition between American machines on the one hand, and German machines on the other, the French dealers and users have a splendid chance to compare the different methods employed. The dealers in Paris seem to think that the American manufacturers neglect the duties they owe to their European trade. Not only are conditions in Europe different from those in America, but those in one European country different from those in another, and it is of great importance that American manufacturers should study the local conditions, and conduct their business in each country according to these, and not according to the conditions in America. It is emphasized that American manufacturers who really want trade in Europe should either go over themselves or send some one, preferably one familiar with the language, to study conditions, and while there, to devote himself to business, and not to sightseeing and pleasure. One dealer pointed out the great success of two American concerns in introducing their products in France. One of these concerns represents the very highest class of machinery, while the other has not as yet attained for itself so high a reputation, but both concerns have from time to time studied the conditions, and conducted the business with due regard to local requirements. The success of the smaller firm mentioned proves that it is not only the very highest grades and classes of machinery that can be sold here, but also the medium grade, if sold at a corresponding price, provided it is properly introduced. As an instance of an American manufacturer neglecting his foreign trade, it may be mentioned that one dealer stated that about half a year ago he had signed a contract of agency for an American concern, but he has not as yet received any price list of the machines he is to sell.

A comparison has been made between the American and German ways of introducing their machinery in France, and the Germans are said to employ superior methods. Of course, they are nearer the territory, and are in possession of more first-hand local knowledge, and can therefore attend to their business better. France gives, however, the impression of being a better territory for American machinery than does Germany. The competition with the home manufacturers would not be keen here. It would, therefore, be deplorable if American manufacturers lost this opportunity as a consequence of neglecting to obtain sufficient local knowledge about the requirements to carry on business with the highest possible efficiency. If American manufacturers do not take advantage of the opportunity presented, there is no doubt that the German manufacturers will use this to their advantage, and gain thereby.

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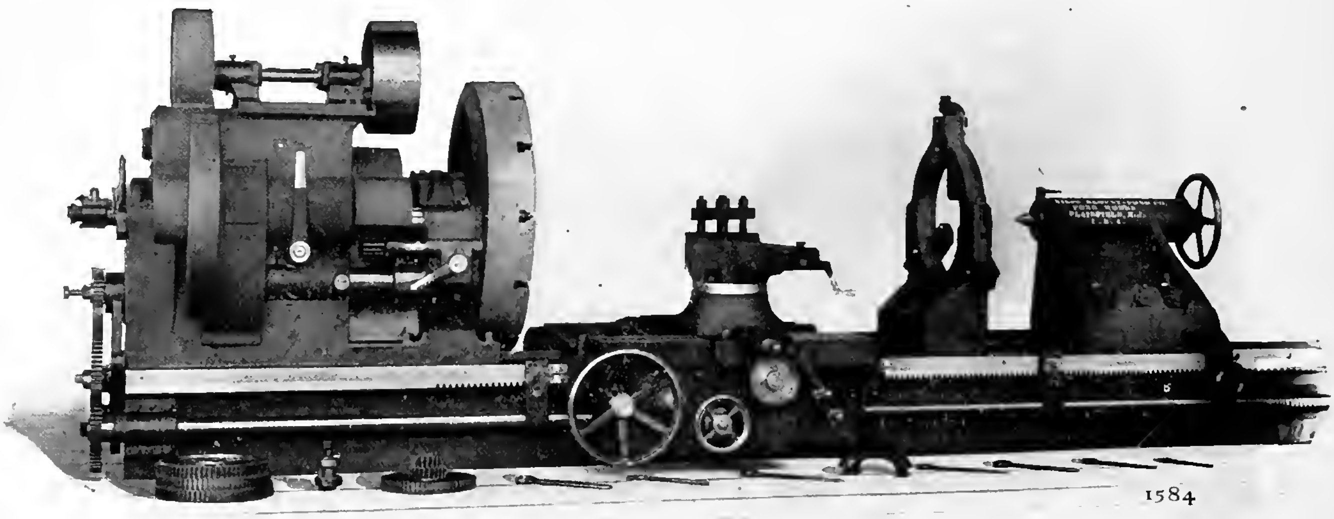

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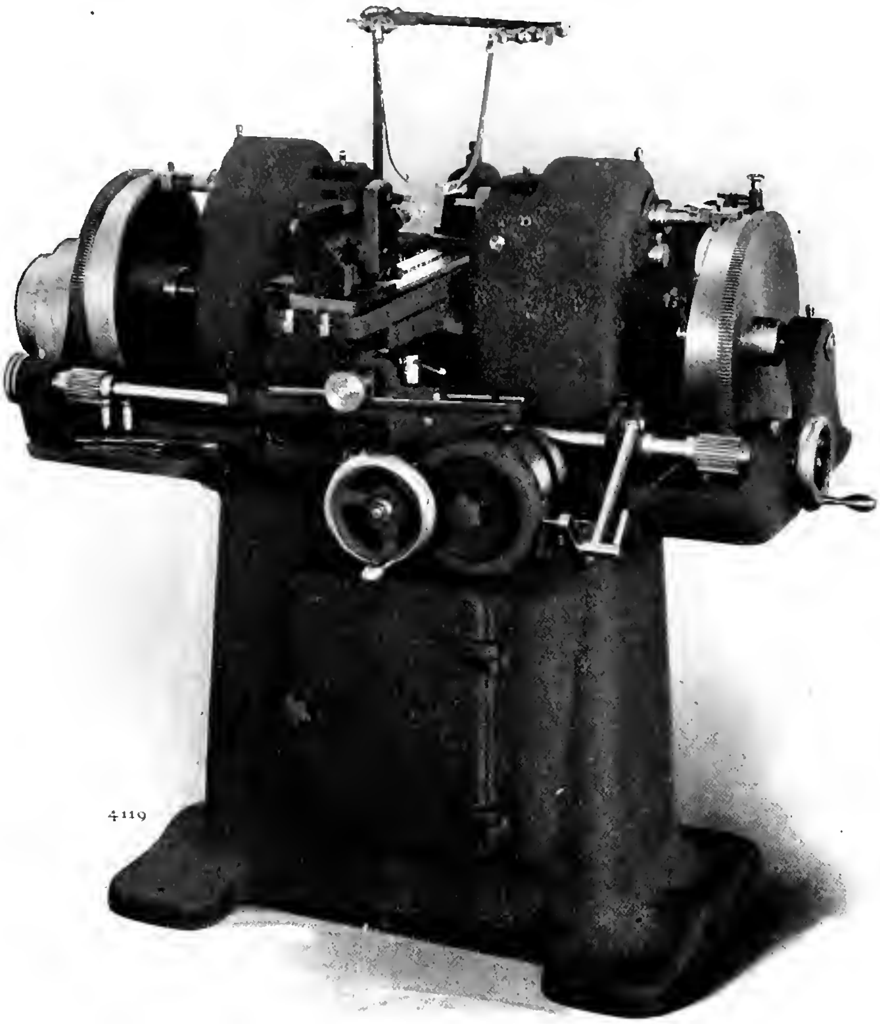

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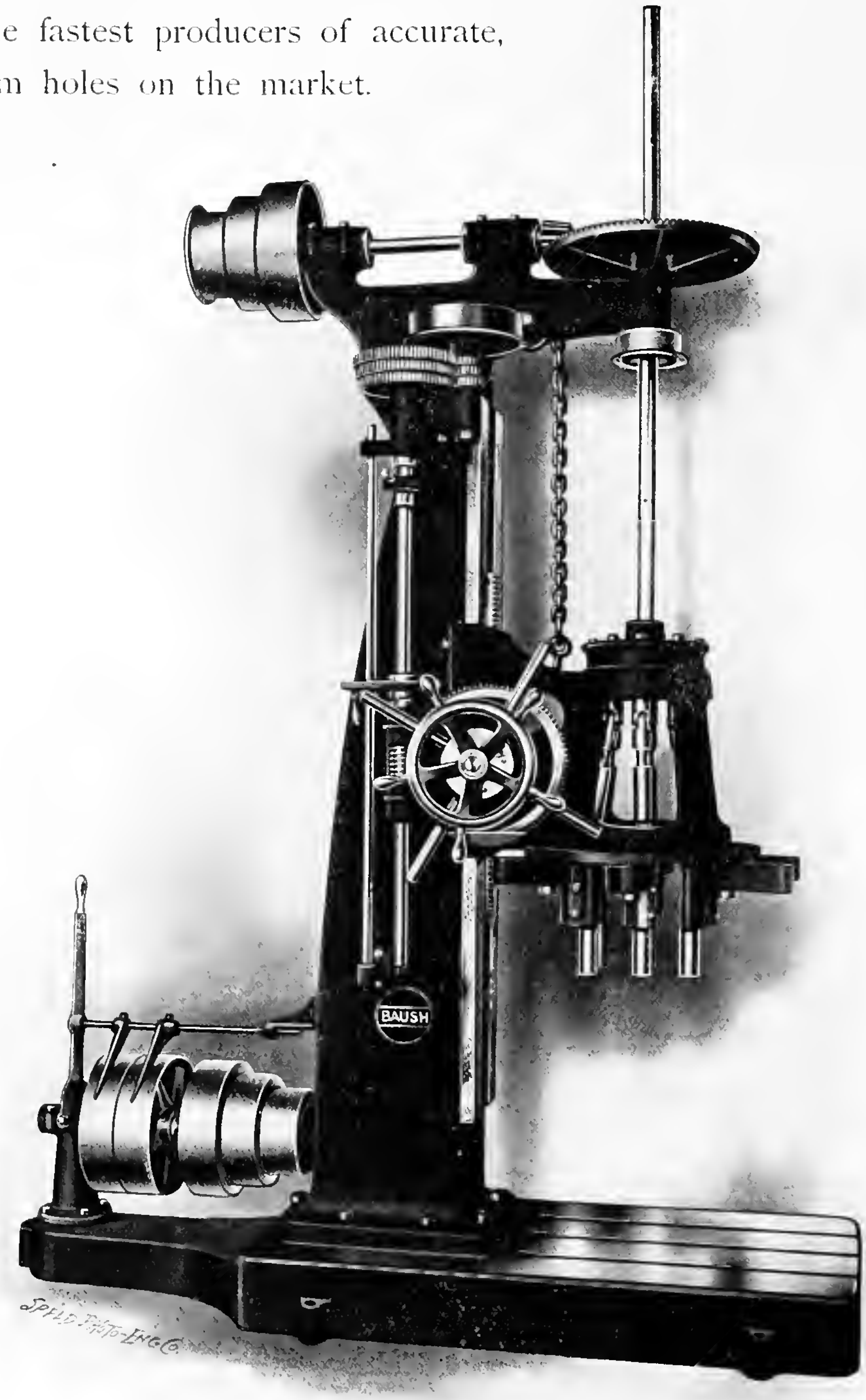

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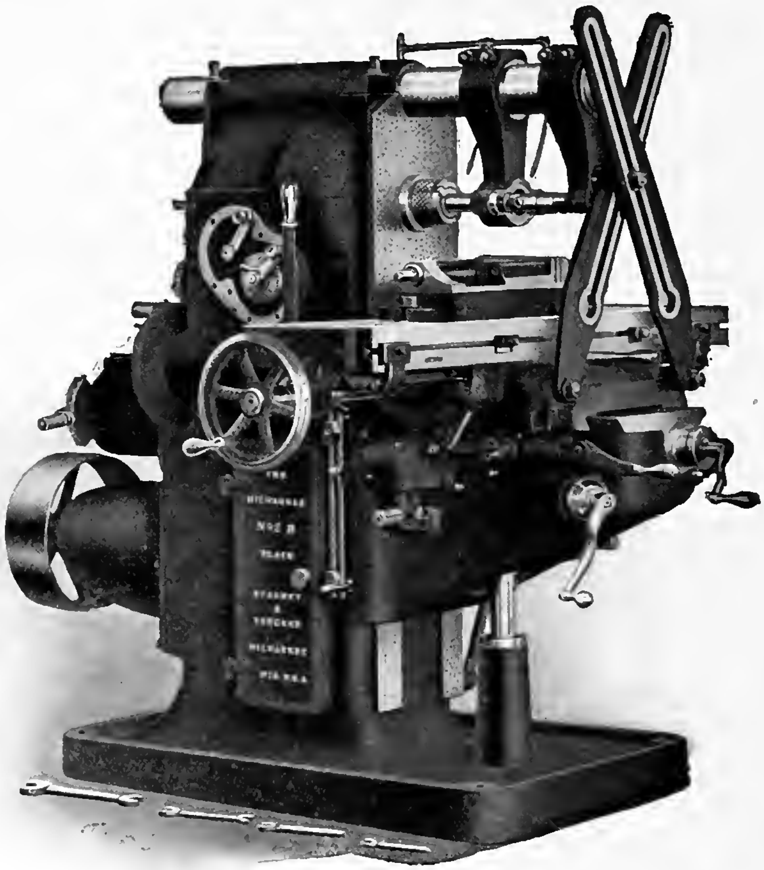

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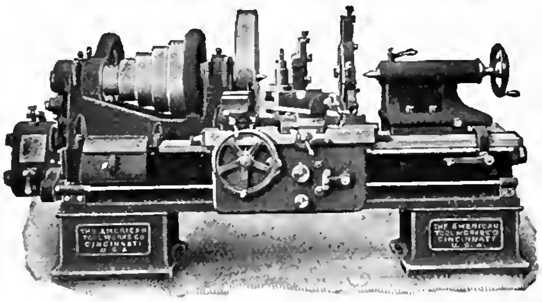

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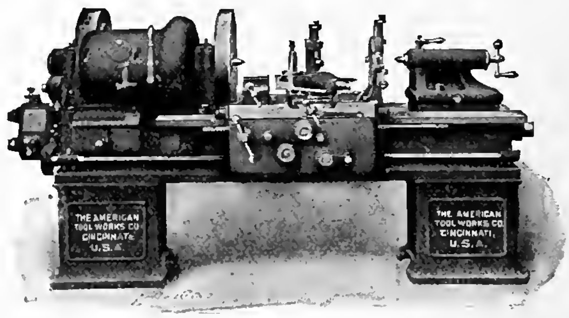
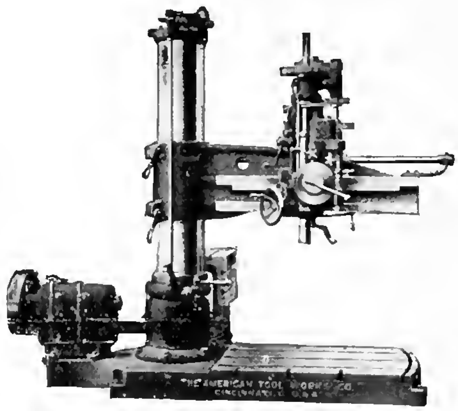
(Cone Pulley Drive.)

POWER



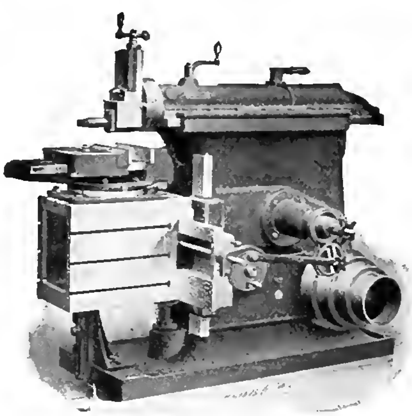
14-in. to 62-in. Swing.
"AMERICAN" "Patented" Geared-Head Lathe.
(Single Pulley Drive)

DURABILITY



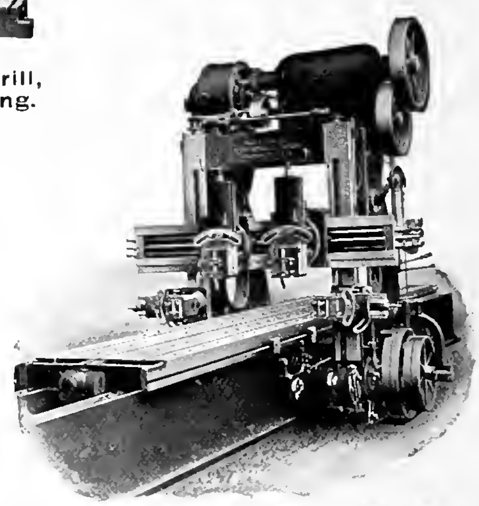
2-ft. to 7-ft. Arm.
"AMERICAN" Plain Radial Drill,
Holds Record for Rapid Drilling.

SIMPLICITY



15-in. to 28-in. Stroke.
"AMERICAN" Back Geared Shaper.
A Marvel for Heavy Duty.
A Manufacturing Tool.

ACCURACY



22-in. to 72-in. Between Housings.
'AMERICAN" Planer, Built with 1, 2 or 4
Cutting Speeds in both Standard
and Widened Patterns.

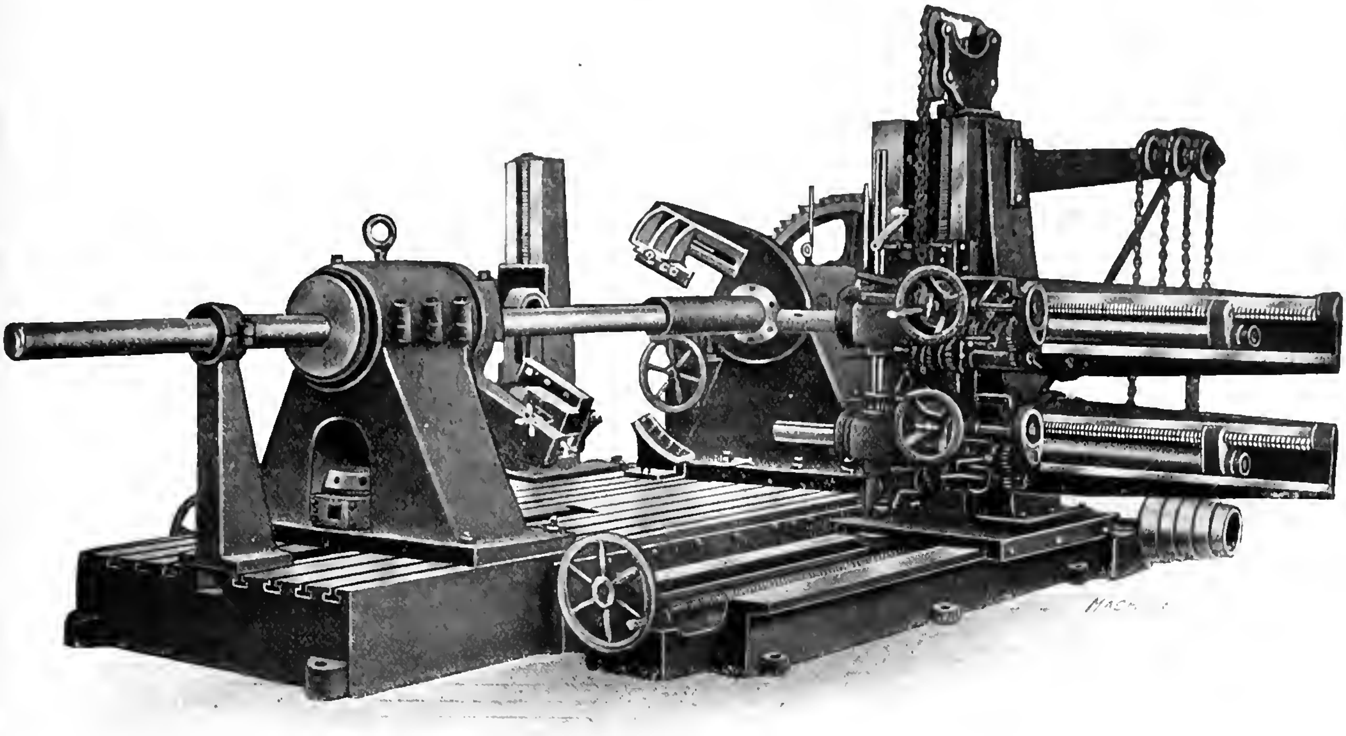
CATALOG "K" NOW READY

"AMERICAN" TOOLS hold the record for PRODUCTION. Increase your OUTPUT without increasing your operating expenses. WILL STAND UP under continuous HARD SERVICE of MODERN METHODS. They are built for FAST SPEEDS and HEAVY FEEDS.

BELT OR ELECTRIC-MOTOR DRIVE

THE AMERICAN TOOL WORKS COMPANY

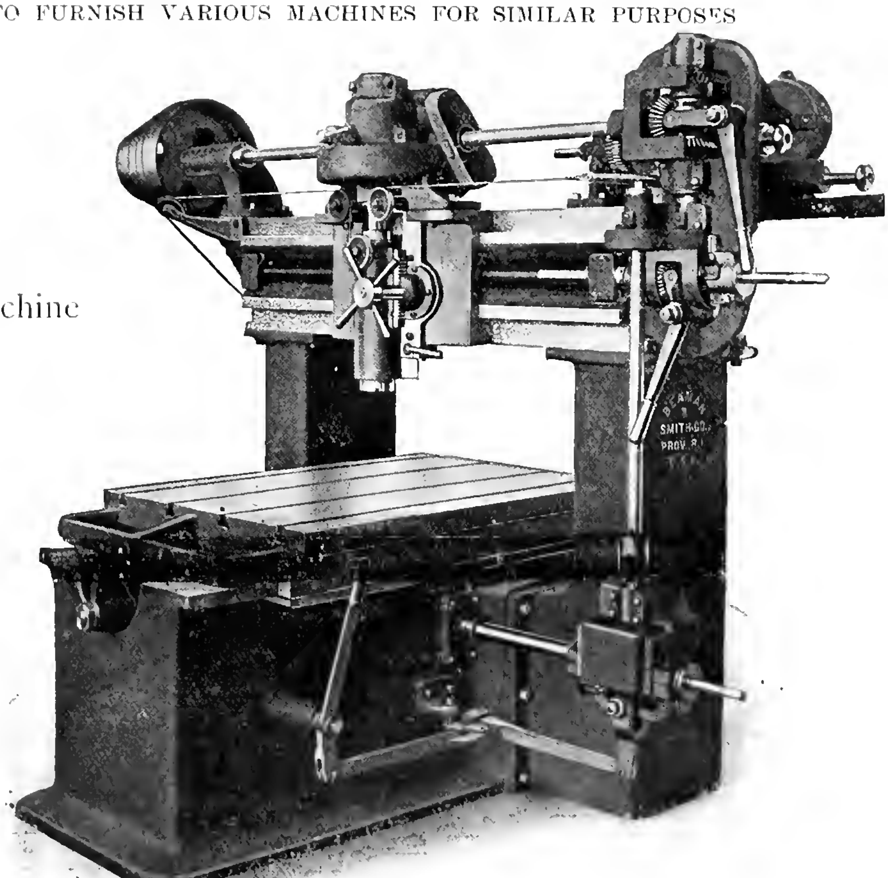
300 to 350 Culvert St., CINCINNATI, O., U. S. A.



Corliss Cylinder Boring Machine

WE ARE PREPARED TO FURNISH VARIOUS MACHINES FOR SIMILAR PURPOSES

Quick Operating Vertical Spindle Milling Machine



Conveniently controlled. Power quick movements and feeds in either direction of work table and spindle saddle. Table 36″ wide, 48″ long.

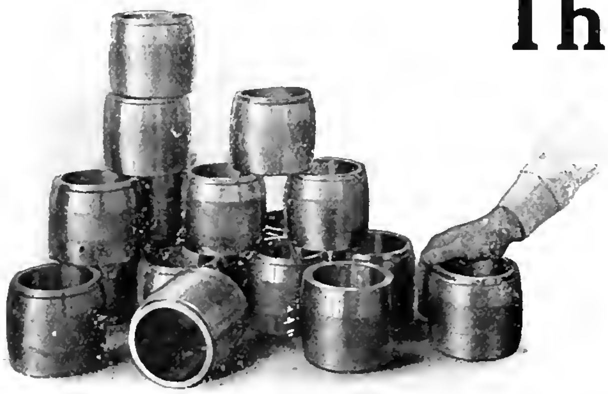
Send for latest Catalogue.

THE BEAMAN & SMITH COMPANY

Providence, Rhode Island, U. S. A.

AGENTS Chas. Churchill & Co., London. Ludw. Loewe & Co., Berlin. Fenwick Freres & Co., Paris

There's an all around Shop using



Samples of chuck work.

The operator is *Satisfied* he can do a good day's work, the superintendent is *Satisfied* with the quality of work produced and the manufacturer is *Satisfied* that he will reap a *Satisfactory* profit.

Reasons for it, of course—the very best of reasons. You'll find them in the sterling qualities of the machine itself. Its strength, convenience, the rigid control of work and tools; wide range of usefulness; ability to handle chuck or bar work with equal facility; rapid change from one class of product to another; universal equipment of tools, and in the special Flat Turret features such as Cross-sliding Head, Single Drive, Variable Speed device and unusual system of lubrication.

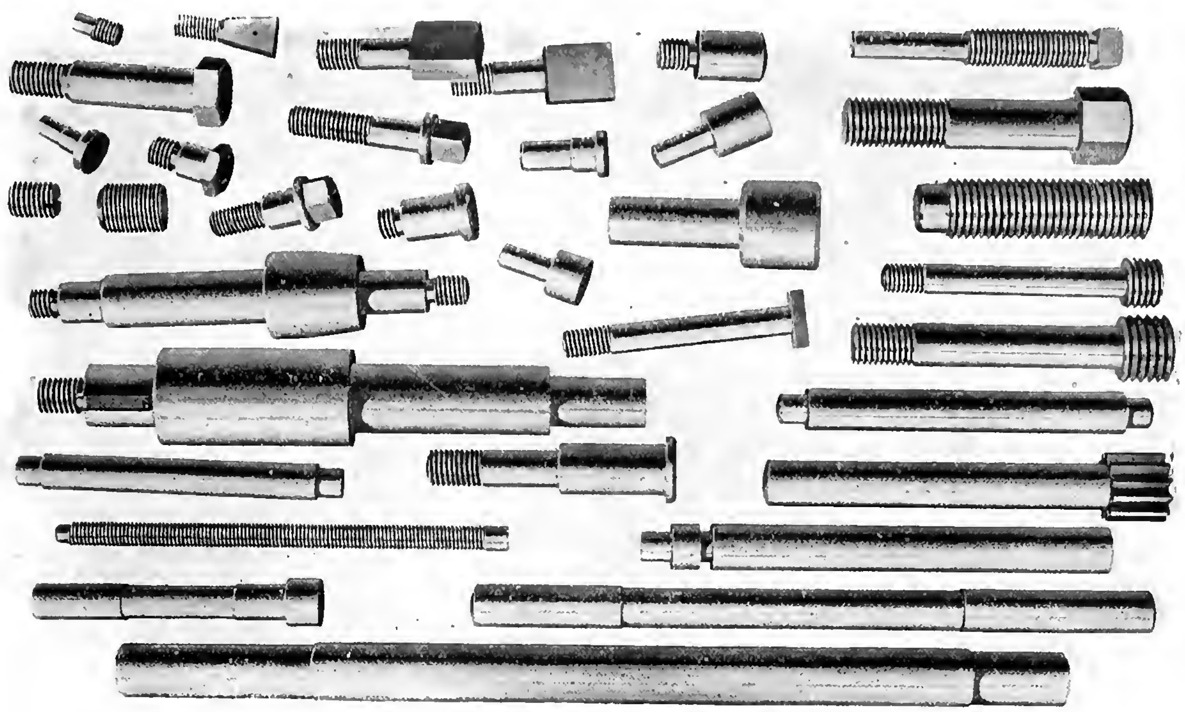
Work from the bar turned out on the Flat Turret Lathe.

Springfield,
Vermont, U. S. A.

JONES & LAMSON MACHINE

Germany, Holland, Belgium Switzerland, Austria-Hungary, M. Koyemann, Charlottenstrasse, 112 Dusseldorf, Germany.
Italy, Adler & Eisenschitz, Milan.

Sense of Satisfaction Pervading the FLAT TURRET LATHES



Work from the bar turned out on the Flat Turret Lathe.

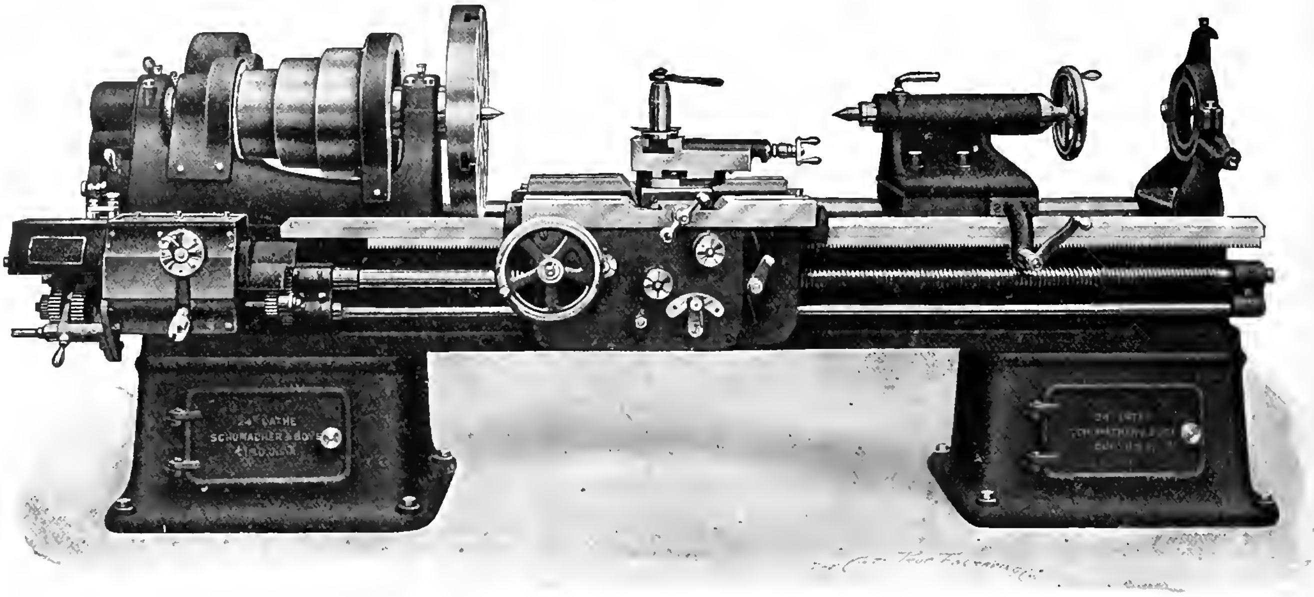
We just mention a few of the reasons to give you a line on its up-to-dateness, but we will be glad to explain fully if you are interested. We make a guarantee as to the percentage of saving the Flat Turret Lathe will effect—and an individual estimate is at your service if you will permit us to send a representative to your plant.

More than 5000 Flat Turret Lathes are in use in this country and abroad. Two sizes, 2 x 24 and 3 x 36.

Examples of chuck work.

COMPANY, Queen Victoria St., London, E. C.

France and Spain, Ph. Bonvillain and E. Ronceray, 9 and 11 Rue des Envierges, Paris



Twenty-four inch Double Back Geared Instantaneous Change Gear Engine Lathe

WITH DOUBLE PLATE APRON

SCHUMACHER & BOYE

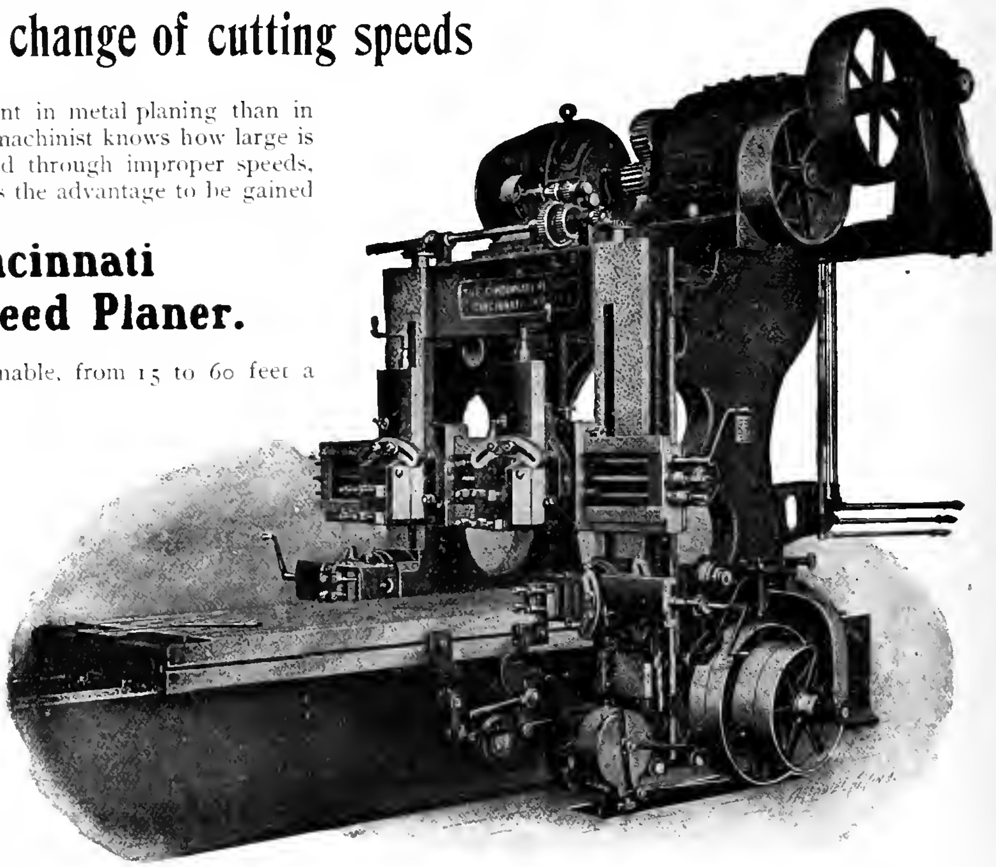
ENGINE LATHES
18" TO 48" SWING

CINCINNATI, OHIO, U. S. A.

The Best Results from High Speed Steels cannot be obtained without ready access to a change of cutting speeds

This is perhaps more important in metal planing than in any other operation. Every machinist knows how large is the percentage of time wasted through improper speeds, and by the same token knows the advantage to be gained through using

The Cincinnati Variable Speed Planer.



Four changes instantly obtainable, from 15 to 60 feet a minute. Massive, powerful and saves 25 to 50 per cent. in time over the one-speed machine.

Write us for more points.

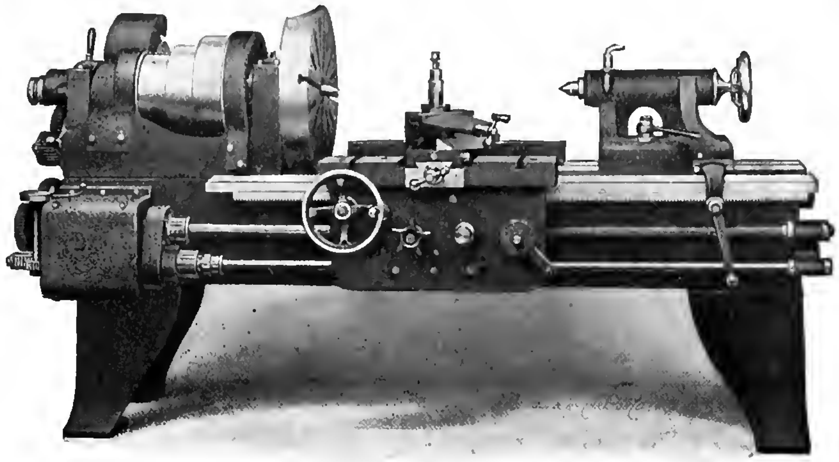
The Cincinnati Planer Co.

Cincinnati, Ohio

FOREIGN AGENTS: Ludw. Loewe & Co., Berlin and Paris. R. S. Stokvis & Zonen, Rotterdam, Holland. J. Lambercier & Co., Geneva, Switzerland. Ing. Ercole Vaghi & Co., Milan. H. W. Petrie, Ltd., Toronto, Montreal and Vancouver.

WHITCOMB

Engine Lathes



Increased Facilities for Operation

Rigid design and unusual power are distinguishing features of our new line of Engine Lathes. The beds are of improved box pattern, deep, heavy and very stiff. Power is obtained through double back gears and a three step cone carrying a wide belt. Changes of speed may be obtained even more easily than in the ordinary lathe. The range of feeds is very wide, and at all times five changes of feed can be instantly obtained by the simple movement of a conveniently placed lever. The capacity of these lathes for high class work, their convenience, durability and economic use of high speed steels, put them in the front rank among manufacturing tools.

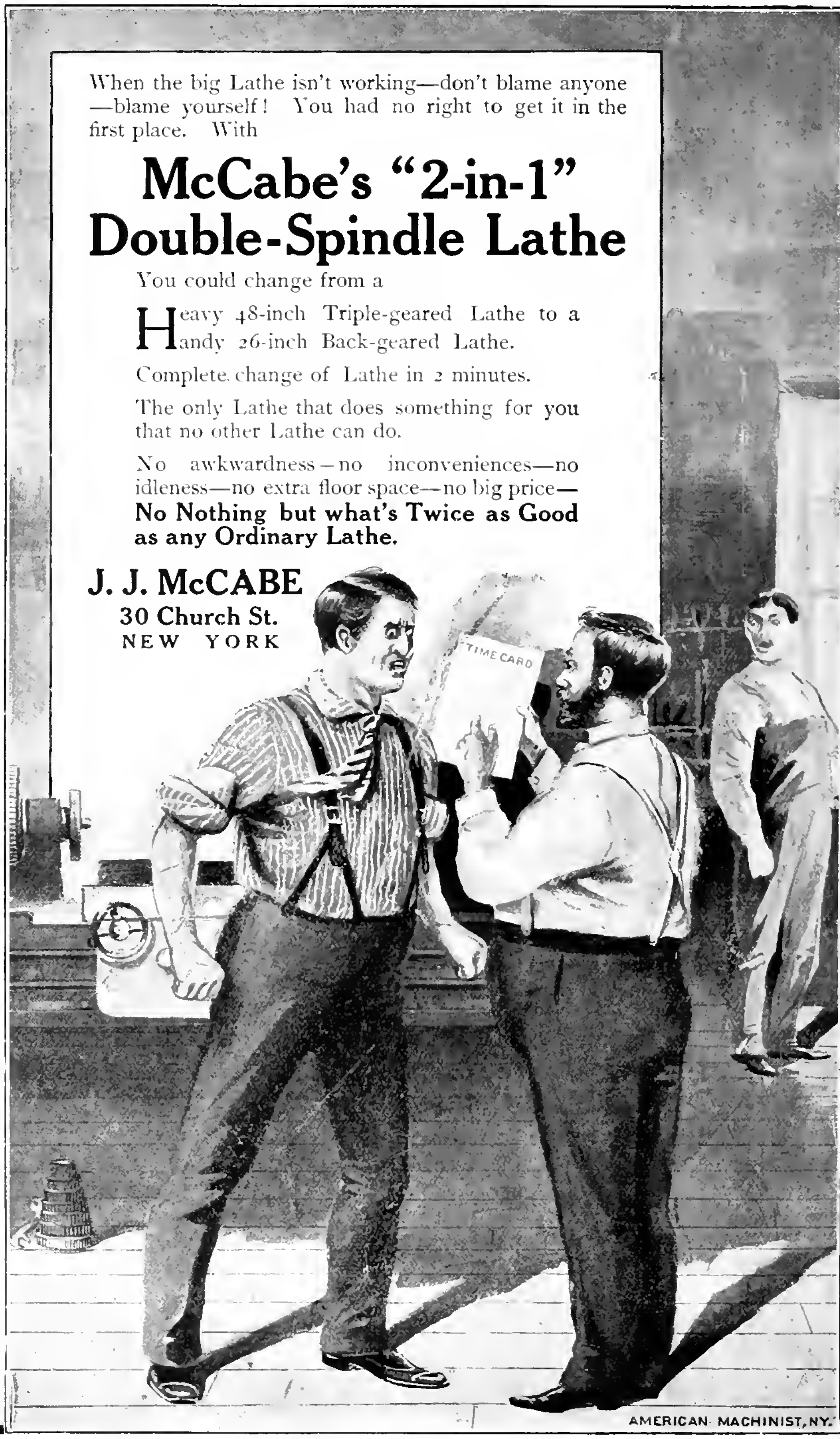
Ask for new Engine Lathe Catalogue.
We also build a full line of Second Belt Planers.

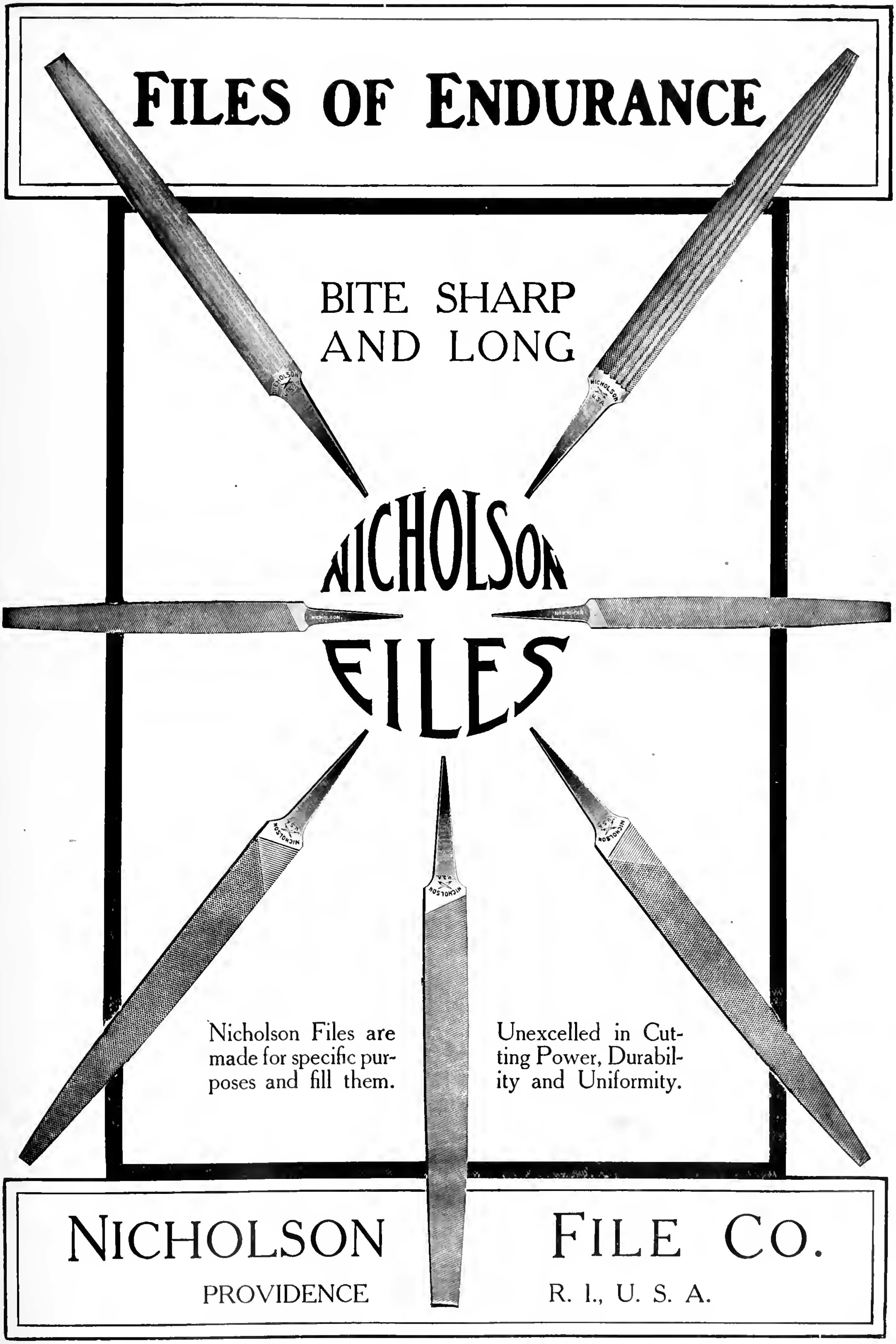
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

AGENTS: Hill, Clarke & Co., Boston and Chicago. Vandyck Churchill Co., New York and Philadelphia. Thomas & Lowe Machinery Co., Providence, R. I. C. H Wood Co., Syracuse, N. Y. McDowell, Stocker & Co., Chicago, Ill. Marshall & Huschart Machinery Co., St Louis, Mo. Patterson Tool and Supply Co., Dayton, Ohio and Indianapolis, Ind. J. L. Osgood, Buffalo, N. Y. H. B. Perine, Seattle, Wash. Pacific Tool and Supply Co., San Francisco, Cal. Somers, Fitler & Todd Co., Pittsburg, Pa, Chas A. Strelinger Co, Detroit, Mich. Zimmerman-Wells-Brown Co., Portland, Ore. L. Booth & Sons, Los Angeles, Cal. C. W. Burton, Griffiths & Co., London, England. Fenwick Freres & Co., Paris, France. Ludw. Loewe & Co., Berlin, Germany. De Fries & Co., Dusseldorf, Germany. Wilh. Sonesson & Co., Malmo, Sweden. Van Riestchoten & Houwens, Rotterdam, Holland. Williams & Wilson, Montreal, Canada. A. R. Williams Machinery Co., Toronto, Canada.

BLAISDELL

Where the blame lies?

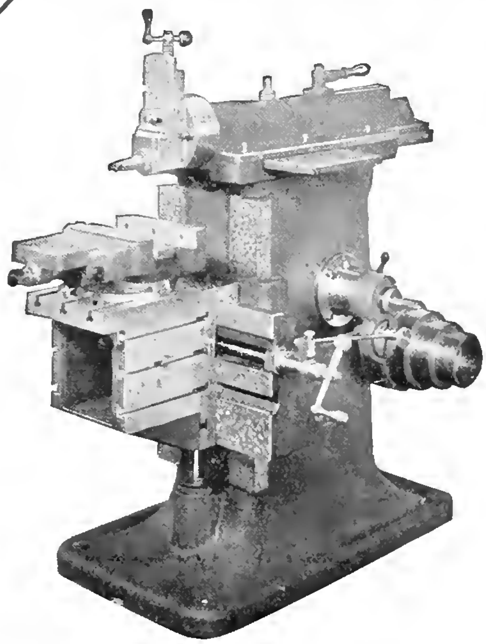



FILES OF ENDURANCE
BITE SHARP
AND LONG
NICHOLSON
FILES
Nicholson Files are made for specific purposes and fill them.
Unexcelled in Cutting Power, Durability and Uniformity.
NICHOLSON FILE CO.
PROVIDENCE R. I., U. S. A.

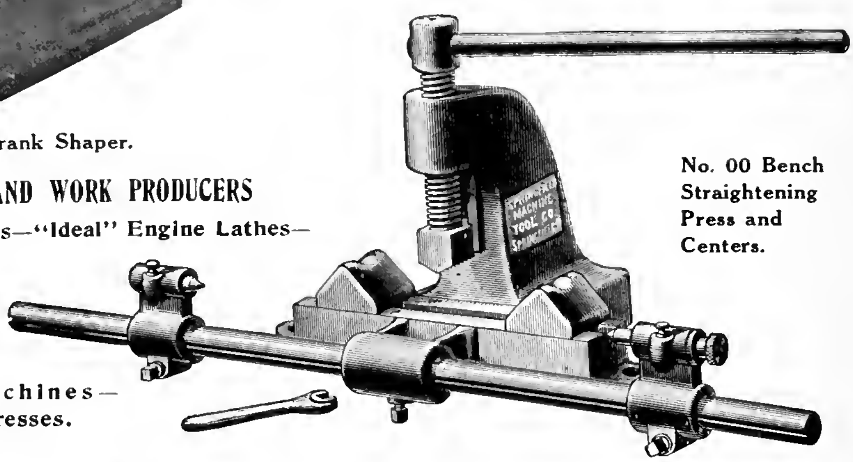
THE MAIN LINE

For Shop Equipment is the Springfield Line of Machine Tools.

They are the "dollar-for-dollar-and-a-dollar-besides" class of machines; designed for service, fitted with all improvements, built in a modern shop under best conditions and run through in large lots so the price is easy.



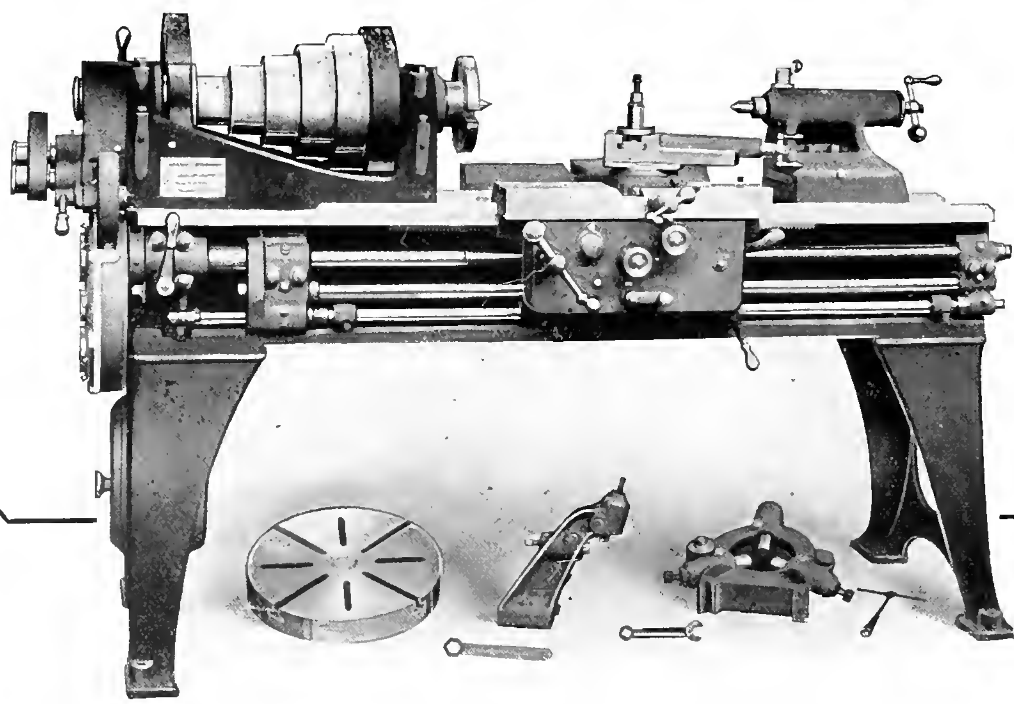
16-in Geared Crank Shaper.



No. 00 Bench Straightening Press and Centers.

COST REDUCERS AND WORK PRODUCERS

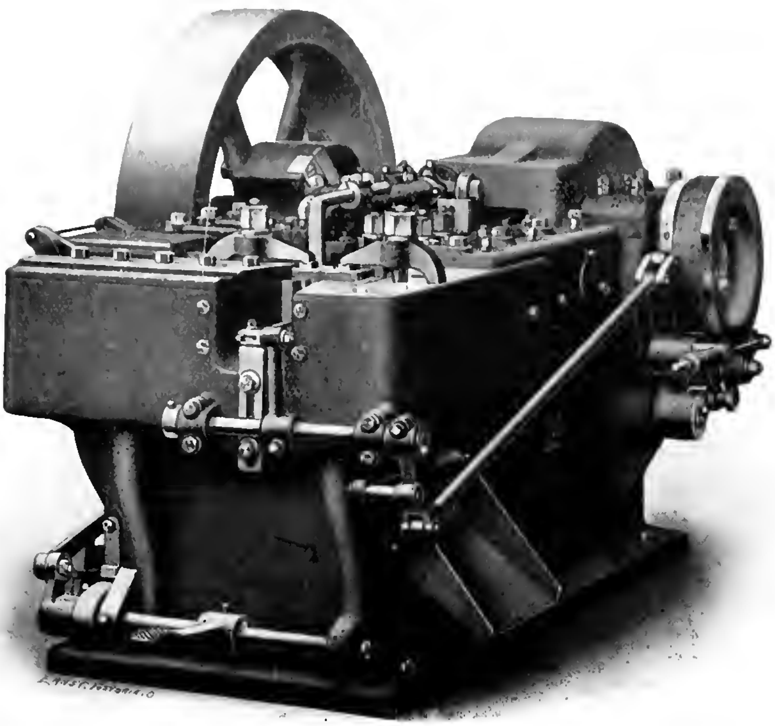
Standard Engine Lathes—"Ideal" Engine Lathes—Friction Geared Head Lathes—Brass Finishing, High Speed and Shafting Lathes—Crank Shapers—Axle and Spindle Boring Machines—Bench Straightening Presses.



THE SPRINGFIELD MACHINE TOOL CO.

631 Southern Avenue, SPRINGFIELD, OHIO, U. S. A.

Agents for Chicago, McDowell, Stocker & Co. Agents for Italy, Ing. Vaghi, Accornero & Co., Milan.
Agents for Germany, L. Loewe & Co., Berlin.



The National New Wedge Grip Bolt and Rivet Header

has exceeded even our fondest expectations, and is worthy of the careful investigation of all bolt machine users.

The wedge prevents any "rocking" or springing open of the grip dies, and it is unnecessary to overgrip (hence batter) the dies to secure the required amount of gripping pressure. *As a result the dies will last from three to four times as long as in the regular toggle headers.*

Fins, also, are practically eliminated, and this combined with the die saving makes the installation of this machine a plain business proposition.

One customer has ordered twenty-four.

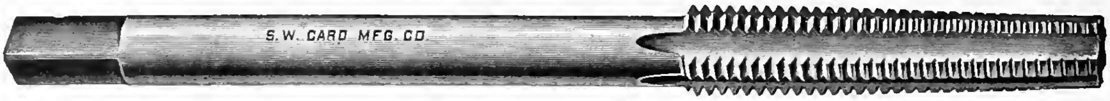
We build complete equipment for Bolt and Nut Plants.

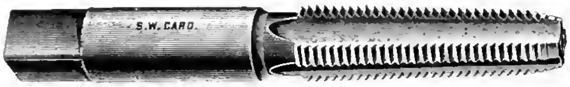
Our aim is to build our machines better, if anything, than need be.

Hence, we are in position to furnish only the best.

THE NATIONAL MACHINERY CO
TIFFIN, OHIO, U.S.A.

FOREIGN AGENTS:
Buck & Hickman, Ltd., London, Birmingham, Manchester, Glasgow.
De Fries & Co., Dusseldorf, Berlin.
Fenwick, Freres & Co., Paris, Liege, Brussels.
White, Child & Beney, Vienna, Budapest.
Takata & Co., Tokio, Japan.
A. B. Horn, Havana, Cuba.
V. Lowener, Stockholm, Copenhagen, Malmo.
Bevans & Edwards Propty. Ltd., Melbourne, Australia.





CARD

There are Taps and Taps
But for Service, Durability,
Strength and Quality

Buy

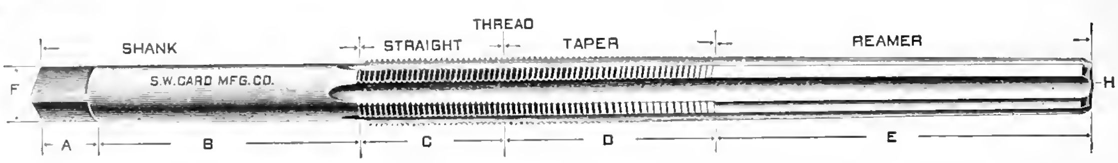
CARD TAPS

All standard styles and sizes in
stock—special taps to order.

*Send for new
Catalogue of Screw
Cutting Tools.*

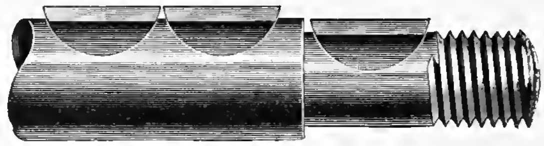
S. W. Card Mfg. Company

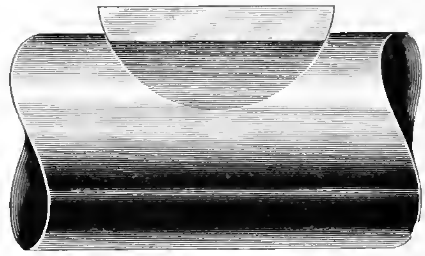
MANSFIELD, MASS.
U. S. A.

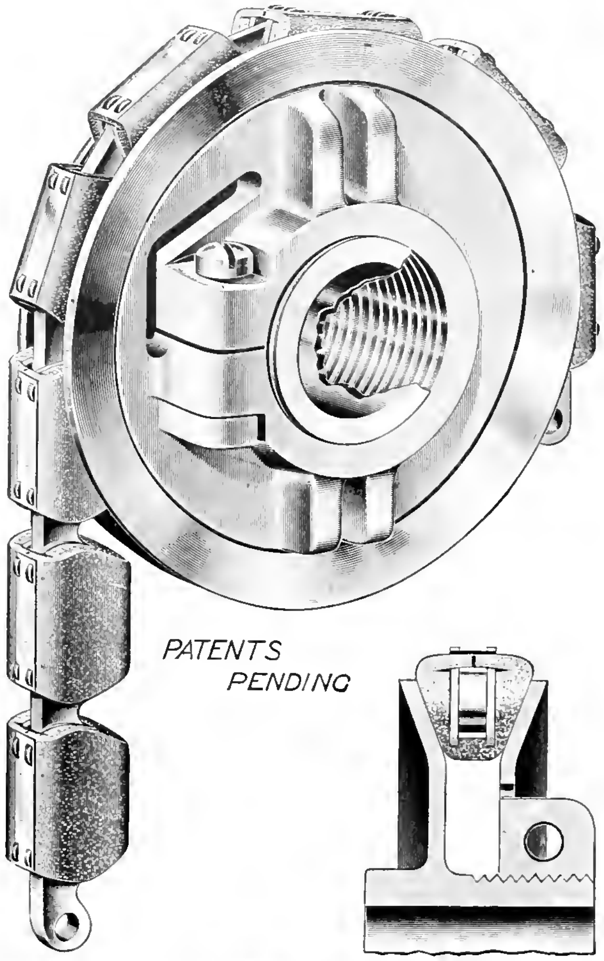


New "Whitney" Chain Belt

For Cooling Fans, Oiling Devices, Motorcycles, Etc.



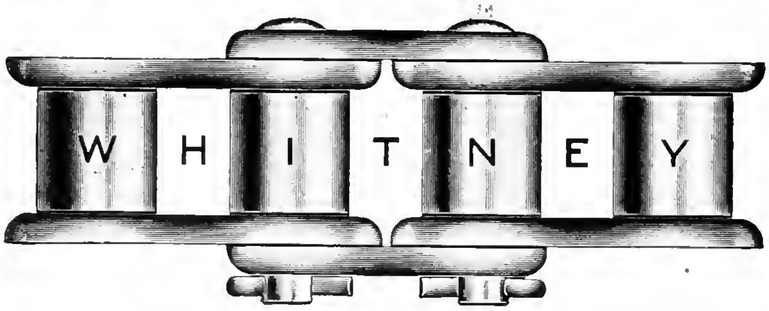




If you are not taking advantage of the Woodruff Patent System of Keying it will pay you to investigate.

Better results and a great saving in cost.

We carry 95 regular sizes of Keys and Cutters in stock for immediate delivery.



"Whitney" Patent Cotter Detachable Roller Chains

Made a fine record in the Briarcliff Road Race.

THE WHITNEY MFG. COMPANY, New York City, May 2, 1908.
Hartford, Conn.

Gentlemen—The uniform strength of an automobile driving chain is one of the important requisites in a speed contest.

The "Whitney" Chains which formed a part of the equipment on our three "Stearns" Cars in the recent Briarcliff Stock Car Road Race, showed their superiority by coming through this exceptionally difficult contest without the sightest evidence of the terrific strain which they had undergone. Our "Stearns" Cars made an exceptional showing in this race, and we attribute our success in no small degree to the entire absence of chain trouble.

Our experience in previous contests has taught us that a faulty chain can cause a lot of trouble.

We therefore take this opportunity to express the satisfaction which we feel at the manner in which "Whitney" Chains demonstrated their worth.

Your very truly,

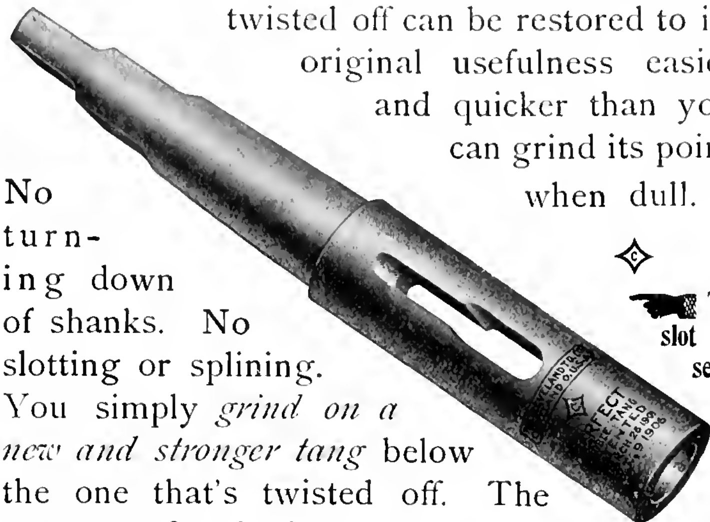
WYCKOFF, CHURCH & PARTRIDGE,
By C. F. Wyckoff, President.

The Whitney Mfg. Company, Hartford, Conn.

Ready for the scrap-heap.

From the Scrap Heap to the Drill Press

Any taper shank drill with its tang twisted off can be restored to its original usefulness easier and quicker than you can grind its point when dull.



The lower slot drives the second tang.

No turning down of shanks. No slotting or splining. You simply *grind on a new and stronger tang* below the one that's twisted off. The new tang fits the lower slot in

"PERFECT Double Tang" SOCKETS

(PATENTED)

Made as Rough, Fitted and Shell Sockets. They are simple, "fool-proof," and inexpensive; have no parts to get out of order, and will *fit any spindle* having a regular taper hole. With them you can

END YOUR TANG TROUBLES

RECLAIM YOUR SCRAP-HEAP

Write for "D.T." Circular and discounts.

Ready for the drill-press.

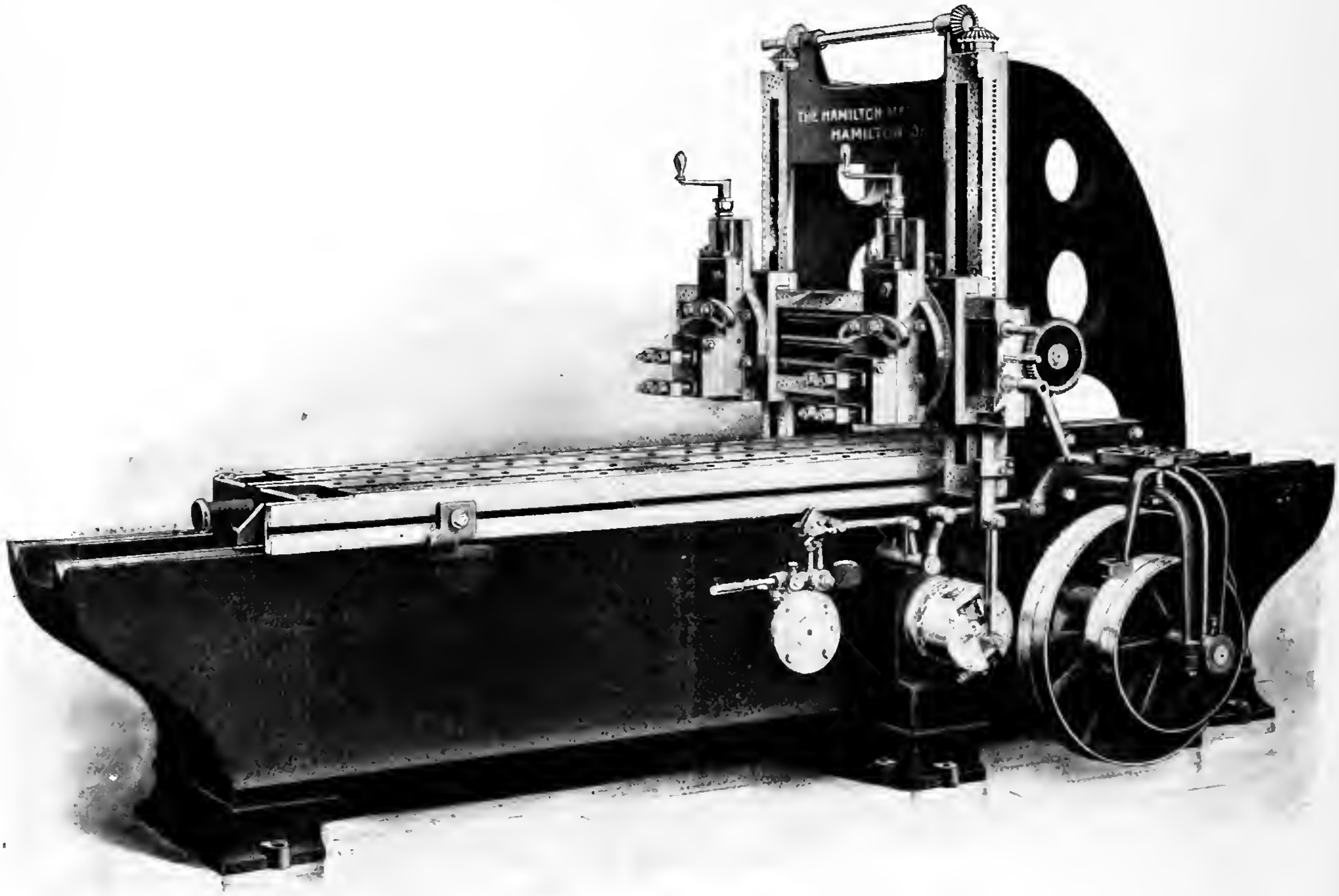
The CLEVELAND Twist Drill Co.

New York CLEVELAND, OHIO Chicago

"HAMILTON" TOOLS

THE KIND THAT SATISFY

Heavy and Powerful Machines of the Latest Design, Accurately Constructed, and Especially Arranged for Rapid and Convenient Operation.



30" x 30" Spur Geared Planer.

A complete line of high grade

LATHES, PLANERS, SHAPERS, UPRIGHT AND RADIAL DRILLS

Belt or Motor Driven as desired.

Our printed matter explains their advantages. Write for it today.

The Hamilton Machine Tool Co.

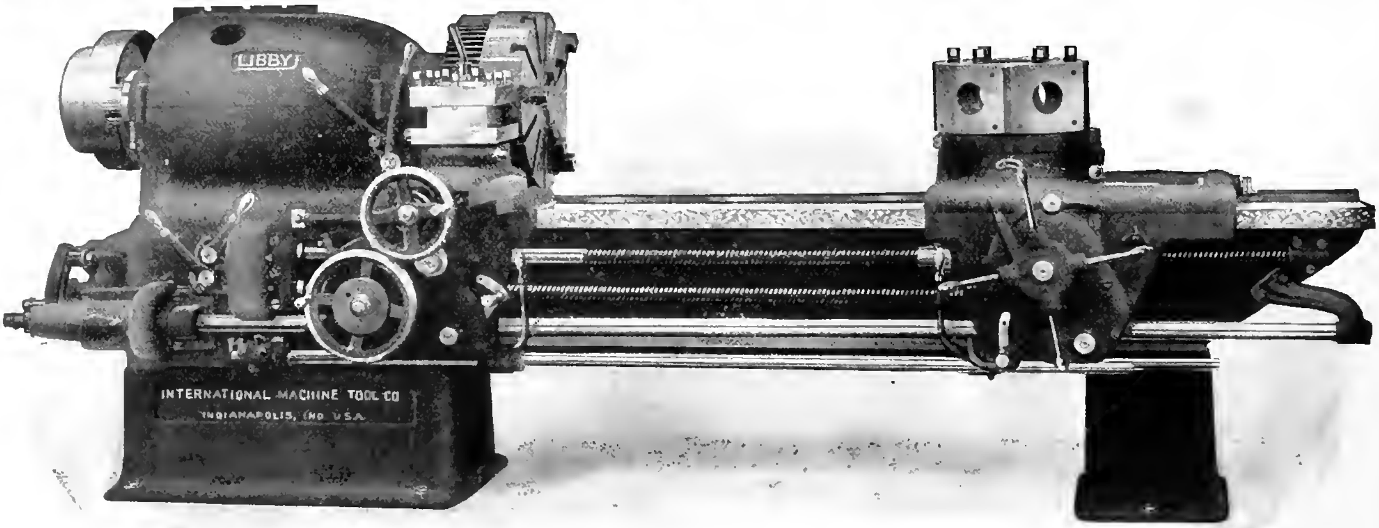
HAMILTON, OHIO, U. S. A.

Cleveland Store: 202-204 St. Clair Avenue, N. E.
W. H. Welsh, Manager.

Philadelphia Store: 48-50 N. Sixth Street
E. L. Frazer, Manager.

FOREIGN AGENTS

Australia—Thos. McPherson & Son........................Melbourne
Australia—Leslie & Co..Perth
Austria—Maschinen-Technisches Bureau Ing. Rudolf Salzer. Vienna
Canada—Williams & Wilson.................................Montreal
Cuba—J. F. Adams Engineering Co.............................Havana
Denmark—V. Lowener.....................................Copenhagen
France—Glaenzer, Perreaud & Thomine..........................Paris
Germany—Hermann Haelbig.............................Dresden A-3
Holland—Van Rietschoten & Houwens.....................Rotterdam
Italy—Ing. A. Baldini & Cie.................................Pontedera
Japan—Mitsui & Co..Tokio
Mexico—Escude & Potts...................................Mexico City
Norway—V. Lowener's Maskinforretning Sverre Mohn...Christiania
Russia—C. & J. W. Gardner Co.......................St. Petersburg
Sweden—Akt. B. A. Hjorth & Co...........................Stockholm
Switzerland—Spoerri & Co..Zurich



The Change from Belt to Motor Drive can be so easily made on the

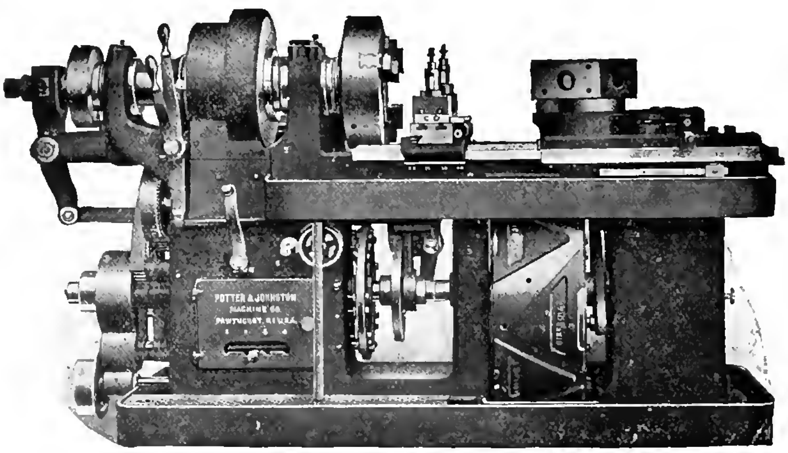
"Libby" Full Swing Side Carriage Turret Lathe

that it is *accomplished* in less time than it takes to arrange preliminaries in the ordinary machine and at a very small cost. No need to change the head-stock, any 2 to 1 type of motor can be used. This new lathe will reduce production costs on a wide range of duplicate machined parts and is especially adapted for heavy service.

Ask for Bulletin giving special "Libby" advantages.

The International Machine Tool Co., Indianapolis, Ind., U. S. A.

One Attendant Operates 4 to 6 MANUFACTURING AUTOMATICS



$8\frac{1}{2}$ x 16 Manufacturing Automatic.

All cutting operations are performed entirely automatically.

Handle duplicate parts from castings of iron, bronze or steel, also forgings, up to 20″ diameter. Bar work up to 6″ diameter.

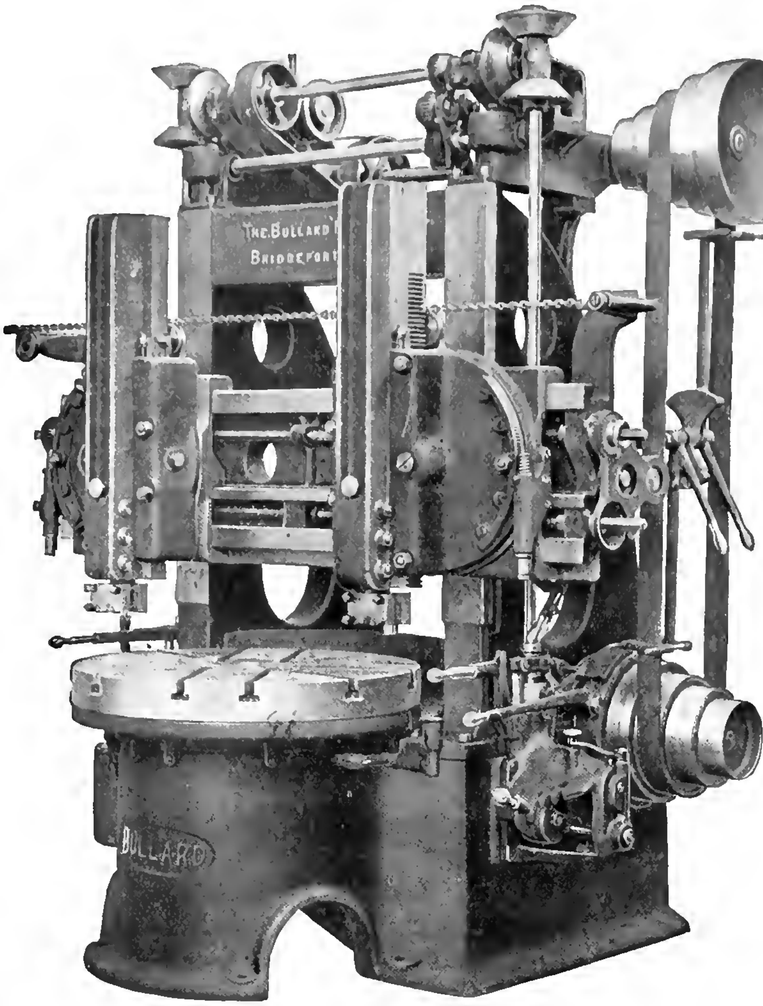
Send us your drawings or samples for production estimates.

ALSO

Universal Shapers

POTTER & JOHNSTON, Pawtucket, R. I.

OFFICES AND REPRESENTATIVES—Paris Office, 78 Avenue de la Grand Armee, J. Ryan, Manager. New York Office, 50 Church St., Walter H. Foster, Manager. Cleveland Office, 309 Schofield Bldg., Modern Machinery & Engineering Co., Representatives.
Foreign Agents: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England, and Glasgow, Scotland. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Barcelona, Bilbao. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest.



42" Rapid Production Mill.

Taken as a Whole, or Taking Each Part Separately,
There is Absolutely No Equal to

THE BULLARD MILL

As a whole it has the necessary weight and strength to endure the heaviest work that can be demanded of it. All the modern high-speed requirements have been met in the the most approved and practical way.

Taking each part separately you will find that its proportions are exactly suited to its functions. You will understand how the "Bullard" gains its extreme ease of operation, its exceptional capacity for quantity and quality of output, and its great durability.

Let us tell you all about the "Bullard" Mill. It pays to know.

The Bullard Machine Tool Co.

BRIDGEPORT, CONN., U. S. A.

AGENTS—Marshall & Huschart Mchy. Co., Chicago, Ill. The Motch & Merryweather Mchy. Co., Cleveland, Ohio. Chas. G. Smith Co., Pittsburg, Pa., The C. H. Wood Co., Syracuse, N. Y., Pacific Tool & Supply Co., San Francisco, Cal. Williams & Wilson, Montreal, P. Q. Chas. Churchill & Co., Ltd., London, E. C., England. Fenwick Freres & Co., Paris. Heinrich Dreyer, Berlin, Germany. Landre & Glinderman, Amsterdam, Holland. A. R. Williams Mchy. Co., Toronto, Winnipeg and Vancouver.

Alphabetical Index of Advertisers.

Do you want the "Real Thing" or a Substitute?

THE GRAHAM OR DETROIT CHUCK

is the Original Chuck for holding drills, taps, reamers, etc., with grooved shanks. The very merit of the device was bound to breed imitators—a good thing is never long without them—but the *Original Chuck* has advantages its followers lack.

It is at once simple, durable and practical. It holds the tools so that all danger of turning, slipping or drawing out of the chuck is eliminated. It fits the spindle of any drill-press or lathe. It saves drill breakage; saves 10 per cent. in time; assures accurate work and is adjusted by a single turn of the sleeve without the aid of wrench, set screw or hammer.

One Chuck, with reducers, will hold a complete range of tool sizes from 3-32" to 2 1-2"

Detroit Twist Drill Company,

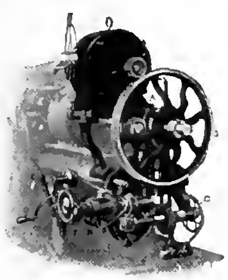
634-646 Fort Street, West, DETROIT, MICH., U. S. A.

Manufacturers of all kinds of Twist Drills, Reamers and Special Tools.

THE

ACME AUTOMATIC

MULTIPLE SPINDLE
SCREW MACHINE



INDEPENDENT
MOTOR
DRIVE

SINGLE
BELT
DRIVE

WILL — **WILL NOT**

Built by
THE NATIONAL-ACME MFG. CO., CLEVELAND, OHIO

Branch Offices:
New York — Boston
Chicago — Atlanta

Gen. Foreign Representatives:
Alfred H. Schutte
Schuchardt & Schutte

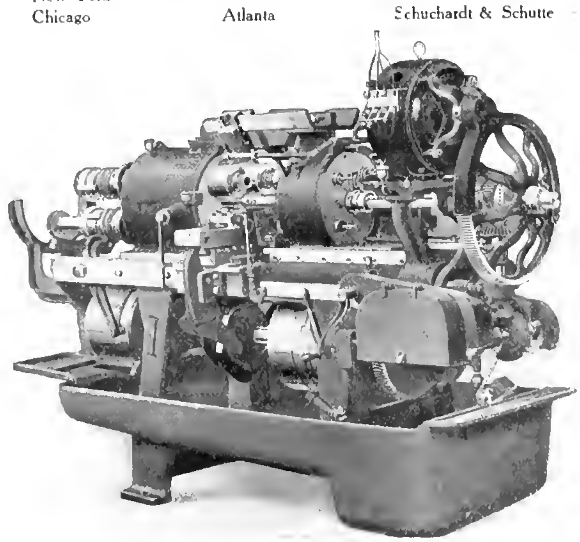
MAKE YOUR PARTS FASTER.
MAKE THEM CHEAPER.
MAKE THEM EQUAL TO THE BEST.

MAKE ANYTHING THAT CAN BE MADE FROM IRON, STEEL, BRASS, ALUMINUM OR ZINC BARS.

FINISH WORK TO AN UNPRECEDENTED DEGREE.

MAKE IT EASIER TO GET ORDERS IN DULL TIMES.

MAKE IT EASIER TO FILL ORDERS IN BUSY TIMES.



TAKE MORE FLOOR SPACE THAN THE SLOWER MACHINES.

REQUIRE MORE ATTENTION.

REQUIRE MORE SKILLED LABOR.

TAKE ANY MORE TIME TO FINISH THE MOST COMPLICATED WORK THAN THE LONGEST SINGLE OPERATION REQUIRES.

SUFFER BY COMPARISON WITH THE BEST MACHINE TOOLS FOR DESIGN AND CONSTRUCTION.

No. 56 ACME AUTOMATIC — Motor Driven

Classified Index to Advertisements.

For alphabetical Index see Page 36.

Classified Index to Advts. (Continued.

Classified Index to Advts. (Continued).

Classified Index to Advts. (Continued)

Factory Equipment.
Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Fans, Exhaust, Electric, Ventilating.
Crocker-Wheeler Co., Ampere, N. J.
Robbins & Myers Co., Springfield, O.
Sturtevant, B. F., Co., Hyde Park, Mass.
Western Elec. Co., Chicago, Ill.

Files.
American Swiss File & Tool Co., Elizabeth, N. J.
Barnett, G. & H., Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Hayes File Co., Detroit, Mich.
Nicholson File Co., Providence, R. I.
Reichhelm, E. P., & Co., New York.

File Sharpeners.
American File Sharpener Co., New York.

Filing Machines.
Simplex Mfg. Co., New York.

Fillet Cutters.
Milwaukee Foundry Supply Co., Milwaukee, Wis.

Fillet (Leather).
Butler, A. G., New York.
Obermayer, S., Co., Cincinnati, O.

Flasks.
Obermayer, S., Co., Cincinnati, O.

Flexible Shafts.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hahn, Wm., Chicago, Ill.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.

Forges.
Billings & Spencer Co., Hartford, Conn.
Buffalo Dental Mfg. Co., Buffalo, N. Y.
Burke Mchy. Co., Cleveland, O.
Sturtevant, B. F., Co., Hyde Park, Mass.

Forgings, Drop.
Billings & Spencer Co., Hartford, Conn.
Hay-Budden Mfg. Co., Brooklyn, N. Y.
Keystone Drop Forge Wks., Chester, Pa.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
Williams, J. H., & Co., Brooklyn, N. Y.
Wyman & Gordon, Worcester, Mass.

Forging Machines.
Acme Machinery Co., Cleveland, O.
Ajax Mfg. Co., Cleveland, O.
Bliss, E. W., Co., Brooklyn, N. Y.
National Mchy. Co., Tiffin, O.
Scranton & Co., New Haven, Conn.
Williams, White & Co., Moline, Ill.

Foundry Facings, Brushes, Barrows, Shovels, Bellows and Blowers.
Obermayer, S., Co., Cincinnati, O.

Foundry Supplies.
Goldschmidt Thermit Co., New York.
Milwaukee Foundry Supply Co., Milwaukee, Wis.
Obermayer, S., Co., Cincinnati, O.

Friction Cone Pulleys.
Evans, G. F., Newton Center, Mass.

Fuel Economizers.
Sturtevant, B. F., Co., Hyde Park, Mass.

Furnaces, Coal Oil.
Burke Machinery Co., Cleveland, O.

Furnaces, Gas.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Gages, Surface, Depth, etc.
Brown & Sharpe Mfg. Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Wks., Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb, J. T., Co., Providence, R. I.
Smith, E. G., Co., Columbia, Pa.
Starrett, L. S., Co., Athol, Mass.
Wells Bros. Co., Greenfield, Mass.
Wyke, J., & Co., Boston, Mass.

Gears.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Wks., Norfolk Downs, Mass.
Caldwell, H. W., & Son Co., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Cullman Wheel Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Eberhardt Bros. Mch. Co., Newark, N. J.
Foote Bros. Gear & Mch. Co., Chicago, Ill.
Ganschow, Wm., Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Morse, Williams & Co., Philadelphia, Pa.
New Process Raw Hide Co., Syracuse, N. Y.
Philadelphia Gear Wks., Inc., Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton Co., Cleveland, O.
Woburn Gear Works, Woburn, Mass.

Gear-Cutting Machines.
Becker Milling Mch. Co., Hyde Park, Mass.
Cincinnati Shaper Co., Cincinnati, O.
Eberhardt Bros. Mch. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Van Dorn & Dutton Co., Cleveland, Ohio.
Waltham Machine Works, Waltham, Mass.
Whiton, D. E., Mch. Co., New London, Conn.

Gear Planers, Bevel.
Gleason Works, Rochester, N. Y.

Gear Shapers.
Fellows Gear Shaper Co., Springfield, Vt.

Generators.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Schenectady, N. Y.
Northern Elec. Mfg. Co., Madison, Wis.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Classified Index to Advts. (Continued).

Graphite.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Obermayer, S., Co., Cincinnati, O.

Grinders, Portable, Electrical Driven.
Cincinnati Elec. Tool Co., Cincinnati, O.
Clark, Jas., Jr., & Co., Louisville, Ky.
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Mch. Co., Cincinnati, O.
Lektro Mfg. Co., Cincinnati, O.
United States Electrical Tool Co., Cincinnati, O.

Grinding Machinery.
Barnes, W. F. & J., Co., Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Becker Milling Mch. Co., Hyde Park, Mass.
Besly, C. H., & Co., Chicago, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Diamond Mch. Co., Providence, R. I.
Gould & Eberhardt, Newark, N. J.
Graham Mfg. Co., Providence, R. I.
Hisey-Wolf Mch. Co., Cincinnati, O.
Hoysradt & Case, Kingston, N. Y.
Landis Tool Co., Waynesboro, Pa.
La Salle Mch. & Tool Co., La Salle, Ill.
Lektro Mfg. Co., Cincinnati, O.
Lutter & Gies, Milwaukee, Wis.
Modern Tool Co., Erie, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Ransom Mfg. Co., Oshkosh, Wis.
Rockford Drilling Mch. Co., Rockford, Ill.
Rowbottom Mch. Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.
Saxon Mch. Co., Holyoke, Mass.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Thompson Grinder Co., Springfield, O.
Walker, O. S., & Co., Worcester, Mass.
Wells, F. E., & Son Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Grinding Machines, Plain, Universal.
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dayton Mch. & Tool Wks., Dayton, O.
Greenfield Mch. Co., Greenfield, Mass.
Landis Tool Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Thompson Grinder Co., Springfield, O.

Hammers, Power.
Niles-Bement-Pond Co., New York.
Scranton & Co., New Haven, Conn.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Williams, White & Co., Moline, Ill.

Hammers, Power, Steam and Drop.
Billings & Spencer Co., Hartford, Conn.
Bliss, E. W., Co., Brooklyn, N. Y.
Bradley, C. C., & Son, Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Dienelt & Eisenhardt, Philadelphia, Pa.
Foglesong Mch. Co., Dayton, Ohio.
Merrill Bros., Brooklyn, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., New Haven, Conn.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Williams, White & Co., Moline, Ill.

Handles, Machine Tool.
Cincinnati Ball Crank Co., Cincinnati, O.

Hardening and Tempering.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., New York.
Coes Wrench Co., Worcester, Mass.

Heading, Upsetting and Forging Machines.
Acme Machinery Co., Cleveland, O.
Ajax Mfg. Co., Cleveland, O.
Bliss, E. W., Co., Brooklyn, N. Y.
Brown, H. B., Co., East Hampton, Conn.
National Mchy. Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Williams, White & Co., Moline, Ill.

Heating and Ventilating, Dust Collecting Systems.
Sturtevant, B. F., Co., Hyde Park, Mass.

Heating Machines.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Heaters.
Sturtevant, B. F., Co., Hyde Park, Mass.

Heaters, Feed Water.
Stewart Heater Co., Buffalo, N. Y.

Hoists.
Cleveland Crane & Car Co., Wickliffe, Ohio.
Mason, Volney W., & Co., Providence, R. I.
Niles-Bement-Pond Co., New York.
Reading Crane & Hoist Works, Reading, Pa.

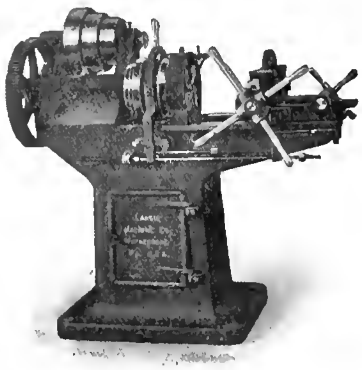
Hoists, Chain.
Harrington, Edwin, & Son, Inc., Philadelphia.
Niles-Bement-Pond Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Electric.
Box, Alfred, & Co., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Wks., Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Shepard Elec. Crane & Hoist Co., Montour Falls.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Northern Engineering Works, Detroit, Mich.
Shepard Elec. Crane & Hoist Co., Montour Falls.
Stow Flexible Shaft Co., Philadelphia, Pa.

Hydraulic Machinery.
Chambersburg Engineering Co., Chambersburg, Pa.
Niles-Bement-Pond Co., New York.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Threads to Cut?



Bolt threading, small pipe, special work of any kind? Do it on the "Landis." The improved Die in the Landis Bolt Cutter has solved the thread cutting problem. It increases production, insures accuracy, outwears any other die ten times over, has positive lead, correct clearance, a permanent throat, requires neither hobbing, annealing or retempering, covers a wide range of special work, and the same chasers will cut right or left hand threads.

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Bolt Threaders, Headers and Nut Tappers.

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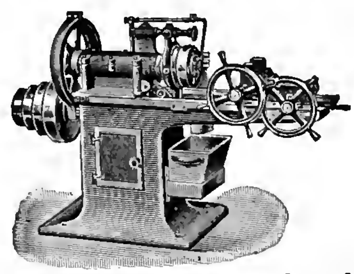

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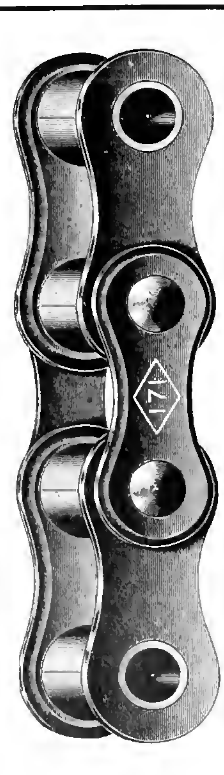

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If you want efficient short drives,

If you haven't time or money to waste on belt dressing, or can't afford power loss through slippage,

If you don't want noise and wasted power as with gears,

If you DO want your machines to run at exactly the right speed all the time,

If space is an object,

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DIAMOND MACHINERY CHAIN

with which you can run the driven shaft always at a speed proportional to that of the driver, and do it without expense for labor or repairs.

Diamond Chain is light, will go into a much smaller space than belting, and will far outlast the best belt made. Try a Diamond Chain, on one machine.

Write for Book "Chain Transmission of Power."

Diamond Chain & Mfg. Co.

240 W. Georgia St., Indianapolis, Ind.

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Classified Index to Advts. (Continued).

Classified Index to Advts. (Continued).

Mandrels.
Cleveland Twist Drill Co., Cleveland, O.
Nicholson, W. H., & Co., Wilkesbarre, Pa.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Western Tool & Mfg. Co., Springfield, O.

Mechanical Draft.
Sturtevant, B. F., Co., Hyde Park, Mass.

Metal.
Goldschmidt Thermit Co., New York.
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Metal Polish.
Hoffman, George W., Indianapolis, Ind.

Milling Machines.
Adams Co., Dubuque, Ia.
Beaman & Smith Co., Providence, R. I.
Becker Milling Mch. Co., Hyde Park, Mass.
Burke Mchy. Co., Cleveland, O.
Chicago Mch. Tool Co., Chicago, Ill.
Cincinnati Milling Mch. Co., Cincinnati, O.
Dalin Bros., Rockford, Ill.
Fox Mch. Co., Grand Rapids, Mich.
Garvin Mch. Co., New York.
Hendey Mch. Co., Torrington, Conn.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
Knight, W. B., Mchy. Co., St. Louis, Mo.
Le Blond, R. K., Mch. Tool Co., Cincinnati, O.
Newton Mch. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Owen Mch. Tool Co., Springfield, O.
Pratt & Whitney Co., Hartford, Conn.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Slate, Dwight, Mch. Co., Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Waltham Watch Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Milling Cutters.
Becker Milling Mch. Co., Hyde Park, Mass.
Boker, Hermann, & Co., New York and Chicago.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Garvin Mch. Co., New York.
Morse Twist Drill & Mch. Co., New Bedford.
National Tool Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Standard Tool Co., Cleveland, O.
Starrett, L. S., Co., Athol, Mass.

Milling Tools (Hollow Adjustable).
Geometric Tool Co., New Haven, Conn.

Molding Machines.
Obermayer, S., Co., Cincinnati, O.

Motors (Electric).
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Schenectady, N. Y.
Northern Electric Mfg. Co., Madison, Wis.
Robbins & Myers Co., Springfield, O.
Sturtevant, B. F., Co., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Name Plates.
Sackmann, W. L., Akron, O.
Turner Brass Works, Sycamore, Ill.
Waltham Mch. Works, Waltham, Mass.

Nozzles.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Nut Tappers.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.

Oil Cans.
Delphos Mfg. Co., Delphos, O.

Oil Cups.
Bay State Stamping Co., Worcester, Mass.
Besly, C. H., & Co., Chicago, Ill.
Tucker, W. M. & C. F., Hartford, Conn.
Winkley Co., Detroit, Mich.

Oil Hole Covers.
Bay State Stamping Co., Worcester, Mass.
Tucker, W. M. & C. F., Hartford, Conn.
Winkley Co., Detroit, Mich.

Oilless Bearings.
Arguto Oilless Bearing Co., Philadelphia, Pa.

Oil Stones.
Norton Co., Worcester, Mass.

Packing.
New York Belting & Packing Co., New York.

Patterns, Wood and Metal.
Penn Pattern Wks., Chester, Pa.

Pattern Letters.
Butler, A. G., New York.

Patents.
Burnham, Royal E., Washington, D. C.
Howson & Howson, Philadelphia, Pa.
Macdonald & Macdonald, New York.
Parker, C. L., Washington, D. C.
Whittlesey, Geo. P., Washington, D. C.

Pattern Shop Equipment.
Colburn Mch. Tool Co., Franklin, Pa.
Fox Machine Co., Grand Rapids, Mich.

Phosphorizers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

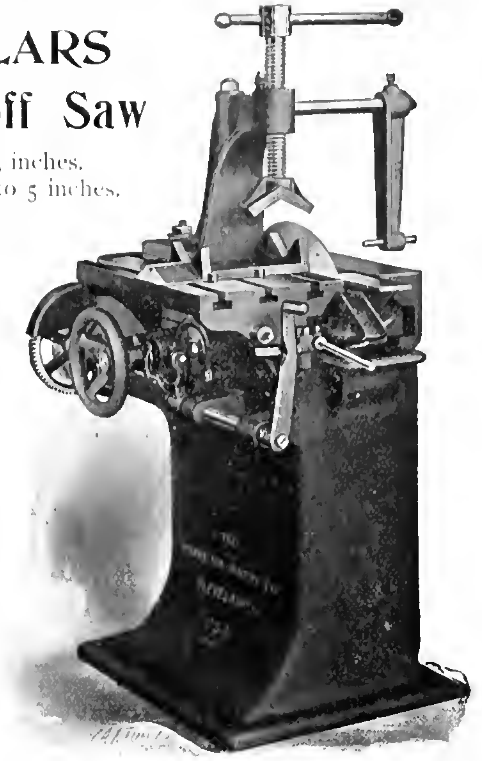
Pipe-Cutting and Threading Tools.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Hart Mfg. Co., Cleveland, O.
Loew Mfg. Co., Cleveland, O.
Merrell Mfg. Co., Toledo, O.

SIXTY DOLLARS

12-in. Cutting-off Saw

Capacity: Rounds, up to 3 inches.
"I" Beams, up to 5 inches.

Friction Power Feed.
Automatic Knockout.
Large Clamping Table.
Up-to-date in every particular.



20-INCH SIZE

$125.00

Capacity: 12" "I" Beams

Write us for complete description.

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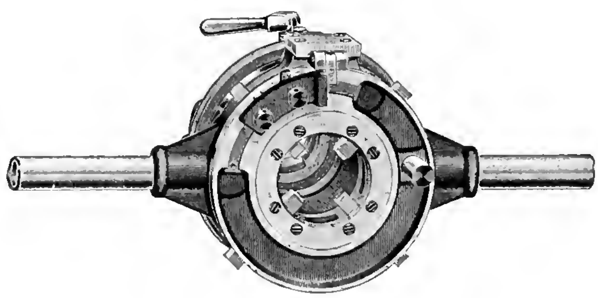
CLEVELAND, O.

In threading pipe with a

"BUCKEYE" DIE STOCK

One man does all the work on 2-inch pipe, for instance, with ease.



The operator simply continues the easy turning-around, until he feels the dies release themselves automatically,—that means the thread is finished; there is no turning back to be done then. Several other good points.

THE HART MFG. COMPANY
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CONTRACT WORK

We use HIGH SPEED STEEL to make our prices right. We finish by grinding to make our work right.

The Blanchard Machine Co Boston Mass

Classified Index to Advts. (Continued)

Murchey Mch. & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Saunders', D., Sons, Yonkers, N. Y.
Standard Engineering Co., Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Lebanon, Pa.
Trimont Mfg. Co., Roxbury, Mass.

Planers, Metal.
American Tool Wks. Co., Cincinnati, O.
Betts Mch. Co., Wilmington, Del.
Chandler Planer Co., Ayer, Mass.
Cincinnati Planer Co., Cincinnati, O.
Cleveland Crane & Car Co., Wickliffe, O.
Cleveland Planer Wks., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Flather, Mark, Planer Co., Nashua, N. H.
Gleason Works, Rochester, N. Y.
Gray, G. A., Co., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Powell Tool Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.
Wilkinson, A. J., & Co., Boston, Mass.
Wilson, W. A., Mch. Co., Rochester, N. Y.
Woodward & Powell Planer Co., Worcester, Mass.

Plumbago.
Obermayer, S., Co., Cincinnati, O.

Pneumatic Tools.
Bliss, E. W., Co., Brooklyn, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Shepard Elec. Crane & Hoist Co., Montour Falls.

Portable Tools, Repair, Railroad, etc.
Underwood, H. B., & Co.

Potash Kettles.
Gray & Prior Mch. Co., Hartford, Conn.

Presses.
Billings & Spencer Co., Hartford, Conn.
Bliss, E. W., Co., Brooklyn, N. Y.
Ferracute Mch. Co., Bridgeton, N. J.
Garvin Mch. Co., New York.
Hamilton Mch. Tool Co., Hamilton, O.
Hoefer Mfg. Co., Freeport, Ill.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Presses, Power, Forcing.
Lucas Machine Tool Co., Cleveland, O.

Pulley Blocks.
Yale & Towne Mfg. Co., New York.

Pulleys.
American Pulley Co., Philadelphia, Pa.
Poole Eng'rg & Mch. Co., Baltimore, Md.
Saginaw Mfg. Co., Saginaw, Mich.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Wood's, T. B., Sons, Co., Chambersburg, Pa.

Pumps.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.

Punches and Dies.
Armstrong-Blum Mfg. Co., Chicago, Ill.
Bliss, E. W., Co., Brooklyn, N. Y.
Burke Mchy. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Globe Mch. & Stamping Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Richards, I. P., Providence, R. I.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Watson-Stillman Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Punching and Shearing Machinery.
Bertsch & Co., Cambridge City, Ind.
Bliss, E. W., Co., Brooklyn, N. Y.
Cincinnati Punch & Shear Co., Cincinnati, O.
Cleveland Crane & Car Co., Wickliffe, O.
Krips-Mason Mch. Co., Philadelphia, Pa.
Long & Allstatter Co., Hamilton, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Royersford Foundry & Mch. Co., Royersford, Pa.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Rapping Plates.
Milwaukee Fdry. Supply Co., Milwaukee, Wis.

Reamers.
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Works, Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Van Dorn Elec. & Mfg. Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Reamers, Adjustable.
Cleveland Twist Drill Co., Cleveland, O.
Crescent Mfg. Co., Scottdale, Pa.
Kelly Tool Co., Cleveland, O.
Lapointe Machine Tool Co., Hudson, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Works, Gloucester City, N. J.
Schellenbach-Hunt Tool Co., Cincinnati, O.

Reamers, Pneumatic.
Stow Flexible Shaft Co., Philadelphia, Pa.

Rivet and Spike Machinery.
National Mchy. Co., Tiffin, O.

Riveters.
Chambersburg Engineering Co., Chambersburg, Pa.
Grant Mfg. & Mch. Co., Bridgeport, Conn.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Shepard Elec. Crane & Hoist Co., Montour Falls.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.

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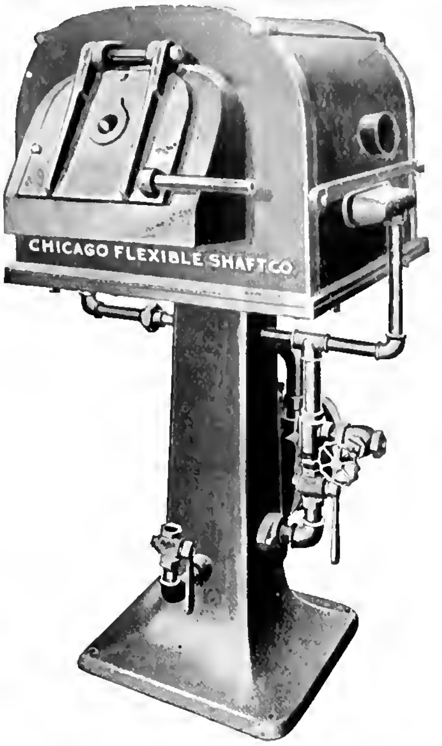
For alphabetical Index see Page 36.

The Stewart Gas Blast Furnace Is



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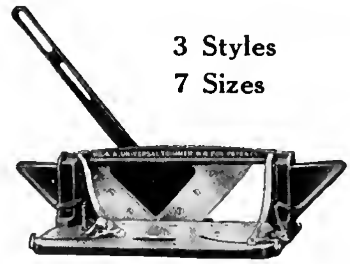
YOUR PATTERNMAKERS

with the block plane and cut-and-try method of fitting together pattern parts.

THEIR TIME IT TOO EXPENSIVE

GET A

FOX TRIMMER



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7 Sizes

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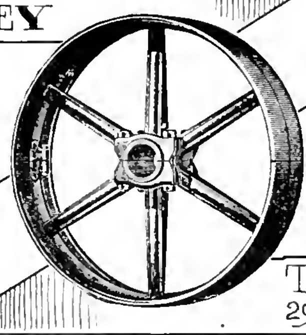

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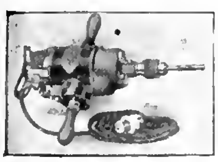

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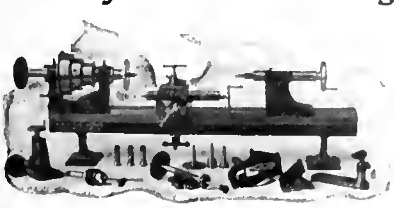

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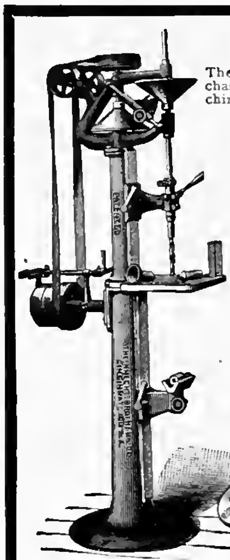

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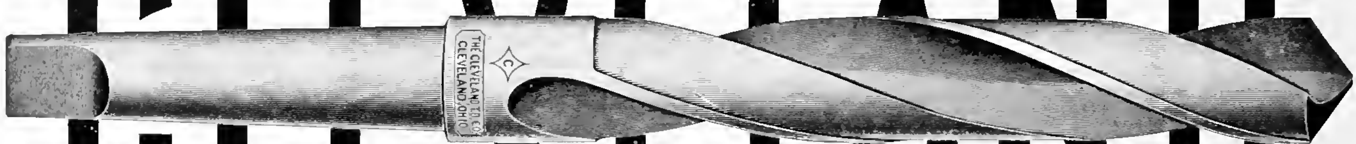

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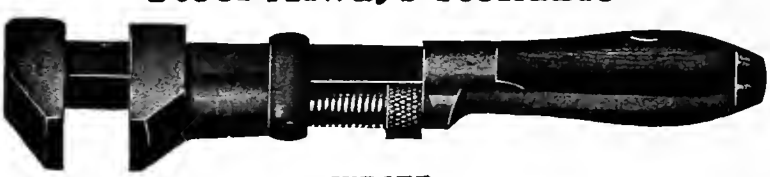

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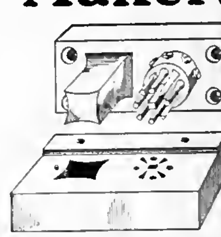

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MACHINERY.

August, 1908.

LAUNCHING A GREAT LAKES FREIGHTER.

RALPH E. FLANDERS *

THE work of the engineer, for the most part, has a dull and uninspiring aspect. Years of experience may have been brought to bear on the design and manufacture of a 90-pound rail, but the traveler who is whirled madly over it in the eighteen-hour train, knows little of the care and skill expended in perfecting this one of the many details which have to be perfected, if his journey is to be reasonably safe and comfortable. The planning and construction of the water system of a great city requires engineering ability of the highest kind, and on the successful solution of the problems involved, depend the health and happiness of thousands of human beings; but, aside from an incidental spectacular undertaking, like the Croton Dam, or the long intake tunnels of the cities bordering on the Great Lakes, there is nothing beyond the occasional frozen pipe or too industrious meter, to draw the attention of the householder to any point more distant than the faucet from which he obtains his supply.

When it comes to the building of a vessel, however, the engineer has his turn, particularly in the act by which the completed hull is transferred from the solid ground on which it was built, to the water which is thenceforth to bear it throughout its useful life. The launching of a vessel is spectacular in the extreme, and has excited the imagination of poets and moralists for generations; and there is no purely engineering event which has such a fascination for the common, everyday, unimaginative citizen who is fortunate enough to witness it.

From what has just been said, the reader may perceive (even if the thought would not occur to him naturally) that Mr. Pessano, president of the Great Lakes Engineering Works, provided a most satisfactory spectacle when he arranged for the launching of a large freighter during the time of the convention of the American Society of Mechanical Engineers, at Detroit, last June. Not only was the event spectacular, as intimated, but the means provided for supporting the hull on land and launching it into the water, are of such an interesting nature, mechanically, that quite possibly a brief description of them will be appreciated by the reader.

In the first place, we will have to understand a little something of the way in which the hull of a vessel is erected. In the shipyard in question, the work is carried on in a very systematic fashion. The various plates and beams which go to make up the keelson, frames, sides, etc., are all cut, drilled, and formed in the shops, to patterns carefully prepared in the mold loft, from drawings furnished by the designers. As these parts are completed, they are taken to the berth in which the vessel is to be constructed, where they are assembled into place in their proper order, it being taken for granted that no further drilling or fitting will be required. The keel plates and keelson are laid, the frames erected, and the side and bottom plates temporarily bolted in place, all with astonishing rapidity.

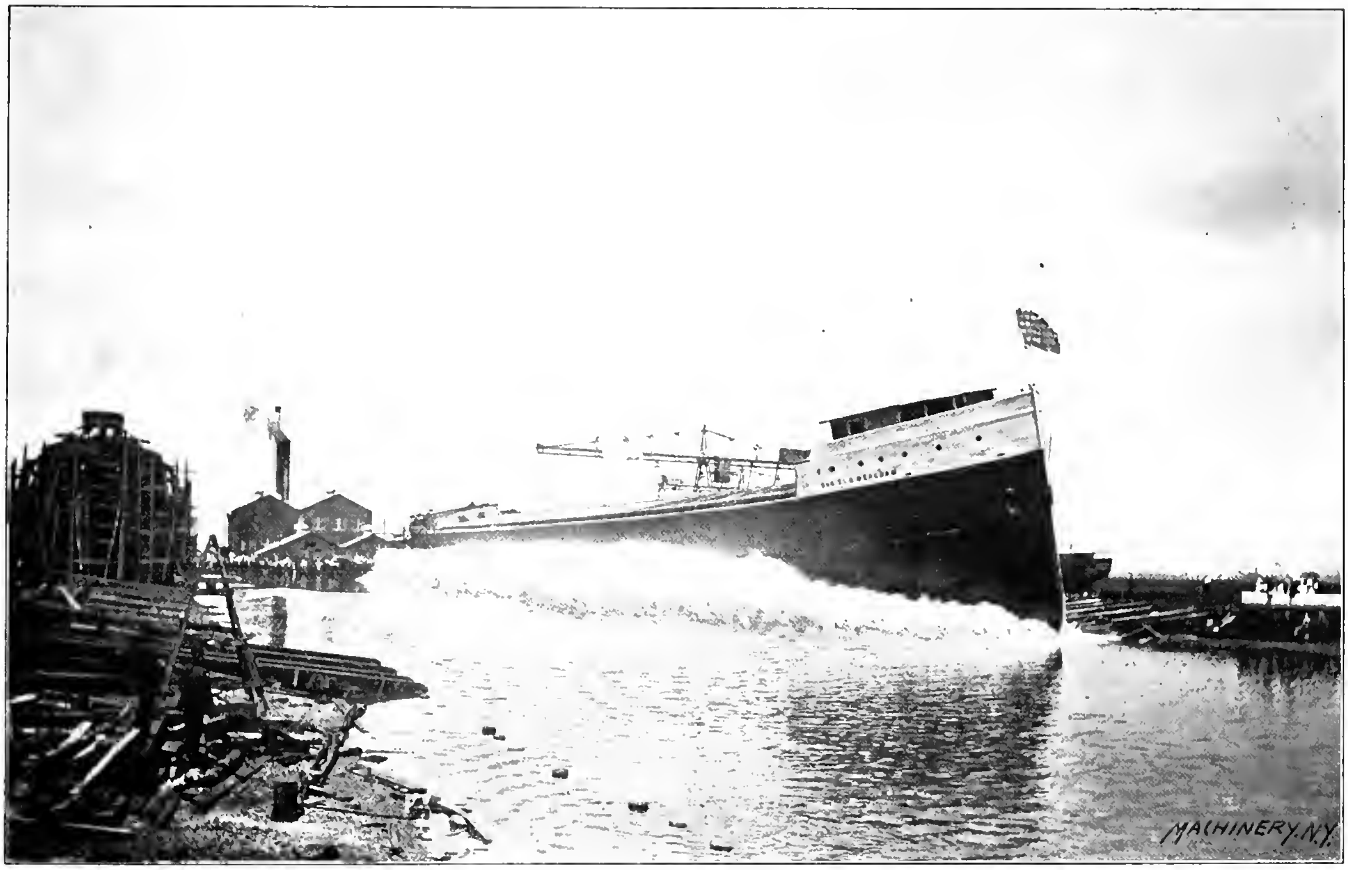

Fig. 1. The Launching of the 10,500-ton Lake Steamer, the Daniel B. Meacham, an Event of the Detroit Meeting of the A. S. M. E.

The whole structure is supported, with the flat bottom five or six feet from the ground, on piles of heavy blocking, placed under the various frames, where the great weight of the hull can be borne without damage to it. These piles of blocking will be seen in Figs. 2, 3 and 4, where they are shown resting on the ground, being thus distinguished from those to be described later, resting on the sloping beams or "ways."

It will be seen that each of these piles is capped by a block set on wedges, by means of which the support given the hull may be increased or relieved. The necessity for this will be understood when it is remembered that each of these many supports has to be removed during the progress of the work,

* Associate Editor of MACHINERY.

to permit rivetting the holes in that portion of the hull which it conceals. As the rivetting proceeds, and these piles of blocking are from time to time removed, the weight reposing on each is transferred (by means of the wedges) to new piles, placed in adjacent positions under completed areas of the hull. It will thus be seen that when the dry land work is finished, every one of the original supports has been removed, and the whole weight transferred to a new foundation.

As the hull approaches completion, preparations are made for the launching. It should be understood that these flat-bottomed, cargo-carrying vessels are, in the Great Lakes district, launched sideways into the water. This can be done into a narrow slip, without obstructing navigation in the channel. No cradle is required for supporting the sliding hull, as is necessary with sharper built, high-speed vessels.

Before the time set for launching, the sloping beams known as the "ways," and shown in all the illustrations, are solidly laid beneath the vessel, with their smooth upper surfaces lined up in the same plane with each other. New piles of blocking (shown in Figs. 2, 3 and 4) are then erected on the ways, with top blocks supported by wooden wedges whose ends are barely entered, as shown best at *A* in Fig. 3. Before laying this blocking, the surface of the way beneath the pile is greased, and a dog is driven in to prevent the blocking from slipping, until the hour arrives for the launching.

When everything is ready, all the wedges *A* in all the piles are driven in, and the whole ship is thus lifted onto the ways. The stationary piles, such as *B* in Fig. 3, are then loosened and

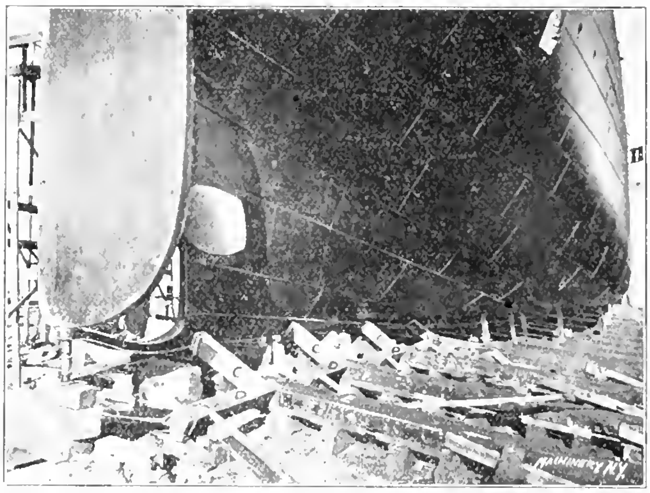

Fig 2. View of Stern showing the Launching Ways, and the Three Triggers which retain the Vessel at this End.

knocked out of the way. To facilitate this, it will be noticed that in pile *B* is a double wedge block, held together by a steel plate with cross pins at each end. If the hull is not entirely lifted from the blocking, the removal of the pin in the plate permits the upper wedge block to slide off the lower one as soon as the vessel begins to move.

Provision has to be made to keep the vessel from sliding off into the water after it has been raised onto the ways by the driving of the wedges, and before the moment for launching arrives.

To effect this, struts or "dog shores" *C* (as shown in Figs. 2, 3 and 4) are set against the seam of the keel-plate of the vessel, with their lower ends bearing on triggers *D*, which, in turn, are supported at the inner ends against abutments *F* on the sides of the ways *E*. The dog shore and the abutment are so located as to make each trigger a lever of high ratio, and the force with which the vessel tends to slide down the ways is transferred (in diminished degree) to the wire ropes looped around the outer end of each. As may be seen in Fig. 4, these wire ropes are carried to the upper side of the berth, where they are attached to posts in the ground by ropes and tackle blocks, by which the triggers and dog shores are strained up against the keel-plate. It is the chopping of these ropes, where they are looped around the posts, that finally releases the vessel.

In this case there were eight triggers—three each at the bow and stern, and two amidships. In Fig. 4 a workman is shown in pantomime in the act of cutting one of the trigger ropes. If he had done it in reality at the time the picture was taken, it is well within the bounds of possibility that he might have been "fired."

The order of procedure in launching is something like this: First, the exposed portion of the upper side of the ways is greased, the area under the blocking having been already treated, as explained. Then a small army of men is set at work driving the wedges (see *A* in Fig. 3), which raise the

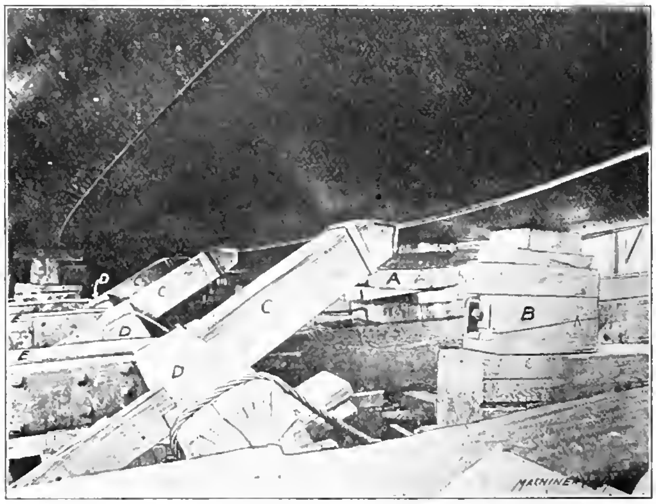

Fig. 3. Details of the Trigger, and the Stationary and Sliding Blocking under the Bow.

vessel onto the ways. After a few minutes of driving, a period of rest follows, to allow the blocking to settle as it receives the weight. Then a second period of driving, another of rest, and the final drive, which leaves most or all of the ground blocking free, the vessel being now held from sliding only by the triggers and the dogs driven into the ways.

As the blocking and the dogs are removed from each section, the foreman of that section, assured by careful inspection that everything is free, removes from the ground a white stake, previously set outside of his section. In addition, there are three stakes at each end of the line, representing the three piles of keel blocking at the stem and the stern. As the clearing away of each section proceeds, the superintendent is informed of the progress of the work by the successive removal of the stakes, and the final removal of the keel block stakes at the ends. When all is thus known to be ready, the time for launching has arrived, and the workmen come out from under.

Now the speeches are made, and the girl with the champagne bottle takes her place on the stand at the prow. Then

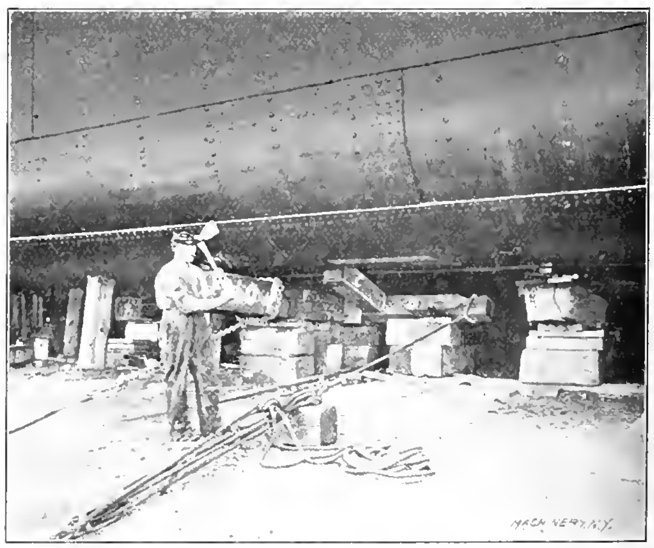

Fig. 4. The Man that wields the Axe that cuts the Rope that binds the Trigger that holds the Ship.

the superintendent gives the order, and the two amidship trigger ropes are cut. The ship is flexible enough to spring down the ways several inches when this is done, being still held at the stem and stern. A fixed gage is generally set in the ground amidships, just touching the side of the vessel before the triggers are released. The deflection is measured by the resulting gap, to get some idea of the ridigity of the

structure. Finally the order is given to cut the stem and stern trigger ropes, and the vessel is thereby released.

This whole mechanism, it will be seen, is of the simplest. In its essentials, it has been changed little in generations, though it has been modified somewhat for the sidewise launching. The carefulness of the axmen in cutting the trigger ropes at the moment of the signal, is relied on to release both ends simultaneously.

The launching at Detroit was witnessed by the members and guests from the decks of the steamer *Brittania*, which lay out in the stream two hundred feet or so from the entrance to the slip. It was a gala day for the assembled employes and their families, as well as for the engineers. The army of workmen beneath the vessel had made their first and second drives before we arrived, and were engaged in their third as our boat took its position. The innumerable hammer blows, whose aggregate force bodily raised the great mass, sounded like the rattle of a battery of rapid-fire guns. We were too far away to hear the orders, or the speech-making, but we could see the white stakes disappearing, one after the other, and knew that the sharp eyes of the superintendent were watching them also. Finally, after what seemed an interminable wait, the stern started slowly down the ways, with the bow following a fraction of a second later. It slid thus, slightly canted, gathering

Fig. 5. General View of the Vessel on the Launching Ways.

speed as it went, and finally shot off the ways into the water, gracefully clearing their dangerous-looking lower ends.

There may have been some in the party who saw the girl in white, smash the beribboned bottle on the prow as the vessel slipped away. It is impossible to see everything at once. The writer's clearest recollection is that of watching the great broadside wave kicked up by the hull, pour over the further edge of the slip, and up onto the land, mixing lumber piles, spectators, and relics of the blocking in one long, confused windrow. None of the unfortunates were drowned, but they were all badly "mussed."

The movement of the vessel was arrested before it struck the other bank, partly by the tremendous resistance offered by the hull against the confined water of the slip, and partly by the numerous cables by which it was connected with the shore. The launching was said to have been one of the most successful on record.

The *Daniel B. Meacham*, for thus the vessel was christened, is to add one more to the wonderful navy of freighters which ply the waters of the Great Lakes. It is one of the sights of the world to watch, from the meadows about this shipyard, the vessels of this great navy as they pass up and down between the grassy banks of the beautiful Detroit River. Long and low, with texas and pilot-house at the prow, and engines, boilers, and crews' quarters at the extreme stern, they are built for "strictly business"—but the builders are proud of them. It is difficult to believe it, but the total tonnage passing through the Detroit River in the eight or nine months the channel is open, exceeds the combined annual tonnage of the harbors of New York, London, Liverpool, and Hamburg. One of these stately freighters passes the city, on an average, every seven minutes, weighted with its cargo of ore, coal, or wheat. Perhaps some time we will build a canal which will release this fleet from its narrow bounds, and permit it to carry our produce and our flag to countries across the sea.

* * *

A certain wealthy man living in New Jersey, not many miles from New York City, maintains a large estate. It is stocked with fine horses and cattle, and has a modern dairy. The surplus milk from this dairy is sold to customers at a price slightly above that received by neighboring dairymen whose dairies are not kept in as scrupulously clean and hygienic condition. Certain captious critics found fault with their wealthy neighbor's enterprise and asked why this man who possesses so much of the material things of life should so demean himself as to "peddle milk." They and others suggested that the eminently proper thing to do with his surplus milk was to give it away to the deserving poor, to charitable institutions, hospitals, etc. It seemed to them to be the only course a wealthy man could follow without doing an injustice to his dairymen neighbors and lowering his position. This mistake, for mistake it certainly is, arises from two causes; the first is pure snobbery, and the second cause, with which this note is concerned, is a mistaken idea of the source of wealth. Wherein is this man wealthy? In his possession of ways and means that enable him to command the labor of others? He has title to land, houses, barns, stock in transportation lines, mines and other wealth-producing enterprises. He, in one way or another, directs the energies of many thousand persons, but he cannot waste their energies without causing economic loss. If he chose to give away the milk produced on his dairy farm it would simply mean in the last analysis that he orders certain laborers or servants to work for other individuals for no compensation. The fact that his personally employed servants receive payment from him does not matter. The persons benefiting by his charity would give no recompense, and such practices would be ruinous if followed on a large scale. Because a man is wealthy, it does not give him the right to waste the work of others. The law of supply and demand hinges on the principle of compensation, and is as immutable as the law of conservation of energy.

* * *

The daily press, and even some technical journals, have published a statement to the effect that a "wireless" truck has been in operation in the yards of the Union Pacific's Omaha shops, this being the latest development in wireless transmission of electrical power. It was stated that this truck was used to haul a string of smaller trucks, loaded with material, from one point in the shops to another, the source of power being a wireless station in the center of the shop plant. It has been stated that the inventors of this wireless power transmission scheme are Dr. Frederick H. Millener and W. R. McKeen, Jr., the latter superintendent of motive power of the Union Pacific Railroad Co. We have been informed by Mr. McKeen, however, that the newspaper articles printed in regard to the operation of the "wireless" truck at the Omaha shops have been considerably exaggerated. The facts in the case are that for experimental purposes a storage battery truck has been equipped with necessary receiving wires, and wireless waves have been used in connection with a wireless telegraph outfit for connecting and breaking the circuit between the batteries and the motor on the car, thereby starting and stopping the latter.

* * *

Engineers, at the outset of their professional careers, are taught to give honest work for their money, and being absorbed in the study of truths of nature, are forced to forego the cunning whereby to possess themselves of money and power which they have not earned.—*W. D. Marks, in Engineering News.*

THE DESIGNING OF MACHINE FRAMES.

E. A. FESSENDEN.*

For men of limited experience, a machine frame of the common C-type, such as is used in punching and shearing machines, in some kinds of riveters, and, in a modified form, in slotters, drill presses, steam hammers, and many other tools, is always more or less difficult to design. The stresses are rather complex, and the means for securing the best distribution of metal for bearing these stresses is not easy. Much has been written on the subject, and the author of this article does not claim any originality in the ideas involved in the discussion. It is believed, however, that the method of presenting the solution of the problem has some points that may merit consideration. A common punching and shearing machine frame will be used for illustration, because the form and proportions of these frames are so well known. The method employed, however, is perfectly general and may be used for many other machine frames.

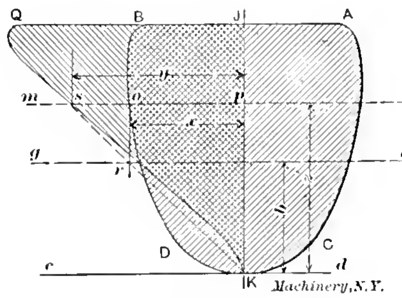

Fig. 1. Graphical Method for Finding the Center of Gravity.

In the discussion which will follow, it will be necessary to use the moment of inertia and center of gravity of an irregular section. The method of finding these quantities, which is outlined below, is not original with the author, but he has not seen it previously published, and it is presented here in the hope that its use may become more general.

The following graphical method for finding the center of gravity and moment of inertia of an irregular figure, will be found to offer an advantage over the ordinary method by calculation, in the matter of time saved.

Let $ABDC$, Fig. 1, represent any irregular section. In the figure, a section symmetrical about a vertical axis is shown, and the construction carried out for half of the figure. For an unsymmetrical section, both sides would have to be considered, as well as a construction for the gravity axis parallel to two base lines. A case of this sort will rarely arise in practice.

Lay off the line gh at any distance b from the edge of the section. The line gh is perpendicular to the center line JK. Then lay off another line mn, parallel to gh, at any distance z from cd. Let the distance op be called x. From o drop a perpendicular on gh cutting at r. Join K and r and extend the line until it cuts mn at s, and let $sp = y$. After determining several points s in the same way, connect them by a smooth curve, giving the figure KQJ.

Then by our construction, we have,

$$\frac{y}{x} = \frac{z}{b}; \qquad y = \frac{xz}{b}$$

The area of KQJ is

$$G = \int y dz = \frac{1}{b} \int xz dz$$

But $\int xz dz$ is the "static moment" of the original figure $KDBJ$, and therefore bG is the static moment of $KDBJ$ about cd. If A is the area of $KDBJ$

$$\frac{bG}{A} = \frac{\text{static moment of } KDBJ}{\text{area of } KDBJ}$$

$$= \text{distance from } cd \text{ to center of gravity} = e.$$

If the areas A and G and the distance b are measured, the distance to the center of gravity is readily found from this last equation. A planimeter offers the best means of measuring the areas, but if this is not possible, sufficient accuracy may be attained by dividing the areas to be measured into rectangles and triangles, computing their separate areas and taking the sum of the areas of all the subdivisions as the area of the original figure.

* Address: University of Missouri, Columbia, Mo.

There is a similar construction for finding the moment of inertia, that should be carried out on the same figure as was used for finding the center of gravity. The two constructions are separated here in order to avoid confusion in explaining them.

In Fig. 2 the lines gh and mn are laid off as before so that pq is x, and pw is y. Then we is drawn from w perpendicular to gh; join K and e and extend Ke to f, making $pf = y_1$. Several points f will give the figure KSJ, and we have, as before

$$\frac{y}{x} = \frac{z}{b}; \qquad y = \frac{xz}{b}$$

and also,

$$\frac{y_1}{y} = \frac{z}{b}; \qquad y_1 = \frac{yz}{b} = \frac{xz^2}{b^2}$$

Then the area of KSJ is

$$J = \int y_1 dz = \frac{1}{b^2} \int xz^2 dz$$

but the moment of inertia

$$I = \int xz^2 dz$$

from which

$$J = \frac{1}{b^2} I; \text{ and } I = b^2 J.$$

In this equation we know b, and can measure J as before.

This construction gives the moment of inerita about the line cd, whereas it is generally required about the gravity axis. It might have been so found if the base line had been the gravity axis instead of the line cd. However, the mathematical computation for the transformation of axes is easily made. The following formula should be used:

$$I_o = I_{cd} - e^2 A,$$

where I_o = moment of inertia about gravity axis,

I_{cd} = moment of inertia about cd,

e = distance from cd to center of gravity,

A = area of $KDBJ$.

It is to be clearly understood that the values of e and I found above refer only to the figure actually drawn on the drawing

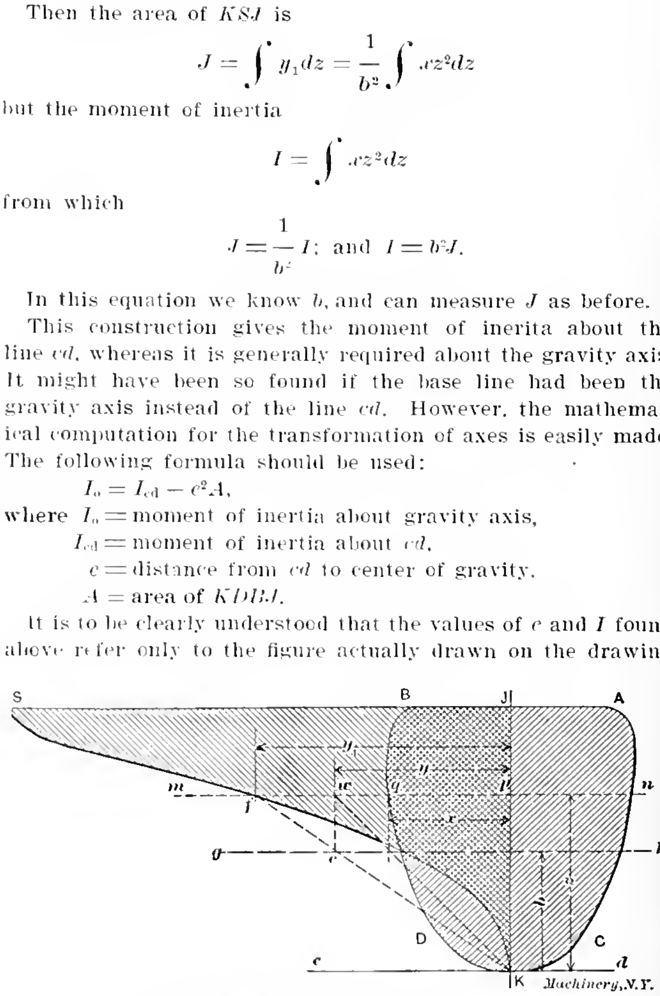

Fig. 2. Graphical Method for Finding the Moment of Inertia.

board and not to the full-sized section. For the actual values we have

$$I_{\text{actual}} = X^4 I_{\text{drawing}}$$
$$e_{\text{actual}} = X e_{\text{drawing}}$$

where X is the scale of the drawing.

Fig. 8 shows the construction applied to a punch frame section.

The Stresses Involved in a Punch Frame.

Let Fig. 3 represent the side view of a punch frame. It will be sufficient to investigate the stresses at four different sections, testing at other points later if it appears necessary. The preliminary calculations will be made on sections indicated at AB, CD, EF, and GH or JK.

For determining the stresses on the section AB, consider the upper portion of the punch a "free body" as shown in Fig. 4. It is subjected to an external force P, acting upwards, arising from the resistance of the material being punched. In the actual punch this force tends to separate the jaws. To balance P there is an internal stress acting over the section AB. The following discussion will show that this internal stress is a compound stress.

Conditions of equilibrium require that the algebraic sum of all forces, external and internal, acting on a body, must be zero; and also that the sum of all couples, or forces tending

to produce rotation, must be zero. It is then evident that to balance P there must be downward forces equal to P. Such downward forces exist in what may be considered as a uniform tensile stress of t_1 pounds per square inch over the section AB. The resultant of all these small downward forces making up the uniform tensile stress, can be considered as a single force P_1, equal to P, acting at the center of gravity of the section AB. The algebraic sum of all the forces on the free body is now zero, but P and P_1 together form a couple of value $Pl_1 = P_1l_1$, tending to rotate the portion of the punch under consideration in a clockwise direction, so that an equal and opposite internal couple is necessary to balance it. This

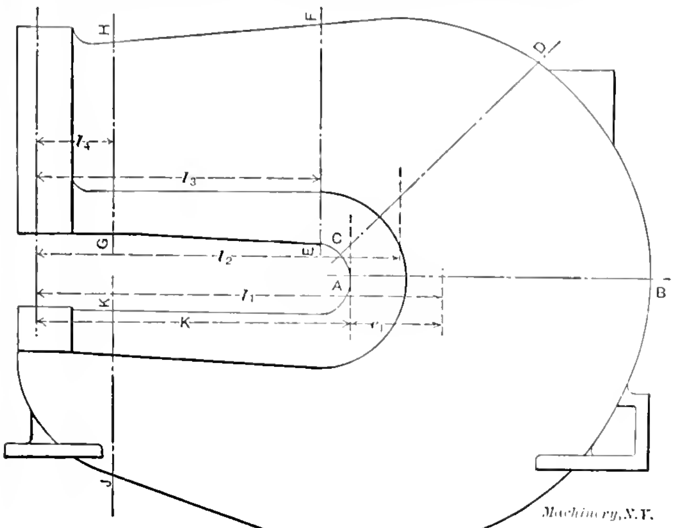

Fig. 3. Side View of Punch Frame.

internal couple acts over the entire surface of the section AB, and may be considered as being made up of an infinite number of small couples, each consisting of a tensile stress on the throat side of the frame sectien and an equal compressive stress on the outer part of the section. (See Fig. 4.) Then the total internal stress may be found by combining these elementary stresses as shown.

The following formulas are used to calculate the values of these internal stresses. Their derivation is comparatively simple, and may be found in any treatise on the mechanics of materials.

$$P = \pi dts, \tag{1}$$

where d = greatest diameter of hole to be punched on the machine considered,
t = thickness of plate punched,
s = shearing strength of material punched.

$$t_1 = \frac{P_1}{A_1} = \frac{P}{A_1}, \tag{2}$$

where t_1 = uniformly distributed tensile stress over section AB, in pounds per square inch.
A_1 = area of section AB, in square inches.

$$f_1 = \frac{P_1l_1}{N_1} = \frac{M_1e_1}{I_1} \tag{3}$$

where f_1 = tensile stress at point A, due to couple P_1l_1, in pounds per square inch.
l_1 = arm of couple in inches $= K + e_1$ (Fig. 4),
e_1 = distance from center of gravity of section to edge next to punch throat, in inches,
N_1 = section modulus, for tension, of section $AB = \frac{I_1}{e_1}$,
M_1 = bending moment in inch pounds,
I_1 = moment of inertia of AB about gravity axis.

$$c_1 = \frac{P_1l_1}{Z_1} = \frac{M_1z_1}{I_1} \tag{4}$$

where c_1 = compressive stress, in pounds per square inch, at point B, due to couple P_1l_1.
Z_1 = section modulus of section AB, for compression, $= \frac{I_1}{z_1}$

where z_1 is the distance from the center of gravity to the outer edge of the section.

The following equations may be written for the maximum stresses on the section AB

Maximum unit tension

$$= T_1 = t_1 + f_1 = \frac{M_1e_1}{I_1} + \frac{P_1}{A_1} = \frac{P_1l_1e_1}{I_1} + \frac{P_1}{A_1} \tag{5}$$

Maximum unit compression

$$= C_1 = c_1 - t_1 = \frac{M_1z_1}{I_1} - \frac{P_1}{A_1} = \frac{P_1l_1z_1}{I_1} - \frac{P_1}{A_1} \tag{6}$$

In equations (5) and (6) everything is known from the conditions that would be given in the problem, as it is received by the designer, except the quantities $\frac{e_1}{I_1}$, $\frac{z_1}{I_1}$ and A_1. It will be seen that these are all factors depending on the size and shape of the section AB under consideration, and these are for the designer to determine.

Method of Designing Frame.

After clearly understanding the stresses involved in the design, the next step will be to proportion the frame to withstand these stresses. This may be accomplished in the following manner:

1. Assume the shape of the section at AB, Fig. 3. In making this assumption the designer will have to be guided by experience, either his own or that of others as shown in machines already built, catalogues, textbooks, drawings, photographs, or any other means of gaining information that is available. The section shown in Fig. 8 will give a fairly good idea of the commonest form used for punches. In making the first drawing it is not necessary to make any assumption as to the *size* of the finished section; the *shape* is all that is necessary.

2. Lay out this section on a drawing board. Use any scale, and make the drawing rather large, say eight inches as the longest dimension. The *size* is of no particular importance, only be careful to get the figure drawn of the same proportions as desired in the final section.

3. Find the gravity axis and the moment of inertia of the figure drawn, by the graphical method explained above.

4. It is evident that the figure drawn will not be the correct *full sized* section of the punch, but it will be a drawing of that sectien to some scale. Let that unknown scale be such

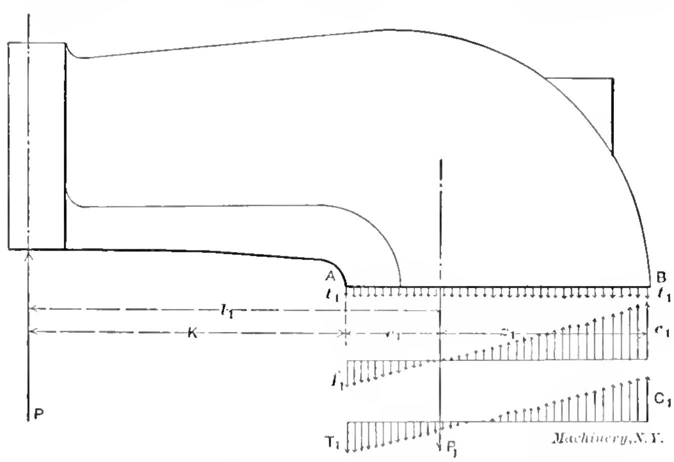

Fig. 4. Graphical Illustration of Stresses in Punch Frame.

that one inch on the drawing represents X inches on the actual section. If, then, quantities relating to the figure on the drawing board are represented by letters with the subscript d, and quantities relating to the actual section, by letters without additional subscripts, the following equations will hold true:

$$e_1 = X(e_1)_d \tag{7}$$
$$z_1 = X(z_1)_d \tag{8}$$
$$A_1 = X^2(A_1)_d \tag{9}$$
$$I_1 = X^4(I_1)_d \tag{10}$$

We can measure $(e_1)_d$, $(z_1)_d$, $(A_1)_d$, and $(I_1)_d$ directly from the drawing, and insert the values for e_1, z_1, A_1 and I_1 in equations (5) and (6). We then have

$$T_1 = \frac{P_1l_1X(e_1)_d}{X^4(I_1)_d} + \frac{P_1}{X^2(A_1)_d}$$

$$= \frac{P_1[K + X(e_1)_d]X(e_1)_d}{X^4(I_1)_d} + \frac{P_1}{X^2(A_1)_d} \quad (11)$$

$$C_1 = \frac{P_1 l_1 X(z_1)_d}{X^4(I_1)_d} - \frac{P_1}{X^2(A_1)_d}$$

$$= \frac{P_1[K + X(e_1)_d]X(z_1)_d}{X^4(I_1)_d} - \frac{P_1}{X^2(A_1)_d} \quad (12)$$

Equation (11) can now be used to solve for X, if the allowable value for T_1 is known. A machine of the punch or shear type is subject to severe shock at the moment the tool strikes the metal. For this reason a very low allowable safe stress should be taken. It is suggested that the maximum allowable tensile or shearing stress be not greater than 2,000 to 2,200 pounds per square inch for cast iron. Equation (11) is a

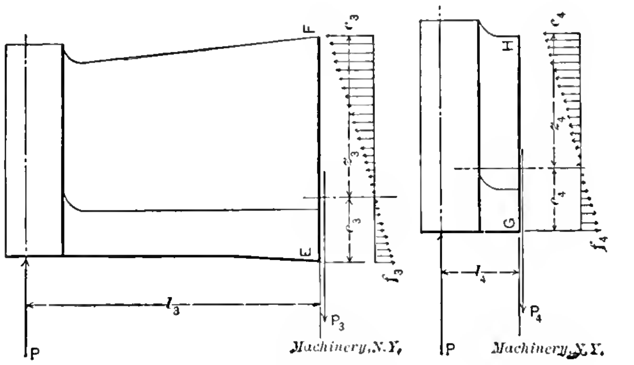

Fig. 5. Fig. 6.

Graphical Illustration of Stresses in Punch Frame.

4th power equation, and the quickest and easiest way to solve it is by trial. After finding the value of X from equation (11), it can be substituted in equation (12) to find the value of C_1. This should not exceed 8,000 to 10,000 pounds per square inch. It will usually be found much less than this, because mechanical difficulties are encountered in the manufacture of the punch if the outer part of the section is made thin enough to raise the compressive stress to the highest allowable value. These difficulties are mainly in the shape of extremely high cooling strains in the casting, so that the risk is too great to compensate for the comparatively small saving in iron. Take the value of X found, and apply it to the original drawing to find the actual size of section. All linear dimensions of the drawing will be multiplied by X to get the actual size. This will fully determine section AB.

Having section AB, there are two methods of determining other sections. They may be found in a manner exactly similar to that used for section AB, by assuming a *shape* of section and solving for the *size*, or the size and shape may both be assumed and then tested for safety. The latter method will undoubtedly give the most satisfactory results, because it would probably require a great many trials by the first method for the reason that while each section would be strong enough to bear the stresses upon it, there would be considerable difficulty in combining these independently found sections into a pleasing and harmonious whole.

After finding section AB, use it as a basis, together with all the other known data about the punch, from which to assume an outline of the side view. In this part of the work, as in the first assumption of the shape of section AB, reference must be made to the results of past experience, and here again books, drawings, and illustrations will be found helpful. Fig. 3 is a side view of the frame of a punch made by one of the largest manufacturers of machine tools in the United States; if nothing better is at hand, it may be used as a guide. The thickness of the outer part of the frame is kept the same as was found for the section AB, and the frame is a trifle narrower from side to side at the tool end than at the back end.

Now, consider a section along some plane EF, parallel to the line of action of the tool. The "free body" is shown in Fig. 5. The forces acting on the free body are found in a manner very similar to that used in discussing the stresses in the section AB. Let all quantities relating to this section be denoted by the subscript 3, and have the same meaning as the same letters had when used with subscript 1 in the discussion of section AB. The following equations may then be used to determine the stresses on the section.

P = the punching pressure.

P_3 = a force equal and opposite to P, causing shearing stress along EF.

P and P_3 with arm l_3 form a couple. This tends to produce bending in the frame and must be resisted by an internal moment of equal magnitude, M_3.

$$M_3 = P_3 l_3 = P l_3. \quad (13)$$

As before, we have the tensile stress in section EF at E due to the couple as

$$f_3 = \frac{M_3 e_3}{I_3} \quad (14)$$

and the compressive stress in the section at F, due to the couple as

$$c_3 = \frac{M_3 z_3}{I_3}. \quad (15)$$

The shearing stress is distributed uniformly over the entire section and its value is

$$s_3 = \frac{P_3}{A_3} = \frac{P}{A_3}. \quad (16)$$

The maximum tension, compression, and shearing effects are found by combining f_3, c_3, and s_3, according to the rules found in various works on the mechanics of materials. "Kent's Mechanical Engineer's Pocketbook" (7th edition, p. 283) gives the following rules, taken from Prof. Merriman's "Strength of Materials."

$$T_3 = \tfrac{1}{2} f_3 + \sqrt{s_3^2 + \tfrac{1}{4} f_3^2} \quad (17)$$

$$C_3 = \tfrac{1}{2} c_3 + \sqrt{s_3^2 + \tfrac{1}{4} c_3^2} \quad (18)$$

$$S_3 = \pm \sqrt{s_3^2 + \tfrac{1}{4} f_3^2} \text{ or } \pm \sqrt{s_3^2 + \tfrac{1}{4} c_3^2} \quad (19)$$

Since the value of s_3 is uniform over the entire section, while the stresses due to the couple are variable, it is evident that the maximum shearing effect will occur at that part of the section where the stresses due to the couple are a maximum, *i. e.*, probably at F.

The section must be designed strong enough to resist both tension and shear. In general, it is not possible to make it equally strong to resist both, when such a material as cast iron is used. At a section near the end, the shearing stress may be the one to fix proportions, but when taken near the back of the throat, the tensile stresses are more liable to require consideration.

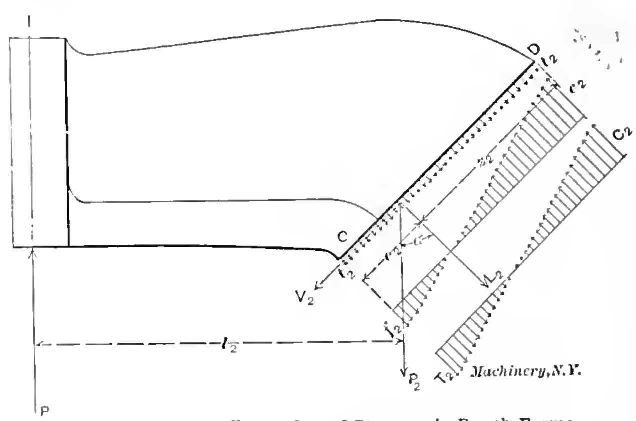

Fig. 7. Graphical Illustration of Stresses in Punch Frame.

Equations (17), (18), and (19) should be solved for T_3, C_3, and S_3, and the results should show values within the maxima stated above. If the section is well designed, the values of T_3 and S_3 will not be very different from those mentioned, and as before, the section will probably be excessively strong in compression.

A section taken at GH or JK would be investigated in a manner exactly similar to that used for the section EF. (See Fig. 6.) It may be expected that the section at GH will appear much stronger than necessary, but this is because it is necessary to provide a space for the main shaft to pass through, as well as for the sake of appearance. The head will need to be large to accommodate the moving parts within it, and the part of the frame immediately behind the head must not appear too small to support the head.

It is next necessary to consider a section taken at an angle, for example along the line CD. The free body is shown in Fig. 7. The forces will be denoted by the same letters as heretofore, but with the subscript 2.

P = the punching pressure,

P_2 = a force equal and opposite to P; P_2 is resolved into two components, L_2 and V_2,

$L_2 = P_2 \cos \alpha$ (produces uniform tension),

$V_2 = P_2 \sin \alpha$ (produces shearing stress).

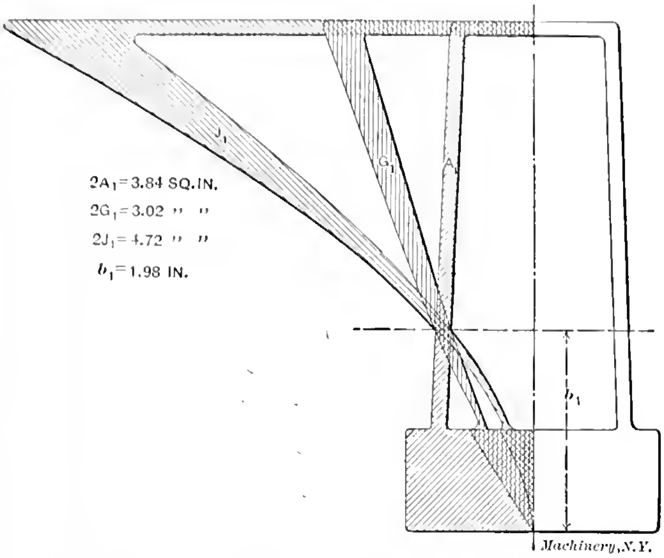

Fig. 8. Section of Punch Frame showing Method of Determining the Center of Gravity and the Moment of Inertia.

P and P_2 together form a couple which has a value $P_2 l_2 = P l_2$, which must be resisted by an internal moment, M_2.

$$M_2 = P_2 l_2 = P l_2, \qquad (20)$$

As before,

$$f_2 = \frac{M_2 e_2}{I_2} \quad (21) \qquad c_2 = \frac{M_2 z_2}{I_2} \quad (22)$$

$$t_2 = \frac{L_2}{A_2} \quad (23) \qquad s_2 = \frac{V_2}{A_2} \quad (24)$$

The maximum stresses per square inch will then be

$$T_2 = \frac{f_2 + t_2}{2} + \sqrt{s_2^2 + \left(\frac{f_2 + t_2}{2}\right)^2} \qquad (25)$$

$$C_2 = \frac{c_2 - t_2}{2} + \sqrt{s_2^2 + \left(\frac{c_2 - t_2}{2}\right)^2} \qquad (26)$$

$$S_2 = \pm \sqrt{s_2^2 + \left(\frac{f_2 + t_2}{2}\right)^2} \text{ or } \pm \sqrt{s_2^2 + \left(\frac{c_2 - t_2}{2}\right)^2} \qquad (27)$$

Take the greater of the two expressions in equation (27) for the subsequent work. This section will have dimensions between those of AB and EF.

Example of Calculation.

In order to illustrate the method of procedure outlined above, the following example is given. The machine in question is designed to punch a 1¼-inch hole in a 1-inch plate. The throat depth is 60 inches.

The punching force necessary may be found from equation (1).

$P = \pi d t s = \pi \times 1.25 \times 1 \times 50{,}000 = 196{,}350$ pounds.

The punch frame is to be of the same general form as that shown in Fig. 3, except that the section at JK is to be of the same size as that at GH. By reference to various drawings and photographs the shape of the section at AB is assumed to be that shown in Fig. 8. This is drawn, in this case, on a drawing board, making the longest dimension 5.01 inches (for general practice it would be well to make the drawing larger than this, say 8 inches high), and the figures denoted by G_1 and J_1 constructed for finding the gravity axis and the moment of inertia. In this case only half of the construction is carried out, because the section is symmetrical about the vertical center line, and it will be understood that the areas measured have to be doubled before they are used in the computations, i. e., the values of the areas A_1, G_1 and J_1 used in the following calculations are not the areas actually measured from the drawing as shown in Fig. 8, but twice these values, to account for the construction for the right hand side of the section which is not carried out on the drawing board. With a value of b_1 as 1.98 inch, the areas of A_1, G_1, and J_1 when measured with a planimeter are as follows:

$A_1 = 3.84$ square inches,

$G_1 = 3.02$ square inches,

$J_1 = 4.72$ square inches.

Then the values of the moment of inertia and the distance from the bottom of the figure to the gravity axis may be found through the use of equations given in the first part of this article, as follows:

$$(e_1)_a = \frac{bG_1}{A_1} = \frac{1.98 \times 3.02}{3.84} = 1.56$$

$$(z_1)_a = 5.01 - (e_1)_a = 5.01 - 1.56 = 3.45$$

$$(I_1)'_a = b^2 J_1 = (1.98)^2 \times 4.72 = 18.5$$

$$(I_1)_a = (I_1)'_a - (e_1)^2{}_a A_1 = 18.5 - (1.56)^2 \times 3.84 = 9.2$$

These values apply only to the figure which was drawn on the drawing board and not to the actual section. It is next necessary to find the size of the actual section. This is accomplished by assuming T_1 as 2,000 pounds per square inch and solving for X in equation (11).

$$T_1 = \frac{P_1 \left[K + X(e_1)_a\right] X(e_1)_a}{X^4 (I_1)_a} + \frac{P_1}{X_2 (A_1)_a} \qquad (11)$$

$$2000 = \frac{196{,}350\,[60 + 1.56X]\,1.56X}{X^4 \times 9.2} + \frac{196{,}350}{X^2 \times 3.84}$$

from which the value $X = 11.45$ is found by trial.

Therefore, to get the actual size of the section at AB, each dimension of the drawing is multiplied by 11.45. This gives the depth of the section as 57.36 inches, and also

$e_1 = 1.56 \times 11.45 = 17.86$ inches,

$z_1 = 3.45 \times 11.45 = 39.5$ inches,

and all other dimensions in the same proportions.

The value of C_1 is next calculated by equation (12) and found to be 3,420 pounds per square inch. It would seem that this is very low for a compressive stress, but the thickness of the outer part of the frame is only about 1⅝ inch, and it does not seem best to make it thinner.

After having determined the size and shape of the section AB, the outline of the punch is sketched in, the general shape being about as shown in Fig. 3, and care is taken to secure a form of pleasing appearance and conforming to general practice. Then drawings are made of sections at CD, EF, GH, and JK, as shown in Figs. 9, 10, and 11, using a scale $X = 12$. The constructions for finding e and z are completed as shown, and the results of the calculations for the sections are tabulated below:

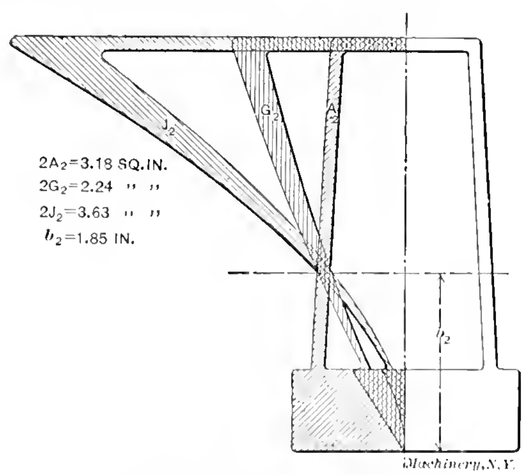

Fig. 9. Section in the Plane C—D, Fig. 3.

Section.	A	G	J	b	e	z	I'	I
CD	3.18	2.24	3.63	1.85	1.304	2.976	12.44	7.03
EF	2.74	1.83	2.58	1.56	1.04	2.51	6.47	3.51
GH } JK }	2.26	1.74	2.47	1.27	0.978	2.02	3.98	1.82

The next step in the design is to investigate the stresses in the sections at CD, EF, GH, and JK. The calculations are shown below. All calculations are conveniently made with a slide rule.

Section C—D.

This section is taken at an angle $a = 45°$. Then, from equations developed in the discussion of the section CD in the earlier part of the article, we have:

$P_2 = P = 196{,}350$ pounds.
$L_2 = P_2 \cos a = 196{,}350 \times 0.707 = 138{,}700$ pounds.
$V_2 = P_2 \sin a = 196{,}350 \times 0.707 = 138{,}700$ pounds.
$l_2 =$ (by measurement from drawing) 69.25 inches.
$M_2 = P_2 l_2 = 196{,}350 \times 69.25 = 13{,}600{,}000$ inch-pounds.

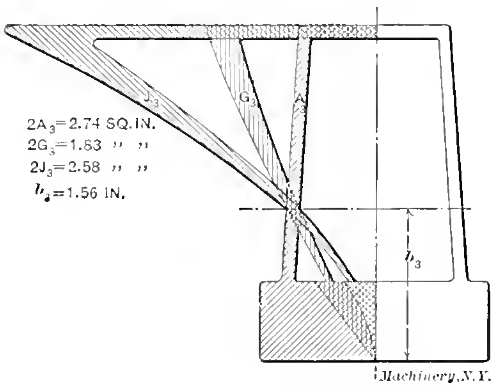

Fig. 10. Section in the Plane E—F, Fig. 3.

$$f_2 = \frac{M_2 e_2}{I_2} = \frac{13{,}600{,}000 \times 12 \times 1.304}{12^4 \times 7.03} = 1460 \text{ pounds.}$$

$$c_2 = \frac{M_2 z_2}{I_2} = \frac{13{,}600{,}000 \times 12 \times 2.976}{12^4 \times 7.03} = 3326 \text{ pounds.}$$

$$t_2 = \frac{L_2}{A_2} = \frac{138{,}700}{12^2 \times 3.18} = 303 \text{ pounds.}$$

$$s_2 = \frac{V_2}{A_2} = \frac{138{,}700}{12^2 \times 3.18} = 303 \text{ pounds.}$$

$$T_2 = \frac{1460 + 303}{2} + \sqrt{303^2 + \left(\frac{1460 + 303}{2}\right)^2} = 1811 \text{ pounds.}$$

$$C_2 = \frac{3326 - 303}{2} + \sqrt{303^2 + \left(\frac{3326 - 303}{2}\right)^2} = 3056 \text{ pounds.}$$

$$S_2 = \sqrt{303^2 + \left(\frac{3326 - 303}{2}\right)^2} = 1544 \text{ pounds.}$$

It will be noted that the tensile stress is somewhat smaller than the maximum value of 2,000 pounds per square inch which was to be allowed. However, the strength of the casting is likely to be least at this point for two reasons: first, because the section is taken at the center of a rather sharp bend for so massive a casting, and second, because of the necessity of introducing a bearing on the upper side near this section, thus requiring the frame to support the reaction from the bearing. For these reasons a lower value for the tension is not out of place.

Section E—F.

If the tabulated values of the properties of the section EF are substituted in the equations developed for that section, the following values of the stresses result:

$P_3 = P = 196{,}350$ pounds.
$l_3 = 54$ inches (measured from drawing).
$M_3 = P_3 l_3 = 196{,}350 \times 54 = 10{,}600{,}000$ inch-pounds.

$$f_3 = \frac{M_3 e_3}{I_3} = \frac{10{,}600{,}000 \times 12 \times 1.04}{12^4 \times 3.51} = 1815 \text{ pounds.}$$

$$c_3 = \frac{M_3 z_3}{I_3} = \frac{10{,}600{,}000 \times 12 \times 2.51}{12^4 \times 3.51} = 4380 \text{ pounds.}$$

$$s_3 = \frac{P_3}{A_3} = \frac{196{,}350}{12^2 \times 2.74} = 498 \text{ pounds.}$$

$$T_3 = \frac{1815}{2} + \sqrt{498^2 + \left(\frac{1815}{2}\right)^2} = 1944 \text{ pounds.}$$

$$C_3 = \frac{4380}{2} + \sqrt{498^2 + \left(\frac{4380}{2}\right)^2} = 4438 \text{ pounds.}$$

$$S_3 = \sqrt{498^2 + \left(\frac{4380}{2}\right)^2} = 2248 \text{ pounds.}$$

These results are all fairly near the requirements, and the section may be said to be satisfactory. The value of S_3 is a trifle higher than was originally specified; this could be reduced by increasing the area of the section slightly. The excess is, however, hardly enough to warrant this.

Sections G—H and J—K.

Sections GH and JK are practically alike in the punch under discussion, although they are not so drawn in Fig. 3. The section as shown in Fig. 3 at GH is nearer the size to be investigated than that at JK. The stresses will result as follows:

$P_4 = P = 196{,}350$ pounds.
$l_4 = 14.5$ inches (measured from drawing).
$M_4 = P_4 l_4 = 196{,}350 \times 14.5 = 2{,}850{,}000$ inch-pounds.

$$f_4 = \frac{M_4 e_4}{I_4} = \frac{2{,}850{,}000 \times 12 \times 0.978}{12^4 \times 1.82} = 885 \text{ pounds.}$$

$$c_4 = \frac{M_4 z_4}{I_4} = \frac{2{,}850{,}000 \times 12 \times 2.02}{12_4 \times 1.82} = 1830 \text{ pounds.}$$

$$s_4 = \frac{P_4}{A_4} = \frac{196{,}350}{12^2 \times 2.26} = 603 \text{ pounds.}$$

$$T_4 = \frac{885}{2} + \sqrt{603^2 + \left(\frac{885}{2}\right)^2} = 1189 \text{ pounds.}$$

$$C_4 = \frac{1830}{2} + \sqrt{603^2 + \left(\frac{1830}{2}\right)^2} = 2011 \text{ pounds.}$$

$$S_4 = \sqrt{603^2 + \left(\frac{1830}{2}\right)^2} = 1096 \text{ pounds.}$$

It is to be noted that in the case of these sections all the stresses are decidedly small. This is caused by the large section required at GH to provide room for the passage of the main shaft and also because a smaller section at this point would present a weak appearance as a support for the massive head. In the case of the section at JK, however, these reasons do not hold, and the frame in question would have been better proportioned had the section at JK been smaller, thus

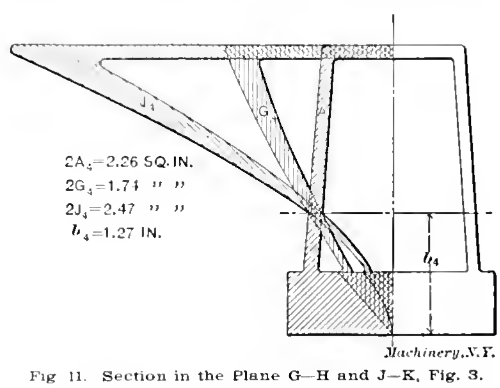

Fig. 11. Section in the Plane G—H and J—K, Fig. 3.

making the stresses more nearly equal over the entire frame. The punch frame illustrated in Fig. 3 is better proportioned in this respect.

The system of design here presented may be applied to frames of many other forms of machines besides punching and shearing machines. It offers the following advantages:

1. It is mathematically correct in principle.
2. The sources of error are comparatively small and are of a kind easily detected.
3. The graphical constructions involved are not laborious, and are sufficiently exact for any ordinary work. The degree of accuracy can be increased at will by employing larger scales.
4. Considerable latitude is allowed for the judgment of the designer.

GEAR-CUTTING MACHINERY—8.

RALPH E. FLANDERS*

This installment of this series of articles continues the discussion of machines for cutting the teeth of bevel gears, the particular type under discussion being that operating on the templet principle.

Fig. 155 shows a machine of this type, built by the firm (Société Suisse pour la Construction de Machines-Outils

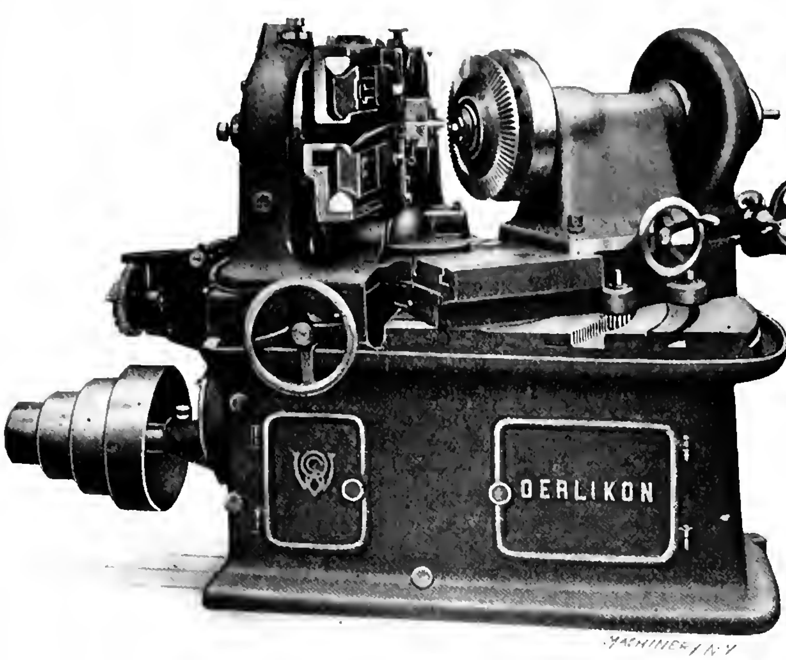

Fig. 155. Oerlikon Bevel Gear Cutter operating on the Templet Principle, and using Two Tools Simultaneously.

Oerlikon, Oerlikon près Zurich, Switzerland) which designed the one last described. The writer has little definite information in regard to this machine. The head carrying the slides is fed inward about a vertical axis, as in the Gleason machine. The swiveling movement of the tool slide about the horizontal axis is also similar to the Gleason machine, but the two are differentiated in their action by the provision of a second slide and tool-holder, both pivoting about the same horizontal axis. The movement which the templet imparts to the upper slide is duplicated on the lower one, though in the reverse direction, so that the outlines formed on each side of the tooth are symmetrical. Besides the use of the two tool slides, this machine also differs from the Gleason in having the head carrying the work spindle and the automatic indexing mechanism, swivel for adjusting to the angle of the work, about the same vertical axis around which the feeding movement of the cutter slide head takes place. This tool was designed by its builders to provide a maximum of accuracy and rapidity for work within its range.

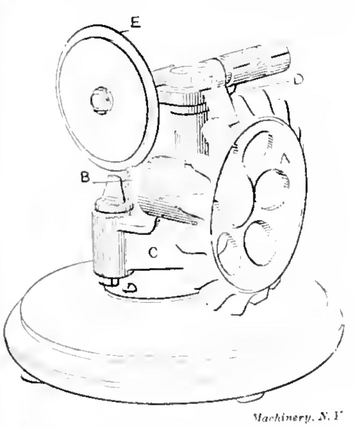

Fig. 156. Model showing the Principle of the Rice Machine shown in Fig 157.

In Fig. 156 is shown the principle of a templet bevel gear planing machine differing in many respects from any of those previously shown. This principle originated with Mr. Charles DeLos Rice, of Hartford, Conn., and the machine he designed, incorporating it, is much used for cutting chainless bicycle gears, though it is not now on the market. The differences consist principally in the form of templet used, and in the form of the follower and the cutting edge of the tool. In other templet machines the follower which makes contact with the templet is presumably a point, as should also be (to insure theoretical exactness) the cutting point of the tool. In reality, of course, the outlines of both these members are rounded, a roll being generally employed for making the contact with the templet, and a round-nose tool being used for doing the cutting. Theoretical accuracy could be obtained under these conditions if the shape of the templet were made to allow for the diameter of the roller which follows it (as is the case in making templets for the Gleason machine, at least) and if the shape of the point of the tool is also considered. The latter, however, should grow continuously smaller as it approaches the small end of the tooth, in the same scale with the decrease in size of the tooth itself, and similarly, it should grow larger as it approaches the large end. As it, of course, remains the same size all the time, a slight error is introduced—so slight, however, as not to introduce anything except a negligible inaccuracy.

In the Rice machine the copying of the former is done with theoretical precision. Both the guiding and the cutting edges are plane surfaces, and being such, obviate the necessity for a change of scale in cutting outlines at different points of the stroke. Fig. 156 shows a model of the movement employed, especially made for the purpose of illustration. The templet *A*, used, is a complete gear of the same proportions as the work to be cut, but on a larger scale. It is mounted on a spindle fast to the blanks *B*. This spindle is carried by a swinging bracket *C*, pivoted about an axis at right angles to that of the work, and passing through the apex of the pitch cone of the work and master gear. The sketch of the model shows a disk *E* mounted on a fixed horizontal spindle, entering one of the spaces which have been cut in the blank. The acting surface of the disk is in the plane of the vertical axis about which bracket *C* swings. In the same plane is the acting surface of a fixed stop or guide plate *D*, which, as shown, is mounted on the same pedestal as the spindle of the disk and enters the space cut in the master gear in the same way that the disk enters the space between the teeth of the work.

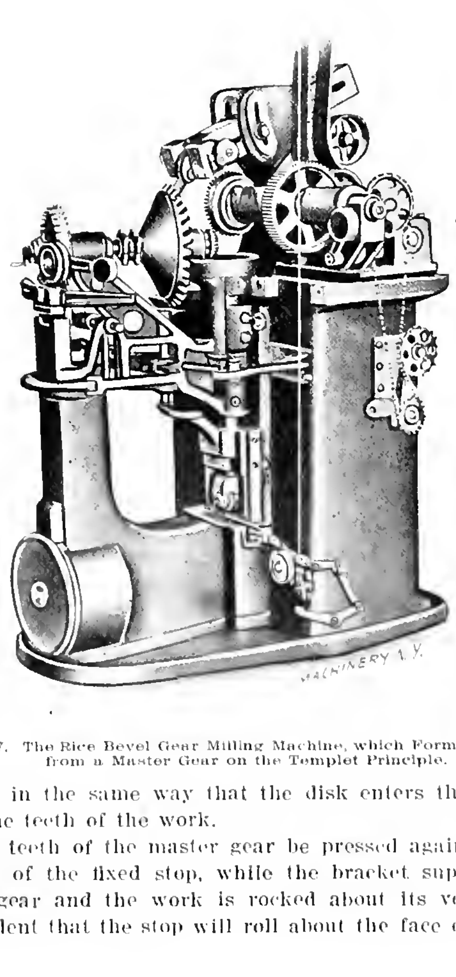

Fig. 157. The Rice Bevel Gear Milling Machine, which Forms the Teeth from a Master Gear on the Templet Principle.

If the teeth of the master gear be pressed against the acting side of the fixed stop, while the bracket supporting the master gear and the work is rocked about its vertical axis, it is evident that the stop will roll about the face of the tooth

* Associate Editor of MACHINERY.

of the master gear or templet, making line contact with it, while the face of the disk will act in an identical manner, though on a smaller scale, with relation to the tooth of the work. If the disk be replaced with a cutter of the same diameter, and with a cutting face in the same plane as that occupied by the acting face of the disk, the rocking of the bracket about its vertical axis will evidently cause the cutter to mill out a tooth face identical with that of the templet or master gear, but on a smaller scale. While this operation appears to have the ear marks of the generating process, it operates on the templet principle in reality, as is shown by the description we have just given. The cutter is made of large diameter, as compared with the work, in order to give as straight a bottom to the tooth space as possible. The deepening of the tooth space in the center does not, of course, affect the accuracy of the working portion of the outline.

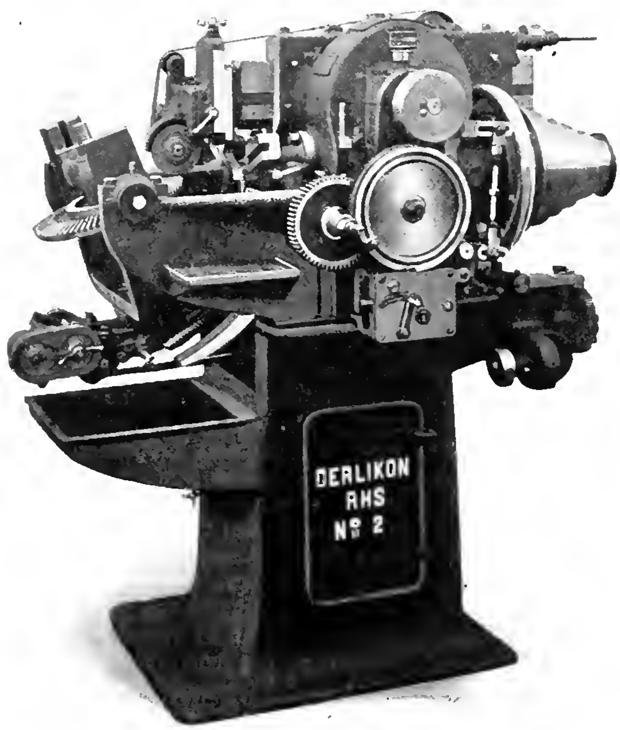

Fig. 158. The Oerlikon Templet Gear Shaper of Fig. 154, arranged with Grinding Wheel for Finishing Hardened Bevel Gears.

An automatic machine in which these principles are embodied is shown in Fig. 157. The mechanism is too intricate to be described without the use of a considerable number of line drawings and an extended description, so we will content ourselves with enumerating the movements which the mechanism effects. The master gear governs the tooth spacing, the tooth thickness and the tooth form. The master gear and a previously-gashed blank being mounted in position in the machine with the guide plate and cutter positions and other adjustments properly made, the mechanism is started. The cam movements provided first feed the master gear and work spindle upward until the cutter is in to depth and the stop bears against the face of the master gear. The bracket carrying them is then rotated about its vertical axis until one face of one tooth of the blank is completed. The work is now dropped down out of the way, and the spindle, with the blank and master wheel, are indexed one revolution, after which they are again raised, repeating the same operations as before. This is done repeatedly until the whole gear has been cut around on one side of all the teeth. When this has been done, the machine stops and the attendant rotates the segment of a hand-wheel rim seen encircling the front pillar of the machine. Through the link connections on this rim, the fixed gage and the cutter are each shifted axially a distance equal to their thickness, so as to bring them to positions to work on the other side of the tooth. The automatic mechanism for swinging the work spindle is also changed by the same movement, so that it swings in the other direction. The mechanism is then started up and the other sides of all the teeth are finished.

An interesting point in the product of this machine is that the gears produced are accurate copies of the master gear on a smaller scale. It is thus possible where bevel gears are to be made in large quantities, to make the master gear and pinion, and run them together under conditions severe enough to test their suitability for the work the smaller gears are to perform. Such corrections as may be required being made in these large gears, assurance is given that the smaller gears will behave in a satisfactory way. The principle of this machine could, of course, be adapted to a machine for general use, by using as a templet but a single tooth of the master gear, instead of employing an entire wheel, as here shown. It was at one time, we are informed, the intention of the inventor to develop such a machine, but so far this has not been done commercially. Obviously, this method of applying the templet principle cannot be applied to teeth having concave surfaces.

Machines Employing the Templet Principle for Grinding the Teeth of Bevel Gears.

The grinding operation has been used in a templet machine built by the Société Suisse pour la Construction de Machines-Outils Oerlikon, Oerlikon près Zurich, Switzerland and shown in Fig. 158. As may be seen, it is a modification of their regular templet planing machine, previously shown in Fig. 154. The change consists merely in replacing the cutting point of the tool with the edge of a grinding wheel, carried on the head of the ram, and provided with suitable means for driving it at the proper speed. Under these conditions, the edge of the wheel shapes the teeth of the gear to the form of the templet provided. The builders state that by the employment of special wheels which they have developed for the purpose, it is possible to cut clear around a large gear without a perceptible change in the condition of the cutting-edge, or a corresponding change in the profile of the tooth produced. If this is so, the greatest objection to the grinding process for gear cutting of any kind is largely obviated. The purpose of the machine is, of course, the finishing of the teeth of hardened gears to remove the inevitable inaccuracies due to distortion arising from the heat treatment. It has been found especially useful in automobile work.

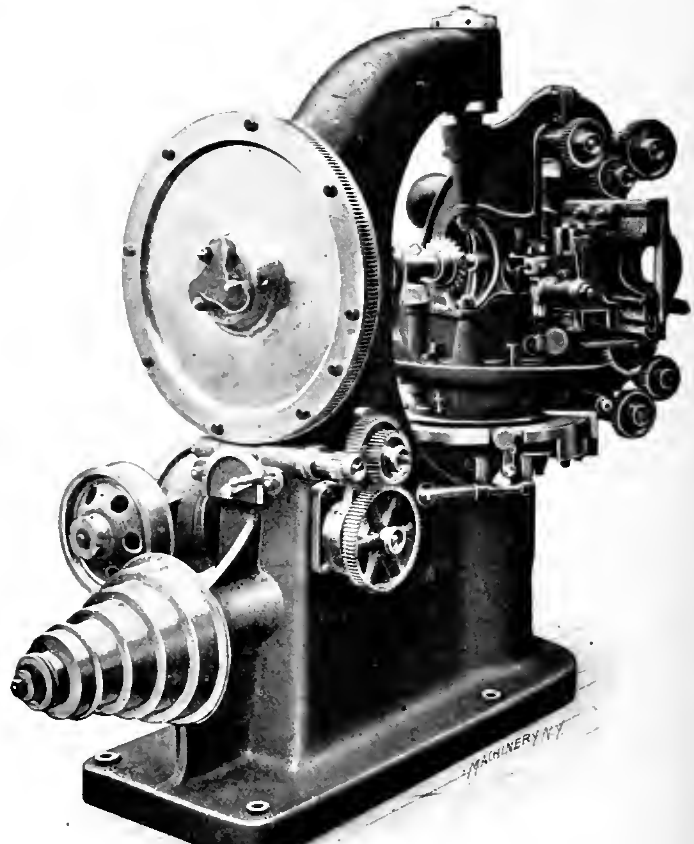

Fig. 159. The Duboec Bevel Gear Planing Machine, cutting Involute Teeth by the Odontographic Principle.

This Swiss firm has done especially noteworthy work in the building of machines for cutting bevel gears. The three we have illustrated, Figs. 154, 155 and 158, and one we will show later for milling bevel gears by the molding-generating principle, do not by any means exhaust their list of machines built for forming the teeth of gears of this type. Among other Oerlikon designs may be mentioned two of great interest, described in a paper by Mr. Fred. J. Miller, to be found in Vol. 22 of the Transactions of the American Society of Mechanical Engineers.

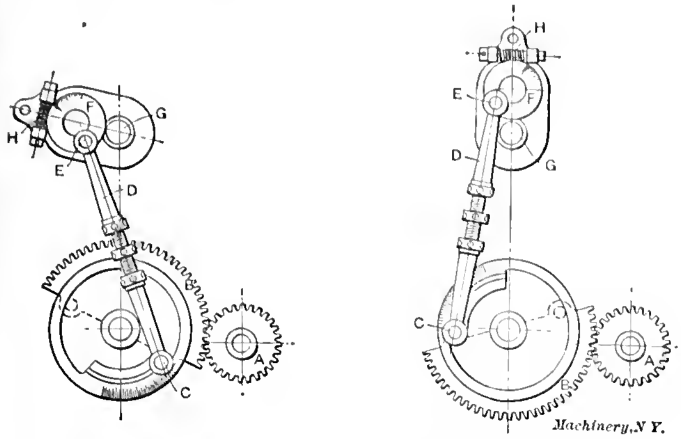

Fig. 160. The Odontographic Mechanism of the Dubosc Machine at the Beginning and End of the Cutting Action.

Machines Working on the Odontographic Principle for Cutting the Teeth of Bevel Gears.

A machine operating on the odontographic principle, in which the point of the tool is guided by mechanism which very nearly reproduces the theoretical shape, is shown in Fig. 159. It is built by Officina Meccanica Ing. E. Dubosc, Via Principi d'Acaia, 62, Turin, Italy. In this machine, as may be seen, the work spindle is horizontal and is indexed by a dividing wheel of large diameter. The work arbor is supported at the outer end in a stirrup held in the swinging tool frame, this support making it possible to do heavy and rapid cutting. The work is adjusted by means of suitable gages until the apex of its pitch cone lies in the center line of the journals provided at the top and bottom of the main casting of the machine for the trunnions of the frame which swings about the work in a vertical axis. This frame carries most of the mechanism of the machine, and is provided with pivots in a horizontal axis, in the same plane with the vertical axis, about which swings a counterbalanced arm having guides for the tool slide. A tool may thus be set to have a reciprocating movement in any plane, toward and away from a point coinciding with the apex of the pitch cone of the work. This being the case, if suitable mechanism for effecting it is provided, the tool may be made to plane a conical surface, vanishing at the center of the horizontal and vertical axes, and determined by any line drawn on the surface of a sphere having the same center. In this respect it resembles all templet and odontographic machines, which are distinguished from each other only in the means provided for guiding the tool, as shown in Figs. 136 and 137.

In the machine in question, the odontographic mechanism provided produces teeth of involute form. This mechanism (which is obscured in Fig. 159) is shown in diagrammatic form in Fig. 160, in two positions. We cannot take the space here to describe why the mechanism produces a curve of almost absolutely true involute form, nor can we enter into the details of the connections by which the movements effected by this mechanism are transferred to the point of the tool, as this would require an article in itself. It can only be said the pinion A is connected with a worm meshing with a segment of a worm-wheel fast to the base of the machine, by means of which the frame carrying the mechanism and the tool is rotated about its vertical axis. This pinion meshes with the segmental gear B, which carries a crank-pin C, angularly adjustable for a certain amount about the center of the gear. A connecting-rod D, adjustable for length, connects crank-pin C with a second pin E attached eccentrically to a disk F, eccentrically seated in turn in a crank whose center is G. Disk F, with crank-pin E, may be adjusted for various angular positions about the center of the disk by worm H. Crank G is connected with mechanism for swinging the tool slide in a vertical plane about its vertical axis, the whole mechanism thus serving to connect the movements of the tool about the horizontal and vertical axes. By setting C according to graduations at various angular positions with relation to B, and by setting E at various positions by the rotating of disk F, and by adjusting the length of connecting-rod D, the movements about the horizontal and vertical axes may be so connected as to produce tooth outlines of correct forms.

This apparatus, as described, determines the form of the tooth. Change gears provided between G and the vertical movement which it accomplishes, and A and the horizontal movement with which it is connected, alter the scale of the outline—that is, adapt it to a large tooth or a small tooth as may be required. Still other change gears are provided for the indexing, which is automatic, as are all the functions of the machine for completely forming one side of all the teeth of the gear. When this has been done, the machine is reversed for cutting the other sides of the teeth. The shape that can be given varies from the straight side of the rack tooth (which is used for all gears having more than 150 teeth), to small bevel pinions with undercut flanks in which a reverse motion has to be given to the movement about the horizontal axis. The tool is provided with mechanism for cutting on both the forward and back stroke on work that is large enough to admit this.

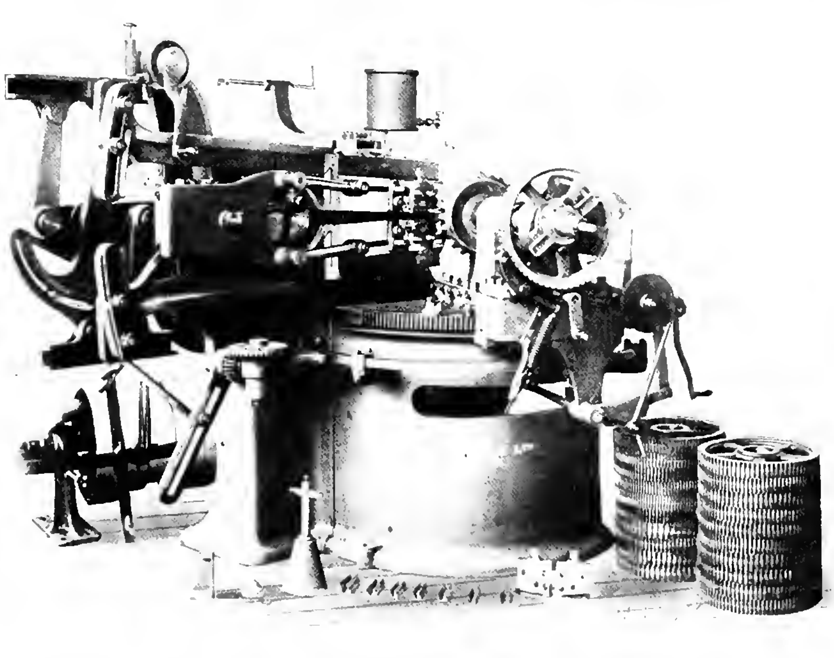
Fig. 161. The Smith & Coventry Odontographic Bevel Gear Planing Machine.

We are informed by the English licensees of the Dubosc patents, Messrs. Selig Sonnenthal & Co., 85 Queen Victoria St., E. C., London, England, that the builders of the tool are preparing a new design, embodying a number of improvements in the mechanism. We hope to be able to describe this new machine at some later time. The machine is ordinarily furnished for cutting involute bevel gears, having a pressure angle of 22½ degrees, this being the usual angle for automobile work. It can be made to order, however, for cutting other angles as desired.

The only other odontographic machine the writer is acquainted with is built by Smith & Coventry, of Manchester, England (see Figs. 161 and 162). It is somewhat easier to

understand than the Dubosc machine, as the curves it employs are simple arcs ot circles. Two tools T_1 and T_2 are used, each set in separate slides S_1 and S_2 pivoted about an axis at the apex X of the pitch cone of the blank being cut. These slides have rearward extensions in the form of arms A_1 A_2, ending in slotted arcs concentric with axis X. Each of these arms is clamped by bolts passing through the slotted arcs to blocks C_1 and C_2 sliding in horizontal guides on parallel bars D_1 and D_2. Bar D_1 is supported on links E and E_1, while bar D_2, pivoted also to double ended link E, is supported by it and short link E_2. As link E is rocked, the two bars swing, one to the left and upward and the other to the right and downward, but with their guiding surfaces always parallel. As they are swung in this way, the two slides A_1 and A_2 are brought together or opened out, as the case may be.

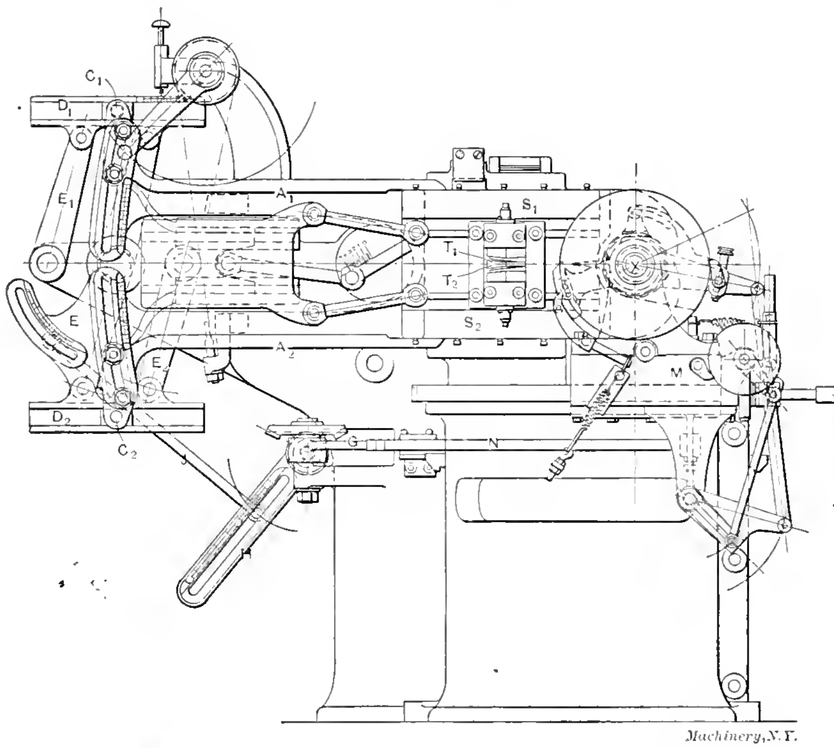

Fig. 162. The Mechanism of the Smith & Coventry Bevel Gear Planer.

The rocking of this parallel linkage system is effected by a connection with the angularly adjustable head M, which carries the work spindle. This is swung inward for the feeding movement to shift the tools down the sides of the tooth until the full depth has been reached. To slide M is clamped a circular bar N, whose rear end has teeth cut in it engaging with those of a sector G, which, by the bevel gearing shown, is connected with slotted arm H. This arm is adjustably connected with link E by a connecting-rod J, which, as shown, may be altered slightly as to length and to the amount of movement given it, depending on the way in which it is clamped to H. From this it will be seen that as the work slide M swings around, moving the teeth of the blank inward toward the tools, its connection with circular bar N through sector G, and the geared connections of the latter with arm H, operate the linkage system E, E_1, E_2, and bars D_1 and D_2, with the tool-slides S_1 and S_2 connected with them. By this means the tools are gradually opened out as the base of the tooth is approached, in such a way as to make their outlines correspond to circular arcs approximate to the desired involutes, the circular form being determined by the swinging of the links E_1 and E_2 about their centers. Tables are furnished for setting J with relation to H, and arms A_1 and A_2 with relation to D_1 and D_2, so as to reproduce on the teeth the proper outlines.

It should have been mentioned that this machine does not work on the principle of completing one tooth, and then indexing to complete the next. The work indexes at every stroke of the double tools. After the first cut has been taken on the first tooth, the work is indexed and the same cut taken on the next tooth. When the work has been once around in this way, the tool starts in with a deeper cut on the first tooth again, this continuous rotation and gradual feeding in of the tool continuing until all have been simultaneously formed to the required depth and proper shape, being similar in this respect to the Bouhey machine in Fig. 152.

A Machine Operating on the Molding-Generating Principle and Employing the Impression Operation.

In Fig. 163 is shown the only example known to the writer of a commercial machine operating on the molding-generating principle. This machine was built by the Brown & Sharpe Mfg. Co., Providence, R. I., for performing the finishing and correcting operations on bevel gears, roughed out in the special full automatic formed-cutter machine, previously described, and shown in Fig. 146. It is not, therefore, a machine which finishes the gear directly from the blank. The impression process is, of course, absolutely impracticable for operations that would require the pressing into shape of as much metal as would be required in that case.

The machine contains two spindles, of which the one carrying the forming gear is driven by suitable belts and pulleys from the counter-shaft, while the other spindle is mounted in a head which, as shown, can be set at any angle with the first, to agree with the angle between the axes of the forming gear and the work being pressed into shape. The forming gear, instead of being a small pinion, as in Fig. 138, is a crown gear; this gear is chosen on account of the facility with which it can be accurately made, the sides of the teeth in the system employed being plane surfaces, as described in connection with Figs. 139 and 140. In the final operation, a forming gear thus correctly made and hardened so as to resist the wear brought to bear on it, is mounted on the belt-driven spindle and brought into proper engagement with the roughly formed gear mounted on the other spindle. The machine is started up and the two are revolved together. The mechanism provided is such that the pair run in one direction for a certain number of revolutions and then reverse and run in the other direction, repeating the process as long as the machine is in operation. Meanwhile a cam mechanism operates to jam

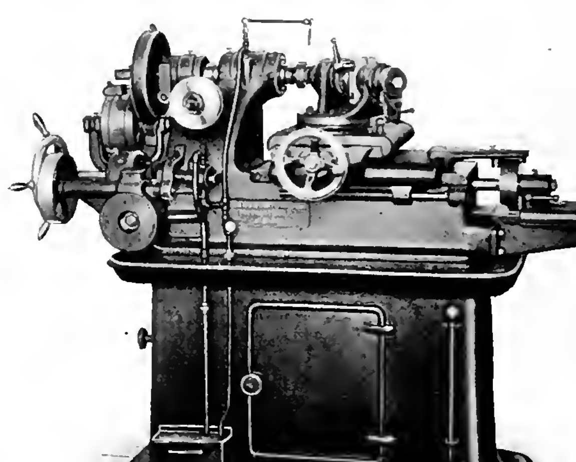

Fig. 163. Brown & Sharpe Machine for Correcting Bevel Gears by the Molding-Generating Principle, employing the Impression Process.

the blank and forming gear together, relieve the pressure for a short space and jam them together again, repeating the process continuously. By this means the hardened surface of the forming crown gear presses out the inaccuracies in the work and smooths the surfaces of its teeth.

The operation we have just described is the final one, however, and does little more than burnish the teeth. The same machine is used for a preliminary operation which does most of the work of smoothing out the inaccuracies of the formed cutter process. This employs the same movements in the machine, but uses a different form of crown gear, shown in action in Fig. 164. As may be seen, the successive teeth are cut off at different heights. The edges thus formed where

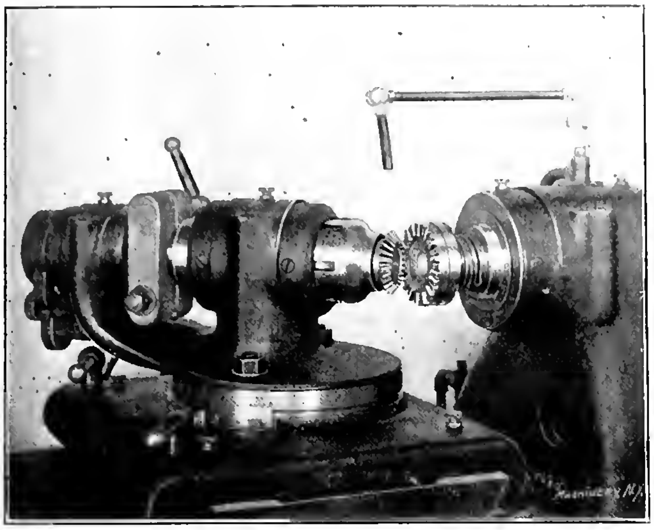

Fig. 164. Near View of the Tool and the Work in the Machine shown in Fig. 163.

the teeth are cut off, dig into the roughed out teeth of the work and remove the metal from the high spots, while they pass freely and without action over the parts of the teeth which are of the correct contour. Being of so many different heights the whole face of each tooth of the work is acted on, though, of course, this is the case only when the number of teeth in the work and in the crown gear do not have a large common factor. In the bicycle trade for which these machines were developed, the gears were so designed that this contingency did not arise.

Machines Operating on the Molding-Generating Principle, and Employing the Planing or Shaping Operation.

The mechanism illustrated in outline in Fig. 139 is one that has been employed in a number of exceedingly interesting and ingenious machines. The first application of this principle was made by Mr. Hugo Bilgram, 1231 Spring Garden Ave., Philadelphia, Pa. His form of machine has been used for a

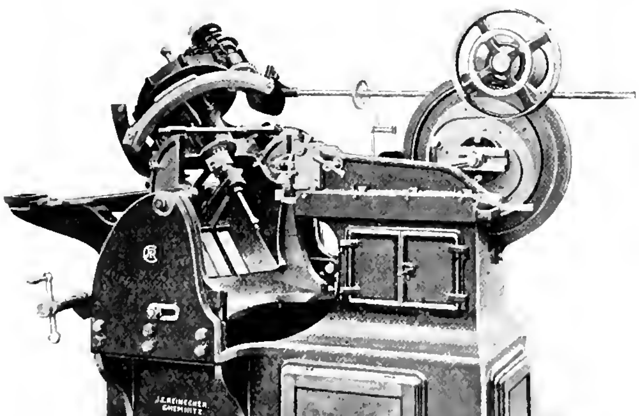

Fig 165. Bilgram Bevel Gear Shaper as built by J. E. Reinecker.

great many years, and produces work whose accuracy has almost become proverbial. An example of this machine, built under Mr. Bilgram's patents by J. E. Reinecker, of Chemnitz-Gablenz, Germany, is shown in Fig. 165. The movements operate on the same principle as that in Fig. 139, but in one of the modified forms explained in the text accompanying that figure. That is to say, instead of rotating the crown gear and master gear together, the imaginary crown gear and, consequently, the tool, remain stationary so far as angular position is concerned, while the frame is rotated about the axis of the crown gear, thus rolling the master gear on the latter and rolling the work in proper relation to the tool. Instead of using crown and master gears, however, a section of the pitch cone of the master gear is used, which rolls on a plane surface, representing the pitch surface of the crown gear. The two surfaces are prevented from slipping on each other by a pair of steel tapes, stretched so as to make the movement positive, in something the same way as shown in Fig. 4. A still further change consists in extending the work arbor down beyond center *O* in Fig. 139, mounting the blank on the other side of the center so that the tool, being also on the other side of the center, is turned the other side up from that shown in the diagram. All these movements can be followed in Fig. 165. As explained, a tool with a straight edge is used, representing the side of a rack tooth, and this tool is reciprocated by a slotted crank, adjustable to vary the length of the stroke, and driven by a Whitworth quick return movement. The feed of the machine is effected by swinging the frame in which the work spindle and its supports are hung, about the vertical axis of the imaginary crown gear.

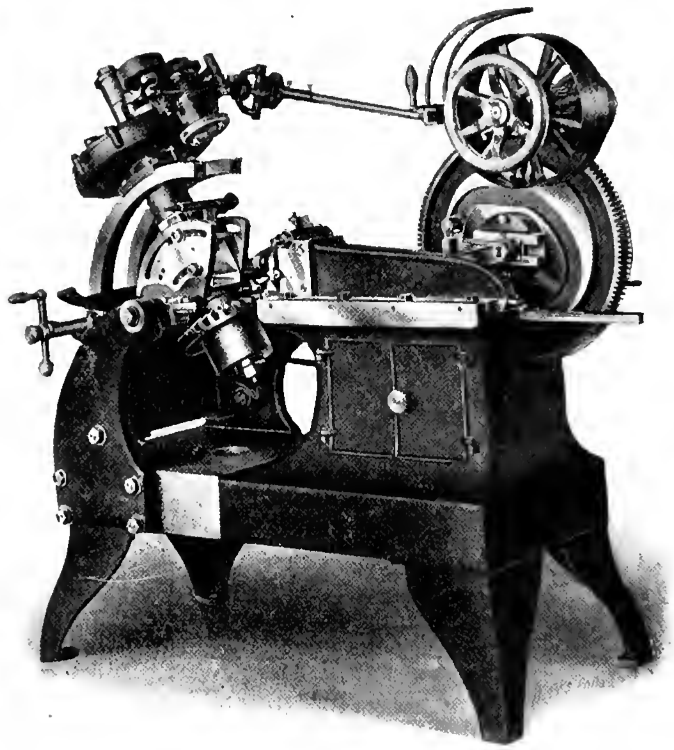

Fig. 166. Full Automatic Bilgram Bevel Gear Shaper, working on the Molding-Generating Principle.

Suitable feed connections, index mechanisms, etc., are provided for convenient operation.

In Fig. 166 is shown a development of this tool, in which the motions are completely automatic. The example illustrated is built and sold by Mr. Bilgram himself. In this case, the operator sets the machine and places a previously-gashed blank on the work spindle and starts the tool in operation. The mechanism provided will, without further attention, complete one side of all the teeth. The machine may be then readjusted and the tool set for cutting the other side, which will be finished in the same automatic fashion. The mechanism does not operate on the principle of completing one side of one tooth before going to the next. It follows the plan adopted by the same builder in his spur and spiral planing machines shown in Figs. 48 and 95, in which the work is indexed for each stroke of the tool, the rolling action being progressive with the indexing so as to finish all the teeth at once. A little thought will show that these three Bilgram machines are identical in principle, with only the modifications required to fit that principle to the making of spur, spiral, and bevel gears, respectively. The bevel gear machine is the only one that has come into extensive use, since the

bevel gear is the only one of the three kinds in which there is any great difficulty in forming the teeth accurately enough for all practical purposes.

Another machine operating on the same principle as the Bilgram is that built by the Ateliers de Constructions

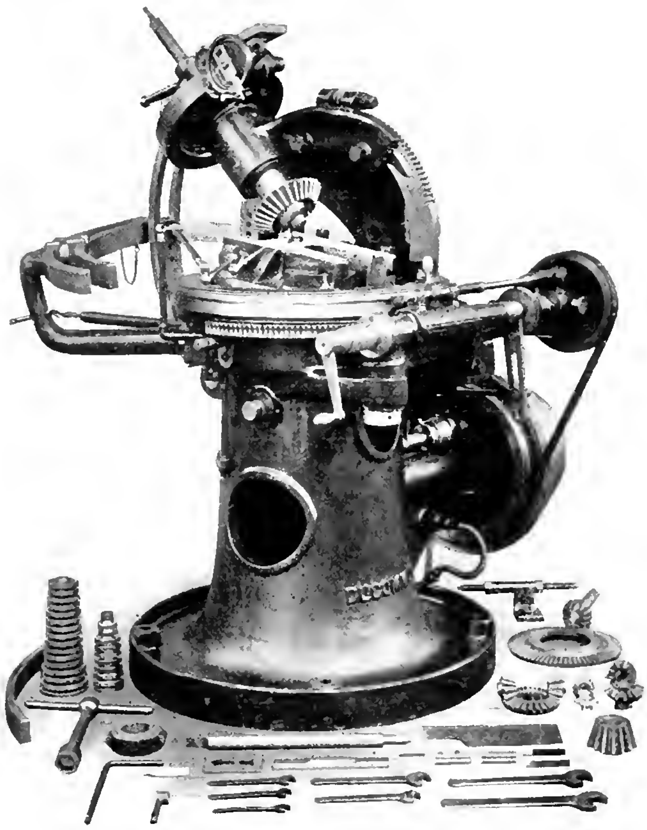

Fig. 167. Ducommun Bevel Gear Generator operating Two Tools.

Mecaniques ci-devant Ducommun, Mulhouse (Alsace). (See Fig. 167.) This machine has been so thoroughly described in MACHINERY* that it will not be necessary to go into minute details here. The principal differences between it and the Bilgram machine (aside from the obvious differences of the shape of the framework and the arrangement of the mechanism) are the link motion used in place of the steel tape for giving rolling movement to the blank, and the provision made for using two tools simultaneously so that both sides of a tooth are finished at once. This machine is not, like the last Bilgram machine described, fully automatic, but is arranged to cut a side of one tooth, after which it is indexed by hand and the side of another tooth cut.

The two tools are each carried in slides of their own, in the center of the circular top of the table. These slides are independently adjusted to bring the movement of the straight cutting edges in line with the plane surfaces of the teeth of the imaginary crown gear of Fig. 139. As in the Bilgram machine, the tool slides are stationary, while the frame carrying the work spindle is revolved about the vertical axis of the crown gear, a tooth of which is represented by the cutting edges of the tool. The swiveling movement of this frame is effected by a sector of a worm-wheel fastened to the circular table on which the frame is mounted. Suitable feeding movements and automatic stops are provided. To roll the blank with the same movement as a master gear rolling with the imaginary crown gear, a circular link, as shown, is clamped at the upper end to the spindle and the dividing mechanism, so that these parts and the work can be rocked by it about their axis. The lower end of this link is controlled by other curved links in such a way that the rolling movement produced on the blank as the circular table is rotated about its vertical axis, is nearly exactly the theoretical movement required. The interesting way in which this is effected has been explained at length in the article previously referred to. The arrangement of the links controlling the rolling movement of the blank shows very plainly the spherical basis of the bevel gear, as illustrated in Fig. 133. This is one of the most interesting of the bevel gear generating machines, and gives evidence of designing ability of a high order.

A French machine of the type we have been considering, built by H. Ernault, 169 Rue d'Alésia, Paris, is shown in Fig. 168. It was designed by Monsieur Monneret, and shown at the Paris exhibition in 1900. The writer is not sure that it is being manufactured for the trade at the present time. It is of such interest, however, as to warrant illustration and description.

This machine is identical in its operation with the typical mechanism shown in Fig. 139, in that the axes of the work and of the imaginary crown gear are fixed in position, and are rotated in the proper ratio with each other to give the desired rolling movement of the tool and the blank on each other. The cutter slide is mounted on what resembles the head-stock of a lathe, at the right-hand side of the machine in Fig. 168. It is driven by a crank seen through the opening at the front of the slide. The tool is carried on the holder at the back upper end of the slide, and is provided with automatic means for positively relieving it on the back stroke.

To understand how this tool slide is rolled about its axis in unison with the rolling of the blank, it is first necessary to state that this machine will cut helical gears only, this being due to the fact that the crank-shaft and the blank are connected positively by change gearing, so that the blank rotates continuously, resembling in this particular the arrangement provided on the Bonhey machine for making, when required, gears of this kind by the templet process. Unlike the Bonhey machine, however, the one we are describing cannot be used for making straight tooth bevel gears; and, since the blank has to have imposed upon it a

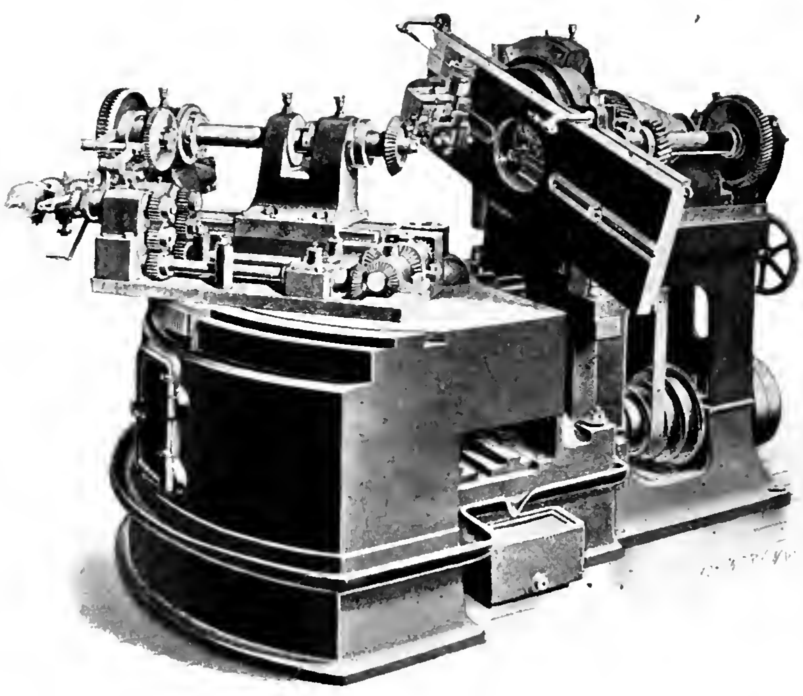

Fig. 168. The Ernault Bevel Gear Generating Machine, which cuts Gears with Helical Teeth.

rotary motion in unison with the rolling of the tool-slide, and in addition to the rotating motion due to its connection through the change gears with the tool-slide crank-shaft, a differential movement has to be introduced for combining the two.

The change gears set for the number of teeth connect the crank-shaft and the indexing worm at the rear of the work

*See article "A European Bevel Gear Generating Machine" in the January, 1907, issue of MACHINERY.

spindle through a train of positive gearing and shafts. The rolling movement of the blank (and of the tool slide about its axis) is driven by a cam and ratchet movement operated by the spur gearing leading from the work spindle at the left of the machine in the engraving. This ratchet-driven motion is connected by bevel gears with a screw which shifts, in the direction of its axis, a cradle or yoke in which is confined the index worm for giving the rotary movement to the blank. This worm is splined upon its shaft, so that it trans-

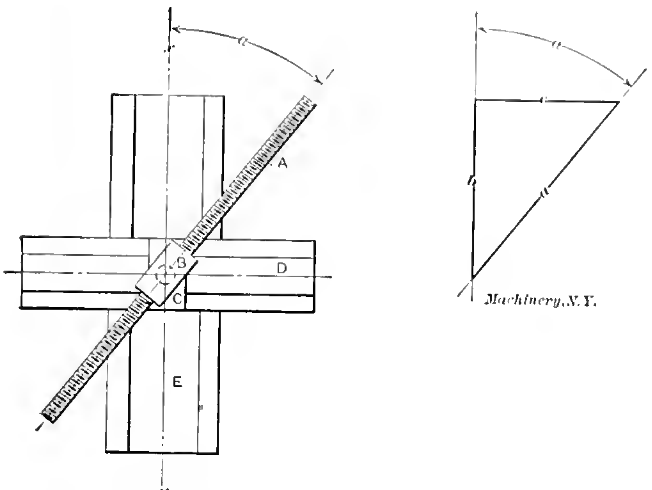

Fig. 169. The Mechanism by which the Proper Ratio of Rolling Movement for the Blank and Tool is obtained for the Machine in Fig. 168.

mits to the work through its longitudinal motion a rolling movement derived from the ratchet feed, and a continuous rotary movement derived from the change gearing and the crank-shaft. These movements are combined without interfering with each other, and either may be started or reversed independently. It will be seen that the mechanism is exactly identical in principle with that described for the Reinecker worm gear hobbing machine in Fig. 128.

The same ratchet mechanism that shifts the indexing worm axially is connected by the train of gearing shown with a vertical shaft passing down through the center of the angular adjustment of the work slide, where it is connected with a screw, shown diagrammatically at *A* in Fig. 169. This screw is supported in bearings connected with the work slide in such a way that, as the latter is adjusted to the angle of the gear being cut, the screw is swiveled with it, being always at right angles to the axis of the work spindle. The nut *B*, which encircles this screw, is pivoted to a sliding block *C*, which is dove-tailed to slide *D*. *D* in turn slides in guiding ways *E* in the direction *xy*. Slide *D* is fastened to a rack meshing with a pinion, connected by shaft and gearing with mechanism for rocking the tool slide, the whole arrangement furnishing the means by which the rolling of the blank effects the corresponding rolling of the imaginary crown gear and the work, in unison.

The ingenious feature of the mechanism in Fig. 169 is the way in which the proper ratio of movement for the rolling of the work and the tool is assured. When the axis of the work and of the imaginary crown gear are set in the same straight line, as would be required when cutting a crown gear, the axis of screw *A* is by that setting shifted until it is parallel with *xy*, and thus the movement of *D* on *xy* is the same as that of the nut *B* along the screw. If, on the other hand, the work spindle is adjusted to angle *a* with the axis of the crown gear, the mechanism will take the position shown in the engraving, and the screw, when moving the nut a distance *a*, will move slide *D* on ways *E* a smaller distance *b*, resolving the motion *a* into two components, *b* and *c*. Of these two, *b* is in exactly the right proportion to *a* to give the rolling movement required for the tool, and it is transmitted to the tool slide by the motion described. This, it will be seen, does away with the necessity for adjusting the rolling movements separately as required for the Bilgram and Ducommon machines.

In Fig. 170 is shown an American machine* of the molding-generating type, employing the planing or shaping operations. It differs from the previous machines of this kind we have described, in employing two tools, one on each side of the tooth, resembling in this respect the Oerlikon templet planer shown in Fig. 155. This tool is identical with the previous one and with the mechanism in Fig. 139, in having the axes of the tool slides and of the blank fixed in relation to each other during the operation, the tool-holders and the blank rocking about their axes to give the rolling movement for cutting. The connections, however, between the blank and the slide are entirely different, and the tools finish each tooth of the work complete before they commence on another. The rocking is effected (in the recent improved form, not shown below) by means of segments of an actual crown gear and master gear. The segment of the crown gear is permanently attached to the face of the rear of the cutter slide frame, while the segment of the master gear (of which there are several furnished with the machine, the one used being chosen to agree with the angle of the gear to be cut) is clamped to the semi-circular arm pivoted at the outer end of the machine at one side, and fastened to the work spindle sleeve on the other. This arm is rocked by a cam mechanism and slotted link at side opposite that shown in illustration.

The cycle of operations is as follows: The machine being adjusted properly in its preliminary position, the tool slide and the head on which it is mounted are swung back about the vertical axis so that the tools clear the work. The blank being set in the proper position, a cam movement swings the cutter slide head inward until the tools reach the proper depth. The cam movement first mentioned now rocks the semi-circular arm extending around the front of the machine upward, rolling the blank and (through the segmental crown

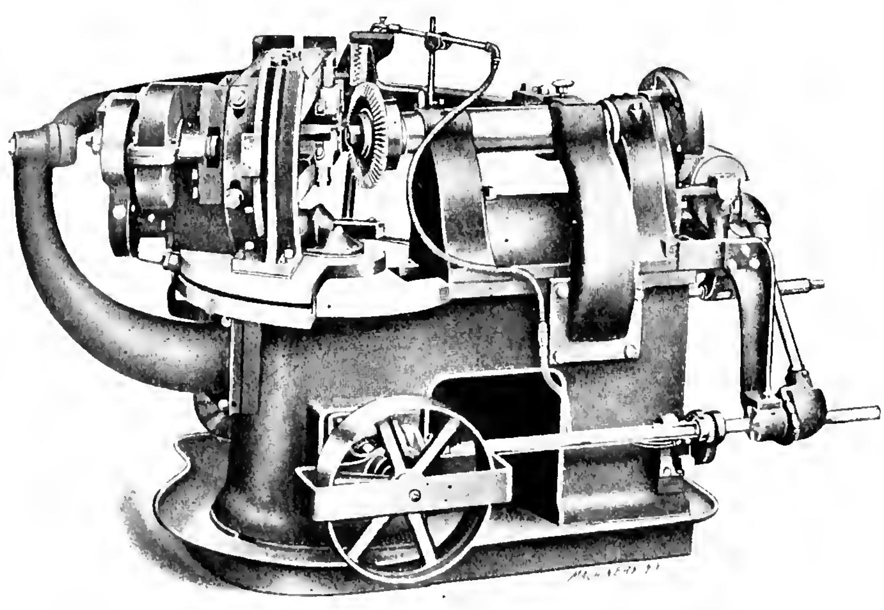

Fig. 170. The Gleason Bevel Gear Generating Machine as first developed.

and master gears) the slide, until the tools have been rolled out of contact in one direction, partially forming the teeth as they do so. The arm is then rolled back to the central position and along downward to the lower position, until the tools are rolled out of contact with the tooth in this direction, completing the forming of the proper shape as they do so. The cam then rocks the arm back to the central position, where the cutter-slide head is swung back to clear the tooth, and the work is indexed, after which this cycle of operations is continued for the next tooth. It will be seen that by starting from the central position, going to each extreme and re-

*See article "The Gleason Generating Bevel Gear Planer" in the July, 1906, issue of MACHINERY.

turning, all parts of each tooth are passed over twice, giving a roughing and a finishing chip.

The machine is entirely automatic. The use of two tools presents a number of advantages. Not only does it increase the rate of working, but it balances the thrust of the cutting action of the two sides of the teeth and reduces chatter and vibration, thus giving greater accuracy. The slides of each of the two tools, of course, have to be relatively adjusted to each other, depending on the size of the tooth being cut.

* * *

A GREAT PUBLIC CLOCK.

CHARLES A. BRASSLER.*

The famous clocks of the old world, with their complicated mechanisms, telling of the movements of the planets, their crowing cocks, and processions of figures representing historical celebrities or biblical subjects, interesting as they are

Fig. 1. Great Clock on Factory of Colgate & Co., Jersey City, N. J.

to the antiquarian and curiosity seeker, could find little place in the practical up-to-date United States. On the other hand, a time-piece that will be a mentor to busy thousands in the great mercantile center of the new world, and a land-mark for the voyaging multitude that annually enters and leaves its portals, possesses more than passing interest.

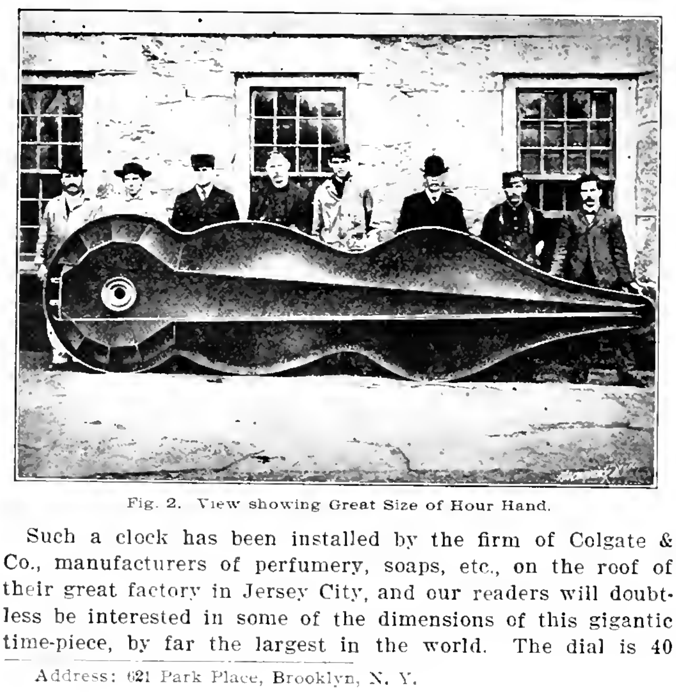

Fig. 2. View showing Great Size of Hour Hand.

Such a clock has been installed by the firm of Colgate & Co., manufacturers of perfumery, soaps, etc., on the roof of their great factory in Jersey City, and our readers will doubtless be interested in some of the dimensions of this gigantic time-piece, by far the largest in the world. The dial is 40 feet 6 inches in diameter, compared with the 37½-foot dial of the church of St. Rombaut at Mechlin (French-Malines), Belgium, hitherto regarded as the largest in the world. The marks used instead of numerals on the Colgate clock are 5 feet long and 30 inches wide.

While this clock is plainly visible and its record easily legible by day from the tall buildings in lower New York and from the decks of the crowded ferry-boats with which the Hudson River is at all times filled, it is after dark that the clock is most conspicuous. Innumerable electric lamps placed in deep grooves to concentrate their light, illuminate the figures on the dial, while the moving hands carry around with them a sufficient number of incandescent lamps to brightly outline them. Forty-two lamps light up the minute hand, which measures 20 feet from hub to tip, and without its counterbalance (which latter weighs 270 pounds) weighs 640 pounds, while twenty-five lamps will outline the hour hand, which is 15 feet from the edge of the hub to the tip, and weighs complete 500 pounds. The circumference of the dial is approximately 120 feet, and the point of the minute hand travels 3 2/3 miles in seven days. For every minute the clock goes, the point of the minute hand covers 23 inches. The distance from center to center of the hour graduations is 10 feet, and the minute spaces or marks are 2 feet apart.

The clock, which was built by the Seth Thomas Clock Co., of Thomaston, Conn., is what is known as the Seth Thomas remontoir tower clock, and will require about 1,500 pounds of weights to propel the hands. It is claimed to be the most

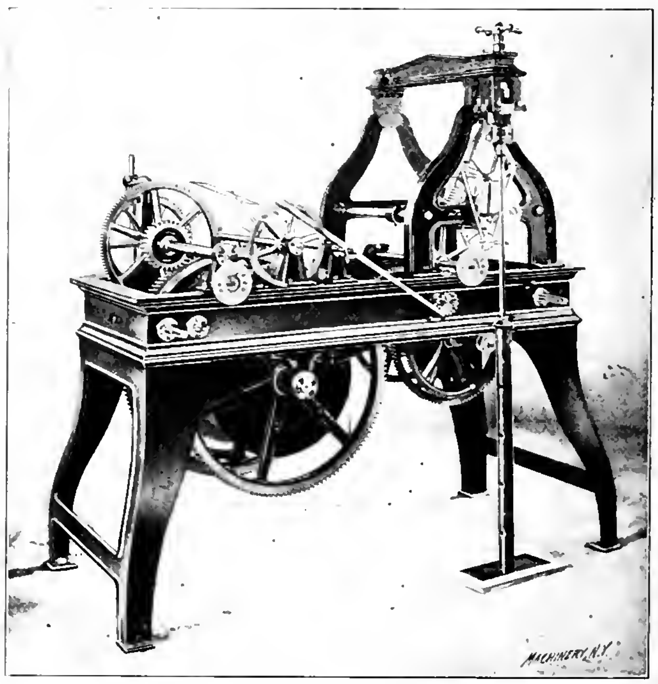

Fig. 3. The Seth Thomas Movement.

powerful as well as the most mechanically correct tower clock ever constructed. The pendulum rod, 8 feet in length, carries a cylindrical bob 330 pounds in weight. A refinement worth noting is that the bob is made with a rounding top to prevent dust from settling on it and affecting the accuracy of the time-keeper.

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* * *

Count Zeppelin made a very successful trial of his airship in Switzerland, July 1, when the ship remained in the air for twelve hours, with Count Zepplin and a crew of fourteen men. He sailed over Lake Constance, making complicated evolutions, and over a large part of Northern Switzerland, visiting Zurich, Winterthur and Lucerne. It was claimed that no automobile was under more perfect control of the driver than the airship. It sailed with and against the wind, and throughout the voyage maintained an average speed of 34 miles per hour. The greatest altitude reached in the long voyage was 2,500 feet and the total distance covered was about 220 miles. This is the fourth large airship built by Zeppelin with a structural frame to hold the cigar-shaped body rigid. It is 435 feet long and 43 feet diameter.

LOCAL HARDENING AND TEMPERING.*

MANIPULATION OF TOOL STEEL BY THE FLEXIBLE COVER OR SHIELD METHOD.

WILLIAM A. PAINTER,†

William A. Painter.‡

In describing the shield process or method of local hardening and tempering of tool steel, I record some of the results of over four years of experimenting and practical application. The process is a radical departure from any practice in use at the present time so far as I know, and acts on a principle that appears not to have been recognized heretofore. We have demonstrated the wearing qualities of dies and tools so treated, by every-day use, and the efficiency of these as compared with tools treated by the conventional processes is decidedly superior. Breakage is reduced to a minimum, both in hardening and tempering and in use.

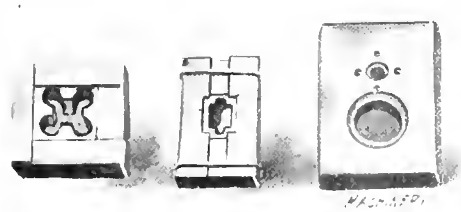
In using the shield method, the same judgment and common sense must be employed as in hardening by the regular method. If the hardener is hardening a piece that should be dipped in clear water, following the usual practice, it should be dipped in clear water when provided with the shield, and allowed to cool with the shield on. Or, if the piece is complicated and of delicate structure that requires cooling in oil, the same practice should be followed with the cover piece, dipping it in oil in the same manner. Again, if a special bath is required for certain work, use the bath in the same way for the shielded work. The results are exactly the same, except that with the shield method only the parts exposed harden, while the parts covered remain soft and in their natural condition.

A B C

Fig. 1. Blanking and Threading Dies in Protective Shield.

Heating.

For heating tool steel to be hardened by the shield method, the operator has the choice of any fire he prefers. An open forge answers the purpose for small work, but the furnace is better on account of the more even heat. A lead bath cannot be used because of the lead getting between the covers and the steel to be hardened, which will cause an explosion when dipped into water. This is not a serious drawback, as I do not consider that a lead bath has any marked advantages over a good coke or gas furnace. Moreover, the lead bath has a disadvantage in that it leaves a thin film or coating on the steel, which tends to keep the cooling bath from penetrating to the steel and cooling the piece as rapidly as it would cool if heated in a furnace.



A B C

Fig. 2. Square Threading Die, and Press Dies with Covers ready for Hardening

General Application of the Shield or Cover Method.

The shield method can be applied to almost all tool steel. Any brand or grade that is desirable to use can be handled in exactly the same way as without the shield. The advantage of the shield is that the essential wearing surfaces are hardened, and if these parts only require hardening, why harden the piece all over? A piece hardened all over is weakened by setting up internal strains and stresses which are likely to develop cracks and fractures and perhaps cause the ruination of an expensive part after it has been made all ready for use.

Gages of all kinds for external and internal use can be treated to advantage, and many gages now being made of machine steel and case-hardened can be made advantageously of tool steel in this manner, only the wearing parts being actually hardened, while the remainder is left soft. Multiple-throw crank-shafts for automobiles and high-duty automobile parts are readily treated by the shield method so that the actual wearing parts are hardened while the remainder of the piece is unchanged. Tool steel bearings for machinery may be hardened on the inside only, whether the bearing is in one piece or is split in two parts. Large rolls for rolling mills can be made with the journals soft or partly soft, thus avoiding the breakage of same at the shoulders. Hammer faces for pneumatic hammers can be treated at the shank so that the shank is soft while the die part is hard, thus avoiding the breakages now generally experienced. All kinds of drill jig bushings can be hardened, either externally or internally, as desired. Shear blades and other large pieces of similar use can be hardened on the cutting edges while the bulk of the metal is left soft.

A B

Fig. 3. Drop-hammer Die, and Punch with Shields.

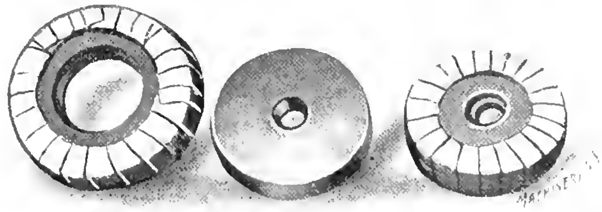


Fig 4. Two Drawing Dies prepared for Local Hardening and One after Hardening.

Materials used for Shields.

In practice the thinnest possible cover to accomplish the desired results should be used. I have not had to use material thicker than 0.020 inch for ordinary work, and not thinner than 0.010 inch for small work. The thickness that serves best for average work is about 0.014 inch. The object of the shield is to cool the steel as quickly as possible under the cover without hardening same and without leaving a line of tension between the hardened and unhardened areas. The cover or shield can be made of any sheet iron or sheet steel, and scrap pieces, even if rusty, answer the purpose satisfactorily. Galvanized iron or tin plate should not be used, as the coating of zinc or tin when heated enters the steel and deteriorates it.

The shields or covers are made in different ways to suit the conditions. Some are made with top and bottom pieces with another strip or piece for the edge to act as a binder to hold the top and bottom in place and to protect the edges of the

* For previous articles on local hardening see "Tempering Hollow Mills and Other Tools," by J. F. Sallows, February, 1907, and "Pack-Hardening Gages," by E. R. Markham, June, 1908. The process here described was patented March 17, 1908, No. 882,162.

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piece. Some shields are made in one piece where the shape is not irregular. This applies in the case of round drawing dies and similar parts. In such cases, of course, the shield is formed to shape by cutting and bending. Where an irregular shape is to be cut out, the piece to be hardened is laid on the sheet metal and the outline scratched on same. The shape is cut out with a chisel, leaving a margin of the required width around the edges that are to be hardened. The width of this margin depends on the size of the part and the nature of the work. A pair of hand shears or snips, a small chisel, a scriber, hammer, punch and pliers are the principal tools necessary. A supply of sheet metal, rivets, and iron binding wire completes the outfit.

How the Shield Method Differs from Other Protective Methods.

Mechanical journals and books on shop practice have not treated of this method, although other methods very similar have been described. There are several methods moderately successful for local hardening and tempering, one being by dipping the piece part way into a bath, a practice that is commonly followed in hardening chipping chisels. Another method is holding a heated piece over and above the bath and directing a stream of water onto the part to be hardened. Large, round drawing dies having to be hardened on the inside are examples of this practice, a cone-shape spout being used at the bottom of the pipe to deflect the stream onto the interior of the die. A third method is that of making a box or form of heavy steel, cutting or drilling out the shape of the piece to be hardened. A lid is fitted to the box and the piece is heated in the fire, and after being heated is placed in the box and quenched. This method is objectionable in that the box, being made of thick material, causes uneven cooling, most of the heat having to be drawn off through the exposed parts of the piece. A fourth method is the use of fire-clay or asbestos wrapped around the parts to be left soft, the holes being plugged with fire-clay, asbestos or even putty. Iron wire is used to wrap around a non-conducting material to hold it in place. It then has to be baked in an oven or furnace until the moisture is dried out. Then the part is heated in the furnace to the hardening heat, and dipped. Inasmuch as these materials are poor conductors of heat and as the heat must be drawn quickly in order for the steel to contract evenly with the hardened or exposed parts, this method has not been very successful.


A B
Fig. 5. Reverse Drawing Die.


Fig. 6. Embossing Die.

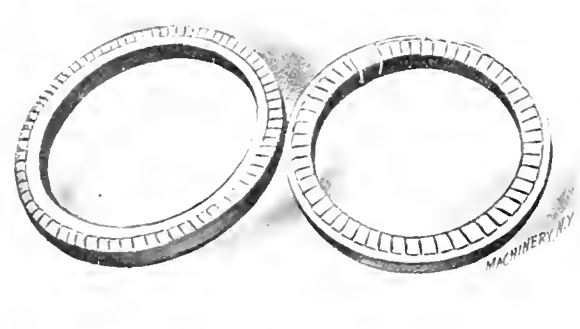
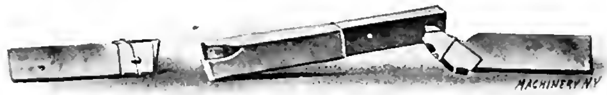


Fig. 7. Blanking Dies.

A piece of steel heated to a proper hardening heat and quenched in a box or shield of very thin steel or iron material, will remain soft because the water cannot cool it directly. Steam or vapor forms between the cover and the steel, driving the water away until the piece has cooled down. If holes are cut through the cover to let the steam out more rapidly, that part of the steel exposed will harden. To show that the steam imprisoned between the steel and the shield is a non-conductor of sufficient efficiency to make the difference between hardening and annealing, take a round piece of tool steel and fit a cover tightly around it, leaving half its length exposed. Heat this piece all over and cool all over. It will be found that the steel has hardened its full length under the cover, as well as on the exposed parts. The reason is that when the cover is tightly fitted no water can penetrate between the shield and the steel, and hence no steam is formed. The cover being thin, the steel cools rapidly and hardening takes place. This proves that the cover itself is a good conductor of heat, but the thin stratum of steam which will always exist between the cover and the piece as ordinarily fitted, is sufficient to check the hardening process.


A B C
Fig. 8. Samples of Lathe Tools with Shields.

Description of Work Locally Hardened.

The part shown in Fig. 1 at *A* is an ordinary blanking or cutting die and is an example showing how any shape to be hardened can be outlined in the cover. The cover is made in two pieces, the top and sides being one piece and the bottom the other piece. The material of this shield is No. 26 sheet steel and is about 0.018 inch thick.

The second piece shown in Fig. 1 at *B* is a round threading die, and the shield is applied so that the threads only are hardened, the exterior remaining soft. It illustrates a very practical use of the shield method. The die is split at one point, being of the adjustable type. Inasmuch as only the teeth are hardened, there is no danger of cracking the die in adjustment, and there is less distortion and change of pitch. The cover is made in one piece and can be used several times before being destroyed by the heat.

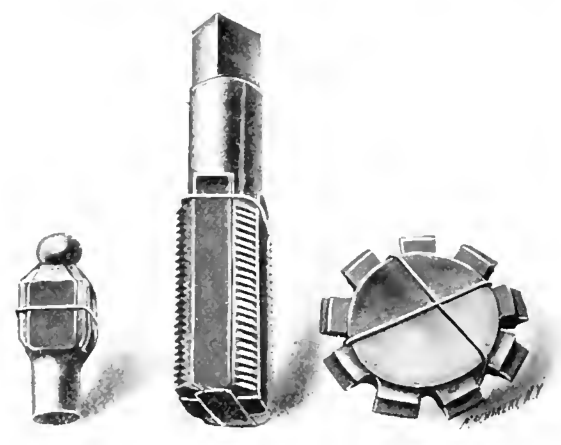


Fig. 9. Miscellaneous Examples.

The third piece shown in Fig. 1 at *C* is a plain blanking die, but instead of being hardened around the edge of the cutting part as in *A*, it is hardened half the thickness of the steel, leaving the whole lower half soft, this being protected by the cover, while the upper half is hardened. This gives the die all the advantages of a die made of composite steel, a material that is made of half tool steel and half soft steel or iron welded together. This material is extensively used on small die work, but the shield method makes its use unnecessary as all its advantages are obtained very simply, and it never splits at the weld as is sometimes the case with composite steel.

A square threading die is shown in the shield at *A* in Fig. 2, and the same remarks apply in regard to distortion and change of pitch as in the case of the round threading die. At *B* is shown a press die in its cover ready to be hardened. The exposed portion is not large in proportion to the size of

the die, but it will harden just as well as if there were a half inch margin exposed all around the edge. The cover is held on by iron wire. Brass wire or rivets should not be used, as the heat destroys them. At C is shown a progressive or following die. There is nothing of special interest in the design, but the method of hardening a narrow ring around each hole is unique. The cover is cut out so as to leave a narrow margin of exposed steel around each hole. The die is hardened exactly as the cover shows, the remainder of the body being soft, as before dipping.

In Fig. 3 at *A*, is a forming die for drop-hammer. It is 8½ inches long, ¾ inch thick and 4 inches high, and has been

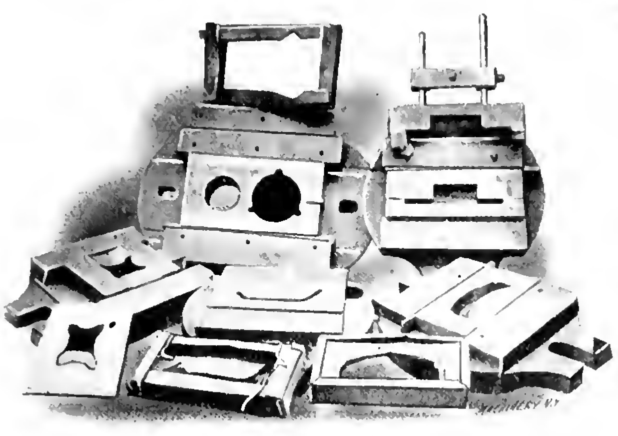


Fig 10. Group of Large Dies and Covers.

hardened all around the outline of the top or face for a width of ½ inch. The scale is still on the steel and no finishing has been done. The cover had two large holes cut out to balance the cooling as the narrow center would warp the bottom. This piece was hardened without warping. At *B* is shown a large blanking punch with the face up. In hardening large punches it is only necessary to harden an area around the cutting edge. The steel plate or cover on the face of the punch is 0.020 inch thick and was held to the face of the punch by three 3/16 inch screws, holes being drilled in the face of the punch to correspond. This is a good example of cover hardening and demonstrates its value, as the punch retains its shape perfectly after being dipped.

Two drawing dies are shown in Fig. 4 with the covers on ready to harden, and a third die is shown without a shield. These shields are made in one piece and can be used over

Fig. 11. Another Group of Large Dies.

again. A drawing die needs to be made as hard as possible, and yet when a die is hardened all over it is necessary to draw the temper in order to relieve the internal strains. By the shield method the working part is made as hard as it can be made while the soft part gives it a suitable backing and strength. The shrinkage can be regulated by the thickness of the shield or by putting vent holes around the edge of same. The vent holes let out the steam and cause the shielded part to cool more rapidly. Dies hardened by the shield process can be shrunk repeatedly to take up the wear.

A reverse drawing die 6 inches outside diameter, 5 inches inside diameter, with hardened ring riveted to the top or wearing edge, is shown in Fig. 5 at *A*. At *B* is illustrated the method of hardening the ring, leaving the shoulder or bottom edge soft by covering it with a shield of thin steel. The ring can be fitted after hardening, driven on a shoe and holes drilled through from outside of the machine steel shoe, and riveted. The hardened portion is then ground to size. If the top ring were welded to the shoe it would have to be discarded when worn down.

In Fig. 6 is shown an embossing die made of tool steel. It is 8½ inches diameter and 3 inches thick. This die was covered on the bottom and sides with No. 25 sheet steel 0.020 inch thick and placed in a basket or hanger so that it could be immersed by a tackle. The embossed part was filled with bone dust for protecting it in the fire, but charcoal or any suitable filling will do as well. When covering shallow dies, the top edge should be left standing about a half inch above the face of the die instead of being folded over, as shown in the illustration. This face is filled in as described above as the filling will protect the face of the die. It should be left in, when dipped, and the die should be suspended face up and about 3 inches below the water level, while a stream of water of large volume but low pressure is directed against the center of the die while the die is moved around in the tank. This can be done with one hand holding the tackle while the other hand directs the stream. The filling or packing will float away, leaving the surface of the die clean. A ¾-inch hose without nozzle is about right for ordinary work.

In this connection it may be mentioned that a skeleton platform with hanger is an advantage for handling large work, as any piece too large for tongs can be placed on the platform and lowered into the tank. It may be cooled from the

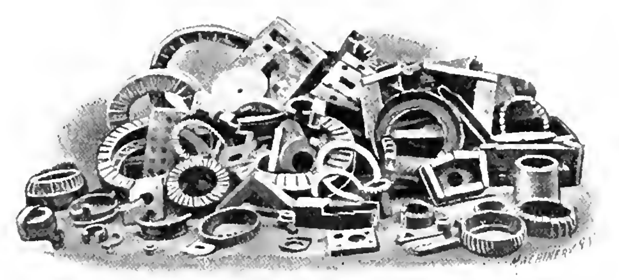


Fig. 12. Miscellaneous Collection of Shields or Covers showing Range of Application.

bottom, if necessary, as well as from the top. Some shapes give better results if covered only on the sides, leaving the top and bottom exposed. The hanger gives the bottom a chance to cool off, but not as rapidly as the top where the stream of water is directed. This method is an improvement over the present way of hardening drop forging dies, this class of hardening being regarded as very difficult where the shapes are irregular and the thickness of the walls uneven. It will apply to all deep or hollow dies.

To the left in Fig. 7 is shown a blanking die 11⅛ inches inside diameter, 1¼ inch thick and 1¼ inch width of walls. This die is covered and hardened in the regular way. The temper is drawn, after which it can be placed in the lathe and trued up. The outside is as soft as it was before dipping. Obviously, this die is much stronger than one hardened all over. At the right is shown a blanking punch 11⅛ inches outside diameter, 1⅛ inch thick, with walls 1⅛ inch wide. It is hardened on the outside only and the temper is drawn. The inside is as soft as before hardening, and is made a driving fit on a cast iron holder. The fit can be made a very tight drive without danger of cracking the ring.

Fig. 8 shows the application of the shield method to hardening lathe tools. At *A* is shown a right-hand side tool of carbon steel hardened on the cutting face only, the back being left soft. The cutting edge can be left much harder than usual without danger of weakening the tool. At *B* is shown a self-hardening tool that has been heated up to the proper temperature without cover and the cover applied to the tool before dipping in oil. This method works equally as well on air-hardened tools, the cover being put on before holding the tool in the air-blast. The breakage of self-hardening steel tools is an expensive item and usually amounts to

more than the actual wear of the tools, but if they are made with a soft back or partly soft back and with only the working parts hard, as will be the case with the shield process, the tool is much stronger, and is much less liable to fracture in service. At C is a half diamond point lathe tool which is hardened only on the working face. The sheet covers can be applied to any shape of lathe or planer tool by any one of ordinary mechanical skill.

In Fig. 9 a ball peen hammer is shown placed ready for hardening and the eye for the handle is not filled, but is covered with a shield of steel wrapped around the part to be kept soft. The eye will not harden, as the heat of the steel inside of the cover, when dipped, creates steam which drives the water back until the heat is reduced. The milling cutter in this illustration is shielded with two circular plates 0.020 inch thick and the hole in the center is not filled. The disks of sheet metal are held together by iron wire, and any desired area on the sides of the cover can be left soft by making the size of the disks to suit. This is far better than the heavy plates that are generally used, as the heat is drawn off more rapidly, leaving less internal stresses in the steel. The tap shown has been hardened on the teeth only, the body and shank being shielded so that they are left soft. Taps hardened in this manner are truer in the pitch and the size is less likely to be changed than if hardened all over. The preparation of the cover took less than 5 minutes' time, only two strips of sheet steel being required and a short section of iron binding wire. Flat drills are hardened on the point and sides only, the center being left soft. Such drills will not snap off short when caught in the work, but will bend before breaking. The shield consists simply of two thin plates held on by iron wire.

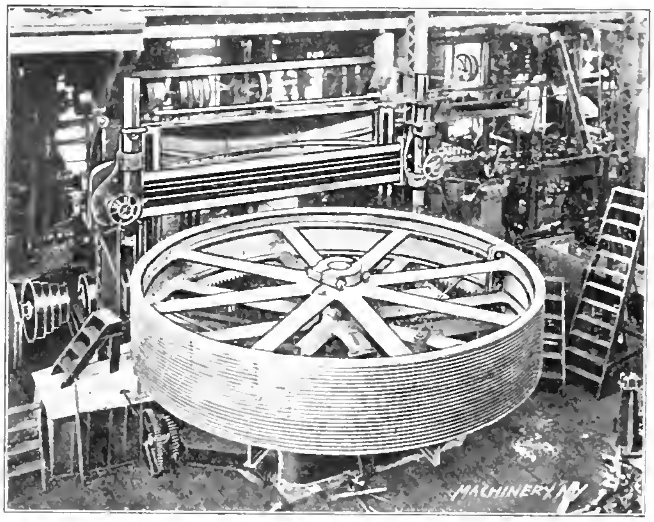


Fig. 1 Rope Sheave 20 Feet in Diameter for Driving Refrigerating Plant.

Fig. 10 illustrates a group of large dies and their covers. In Fig. 11 is illustrated another group of large dies, and in Fig. 12 is shown a miscellaneous collection of covers that have been used to shield work from $\frac{1}{4}$ inch diameter to 12 inches diameter. The shields are made mostly from stock 0.010 to 0.020 inch thick. Some of the circular shields have been in the fire several times.

My conclusion is that the shield method of local hardening is applicable to a vast range of work, and that the cutting tools, dies, taps, gages, etc., locally hardened and tempered, are less likely to warp and change in shape in hardening and are more durable in service than when hardened in the common way. The application of the shields is cheap, and any one of ordinary skill is able to cut them out and apply them to the work. The saving in breakage alone will more than pay the expense of applying the shields, while the greater durability of tools so hardened makes the process profitable to follow.

* * *

One of the most remarkable flying machine performances, undertaken under the auspices of official supervision, is that of Delegrange, a French aeronaut, who, on June 22, with an aeroplane covered a little more than 11 miles in $16\frac{1}{2}$ minutes, making nine rounds of a measured course.

LARGE ROPE SHEAVE—CUT GEARS OF UNUSUAL DIMENSIONS.

A rope sheave 20 feet in diameter, with 20 grooves for 2-inch rope, weighing 48,000 pounds finished, was recently made by H. W. Caldwell & Son Co., Chicago, Ill. The sheave is shown in Fig. 1 on the boring mill. It has a double set of arms, and was cast in one piece and then split apart for convenience in handling and erecting. It was cast in the foundry of the company, and was finished on a 20-foot boring mill. The sheave will be used in connection with the main drive of a refrigerating plant in Mexico to reduce the speed of an electric motor, the motor being direct connected to a small sheave. The transmission is by means of what is generally known as the American or single rope system.

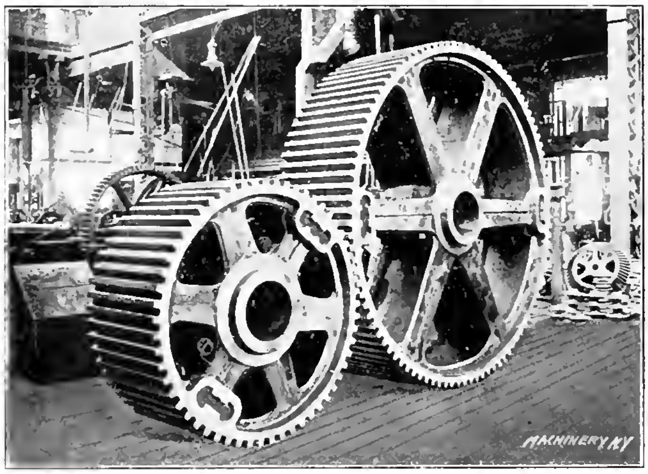


Fig. 2. Heavy Cut Gears of Unusual Dimensions.

Figs. 2 and 3 show a pair of heavy cut gears of unusual dimensions, recently produced in the same works. The gears are of semi-steel mixture, and were cast in halves and the joints planed. The weight of the large gear is 13,800 pounds and of the small gear 8,000 pounds. The diameter of the large gear is 95.51 inches, 100 teeth, and of the small gear 55.41 inches, 58 teeth. The width of the face is 27 inches and the pitch is 3 inches. The teeth were machined in a Gleason gear planer, it being preferable to plane the teeth rather than mill them on account of the extraordinary dimensions of the gears. It may be said as a general proposition that it is preferable to plane spur gears in all sizes above 2 or $2\frac{1}{2}$ circular pitch. The gears illustrated are to be used in connection with the drive of a mining hoist in the Lake Superior copper mines.

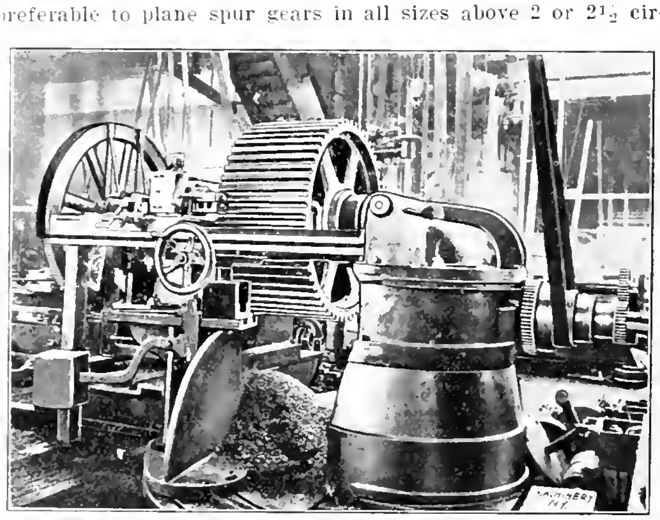


Fig 3 Gears being planed on a Gleason Gear Planer.

* * *

The Pennsylvania Railroad has had a long line of engineers for presidents, and for many years it did not list its stock on the New York Stock Exchange. The pre-eminence of this corporation over all other railway organizations as a legitimate enterprise is undoubtedly due to these facts and to the sense of duty and practical ability of its presidents.—*W. D. Marks, in Engineering News.*

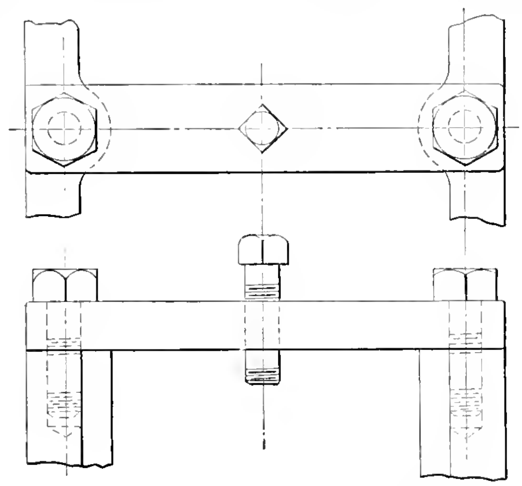
JIGS AND FIXTURES—5.

EINAR MORIN *

CLAMPING DEVICES (Continued.)

It was mentioned in the previous installment, appearing in MACHINERY last month, that the loose leaf construction, as a rule, is only used when a guide bushing can be put into the leaf, because its construction is rather expensive to use for the single purpose of clamping. When the leaf is simply intended to hold one or more set-screws by which the work is held down, it may be made and fastened as shown in Fig. 51. In this case, the name "leaf" is rather out of place, and this fastening device becomes merely a strap. Some improvements of this kind of clamping device are shown in Fig. 52, where the ends of the strap are slotted in various ways so as to permit getting the strap out of the way rapidly when the work is to be removed.

The ordinary jack-screw is used to some extent as a clamping device in drill jigs, but the objection to its use is that, not being an integral part of the jig, it is very apt to get lost. In Fig. 53 are shown two simple devices working on the same principle as the jack-screw, but having the advantage of being connected to the jig by the pin shown at *B*. At *A*, in Fig. 53, a set-screw screws directly into the end of the eye-bolt, and at *C* a long square nut is threaded on the eye-bolt. These nuts must be made of special length, and be made up especially for this purpose. The eye-bolts are fastened, as



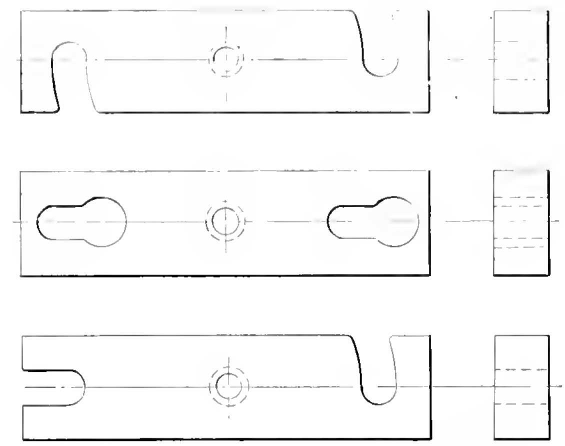
Machinery,N.Y.

Fig. 51. Common Clamping Strap.

shown, directly to the wall of the jig, and the set-screw or nut is tightened up against the work. The eye-bolt can be set at different angles to suit the work, thereby providing a clamping device which may be said to possess double adjustment. This device makes a very convenient clamping arrangement. It works satisfactorily, and has the advantage of being easily swung out of the way.

The principles of clamping work in the jig by means of a wedge or tapered gib is illustrated in Fig. 54. The work is located between the wedge *A* and the wall *B* of the jig and pressed up against the wall by the wedge which can be driven in by a hammer, or screwed in place when the jig is constructed as shown. It is preferable to have the wedge screwed in place, as it is then less apt to loosen by the constant vibrations to which it is subjected, and at the same time the wedge is less apt to get lost, being an integral part of the jig. The ear for the screw may be placed in any direction in regard to the gib, as indicated by the dotted lines in the end view of Fig. 54. This tightening device is, in particular, adapted to work of dove-tail shape, as shown in Fig. 55. In this case the wedge is made similar to the common taper gib used for taking up the wear in dove-tail slides. It is sometimes of advantage to relieve the bearing surface opposite the wedge, as shown in dotted lines in Fig. 54, in order to provide two distinct bearing points, which prevents the work from rocking.

If it is required to get a bearing on two points of a surface that is likely to vary in its dimensions, a yoke can be used, designed on the principle of that shown in Fig. 56. In the engraving, *A* is the work to be clamped, and *B* is the yoke which fits into a slot in the center of the strap or clamp *C*. The yoke is held by a pin *D*, around which it can swivel to adjust itself to the work. It is evident that the amount of pressure at the two points *E* and *F* will be equal, or at least near enough for all practical purposes, even though the screws at the ends of the strap may not be equally tightened. In

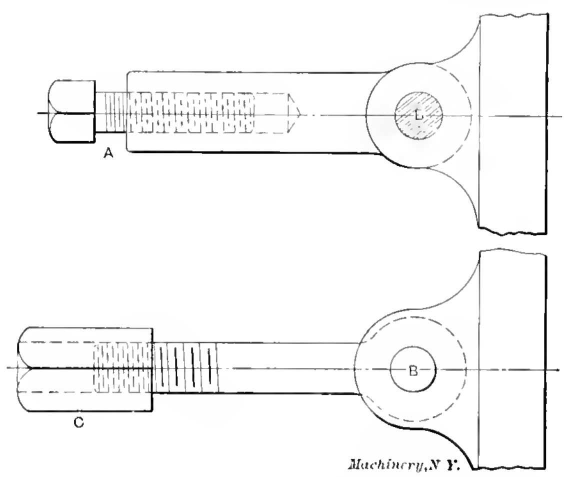


Machinery,N.Y.

Fig. 52. Improved Designs of Clamping Straps.

this device the pin *D* takes the full clamping strain, and should therefore be designed strong enough, and the strap which is weakened by the slot and the hole in the center, should be reinforced, as indicated, at this place. It is preferable to have spiral springs at each end of the strap to prevent the strap from slipping down when the work is taken out. The strap may be made either of cast iron or machine steel, the yoke being made out of machine steel.

Eccentric clamps and shafts for binding purposes are often used. In Figs. 57 and 58 are shown two applications of the principle of the eccentric shaft. In Fig. 57 the eccentric shaft *A* has a bearing at both ends, and the eye-bolt *B* is connected to it at the center and is forced down when the eccentric shaft is turned. This causes the two end points of the clamp *C* to bear on the work. This clamping arrangement has a very rapid action and gives good satisfaction. The throw of the eccentric shaft may vary from 1/16 inch to about 1/4 inch, depending upon the diameter of the shaft and the accuracy of the work. In cases where it is required that the clamp should bear in the center, an arrangement like the one shown in Fig. 58 may be used. Here the eccentric shaft *A*



Machinery,N.Y.

Fig. 53. Clamping Devices working on the Jack-screw Principle.

has a bearing in the center and eye-bolts *B* are connected to it at the ends. As the eccentricity is the same at both ends, the eye-bolts or connecting-rods will be pulled down evenly when the lever *C* is turned, and the strap *D* will get an even bearing on the work in the center. If the force of the clamping stress is required to be distributed equally at different points on the work, a yoke like that shown in Fig. 56 may be used in combination with the eccentric clamping device in Fig. 58.

*Address: 833 W. Sixth St., Plainfield, N. J.

When it is essential that the strap *D* should also be used for locating purposes, necessary guides will be provided for the strap, so as to hold it in the required position. These guiding arrangements may consist of rigid rods, ground and fitted into drilled and reamed holes in the strap, or square bars held firmly in the jig, and fitted into square slots at the ends of the strap. The bars can also be round, and the slots at the ends of the strap half round, the principle in all cases remaining the same, excepting, of course, that the more rigid the guiding arrangement is, the more may the accuracy of the locating be depended upon.

The ordinary eccentric lever works on the same principle as the eccentric rods just described. There is a great variety of eccentric clamping devices, but they are not as commonly used in present-day jig design as they used to be a few years ago. The eccentric clamping levers, however, provide good and rapid clamping action. In Fig. 59 is shown one especially intended for clamping finished work. It is not advisable to use this kind of lever on rough castings for the reason that these latter may vary so much that the cam or eccentric will have to have too great a throw for rigid clamping to suit the rough castings. The extreme throw of the eccentric lever

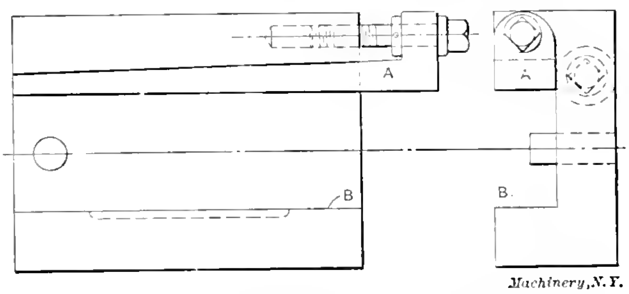


Fig. 54. Wedge or Taper Gib used for Clamping.

should in general not exceed 1/6 of the length of the radius of the eccentric arc if the rise takes place during one-quarter of a complete turn of the lever. This would give an extreme throw of say 1/4 inch for a lever having 1½ inch radius of the cam or eccentric. Even to one unfamiliar with this kind of work it is plain that as the eccentric cam swivels about the center *A*, the lever being connected to the jig with a stud or pin, the face *B* of the cam, which is struck with the radius *R* from the center *C*, recedes or approaches the side of the work, thereby releasing it from, or clamping it against, the bottom or wall of the jig. The lever for the eccentric may be placed in any direction, as indicated by the full and dotted lines in Fig. 59. In Fig. 60 is shown another eccentric lever, which is used frequently on small work for holding down straps or leaves, or for pulling together two sliding pieces, or one sliding and one stationary part, which in their turn hold the work. These sliding pieces may be V-blocks or some kind

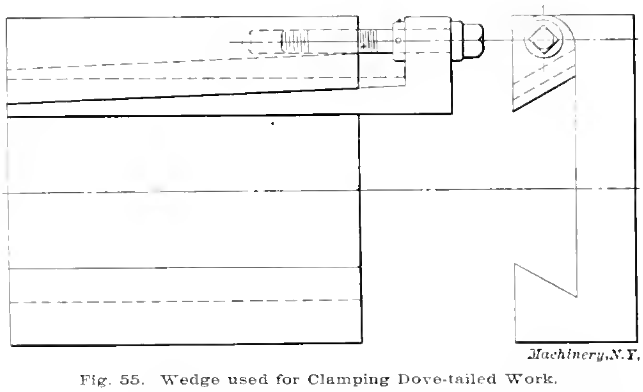


Fig. 55. Wedge used for Clamping Dove-tailed Work.

of jaws. The cam lever is attached to the jig body, the leaf, or the jaw, by a pin through hole *A*. The hook *B* engages the stud or pin *C* which is fastened in the opposite jaw or part, which is to be clamped to the part into which the pin through hole *A* is fastened.

The variety of design of eccentric cam levers is so great that it is impossible to show more than the principles, but the examples shown embody the underlying action of all the different designs.

The Design of Jigs.

To give any rational rules or methods for the design of drill jigs would be almost impossible, as almost every jig has to be designed in a somewhat different way from every other jig, to suit and conform with the requirements of the work. All that can be done is to lay down the principles. The main principles for jigs as well as fixtures were treated at length

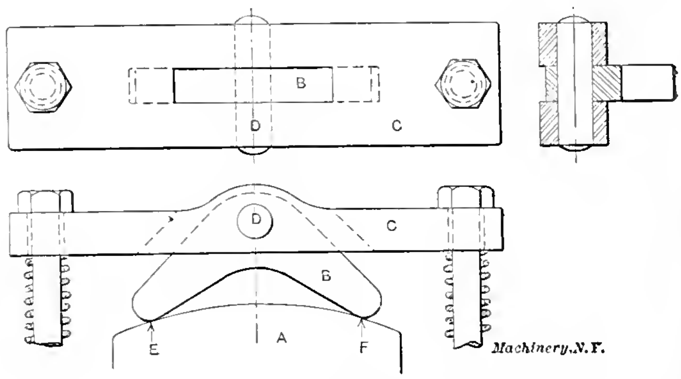


Fig. 56. Equalizing Clamp.

in the first installment (April issue) of these articles. It is proposed in the following to dwell more in detail on the carrying out of the actual work of designing jigs.

Before making any attempt to put the lay-out of the jig on paper, the designer should carefully consider what the jig will be required to do, the limits of accuracy, etc., and to form, in his imagination, a certain idea of the kind of a jig that would be suitable for the purpose. In doing so, if a model or sample of the work to be made is at hand, it will be found to be a great help to study the actual model. If the drawing, as is most often the case, is the only thing that is at hand, then the outline of the work should be drawn in red

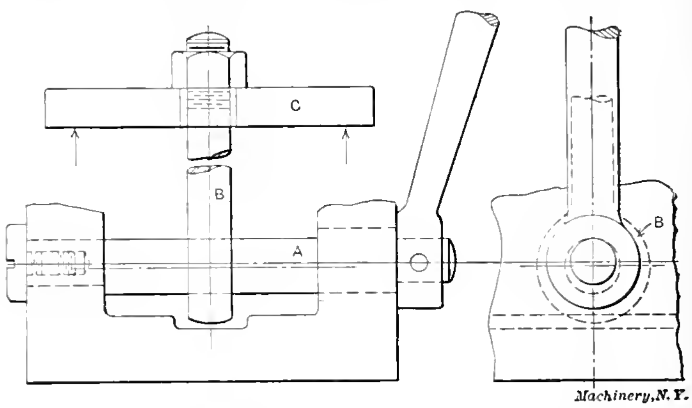


Fig. 57. Eccentric Clamping Bolt.

ink on the drawing paper, on which the jig is subsequently to be laid out, and the jig built up, so to speak, around this outline. The design of the jig will be greatly simplified by doing this, as the relation between the work and the jig will always be plainly before the eyes of the designer, and it will be more easily decided where the locating points and clamping arrangements may be properly placed. When drawing and projecting the different views of the jig on the paper, the red outline of the work will not in any way interfere, and when the jig is made from the drawing, the red lines are simply ignored, excepting to the extent in which the outline of the pieces may help the toolmaker to understand the drawing and the purpose of certain locating points and clamping devices.

If it is possible, the jig should be drawn full size, as it is a great deal easier to get the correct proportions, when so doing. Of course, in many cases, it will be impossible to make the jigs full size. In such cases the only thing to do is to make them to the largest possible regular scale. Every jig draftsman should be supplied with a set of blue-prints containing dimensions of standard screws, bolts, nuts, thumb-screws, washers, wing nuts, sliding points, drills, counterbores, reamers, bushings, etc.; in short, with blue-prints giving dimensions of all parts that are used in the construction of jigs, and which are, or can be, standardized. It should be

required of every designer and draftsman that he use these standards to the largest possible extent, so as to bring down the cost of jigs to as low a figure as possible.

If it does not meet with objections from higher authorities, which it ought not to, it is highly advantageous for the obtaining of best results, that, before starting on the drawing, the draftsman who is to lay out the jig should converse with the foreman who is actually going to use the jig. Oftentimes this man will be able to supply the best idea for the making of the jig or tool. Not only is advantage taken of the combined experience of the draftsman and the foreman, but it is also a precaution of great importance for making all parties feel satisfied.

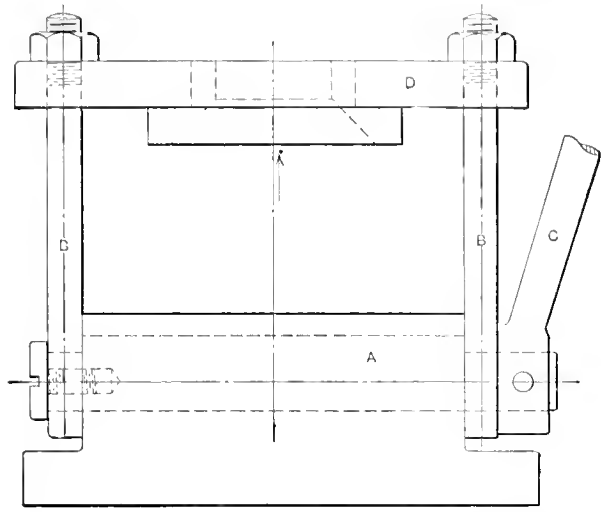
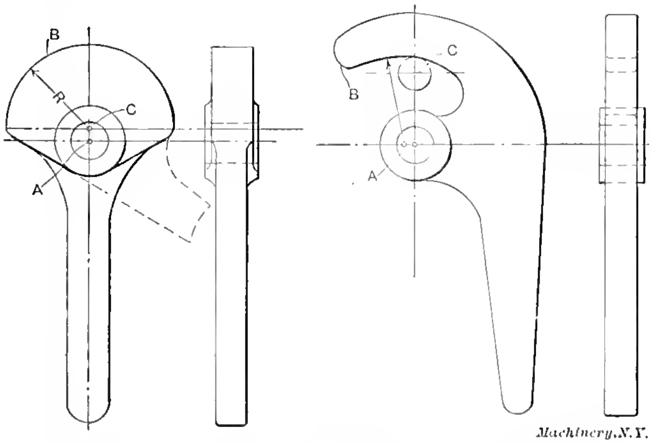


Fig. 58. Another Example of Eccentric Clamping Bolt.

As a jig drawing, in most cases, is only used once, or at most only a very few times, it is not considered worth while to make a tracing or blue-print from the drawing, but, as a rule, the pencil drawing itself may be used to advantage. If, however, it is given out in the shop directly as it comes from the drawing-board, it is likely to get soiled, and to be used in such a manner that, after a while, it would be impossible to make out the meaning of the views shown on it. For this reason, in the first place, jig drawings should be made on some heavy paper, preferably of brown color, which is not as quickly soiled as white paper. In order to prevent the drawing being torn, it should be mounted on strawboard, and held down along the edges by thin wooden strips, nailed to the board. It is also desirable to cover the drawings with a thin coat of shellac before they are sent out in the shop. When this is done, the dirt and black spots which will always be found on the drawing when it stays in the shop, even if but for a few hours, may be washed off directly; and the shellac itself may be washed off by wood alcohol, when the drawing is returned to the drafting-room. The drawing, after having been cleaned, is then detached from the strawboard, which latter may be used over and over again. The drawing is, of course, filed away, according to the drafting-room system.



Figs. 59 and 60. Cams or Eccentrics used for Clamping.

The most advantageous sizes for jig drawings for medium to heavy work are as follows:

Full size sheet, 40 × 27½ inches.
Half size sheet, 27½ × 20 inches.
Quarter size sheet, 20 × 13¾ inches.
Eighth size sheet, 13¾ × 10 inches.

Of course, these sizes will vary in various shops, and in many cases, particularly when the tool designing department and the regular drafting-room are combined as one drafting department, the jig drawings should be of the same regular sizes as the ordinary machine drawings.

It is common in a great many shops to make no detailed drawings of jigs, but simply to draw a sufficient number of different views and sections, and to dimension the different parts directly on the assembly drawing. In cases where the jig drawings are extremely complicated, and where they are covered with a large number of dimensions which make it hard to read the drawing and to see the outlines of the jig body itself, it has proved a great help to trace the outlines of the jig body, and of such portions as are made of cast iron, on tracing paper, omitting all loose parts, and simply putting on the necessary dimensions for making the patterns. A blue-print is then made from this paper tracing, and this is sent to the pattern-maker, who will find the drawing less of a puzzle, and who will need to spend far less time on making out how the pattern actually looks. A less skilled, and consequently a cheaper, man may also be used for making the pattern. It is, however, greatly to be doubted whether it is good policy not to detail jig drawings completely, the same as other machine details.

When jigs are made up for pieces of work which require a great many operations to be carried out with the same jig, and where a great number of different bushings, different sizes of drills, reamers, counterbores, etc., are used, a special operation sheet should be provided which should be delivered to the man using the jig, together with the jig itself. This enables him to use the jig to best advantage. On this sheet should be marked the order in which the various operations are to be performed, and the tools and bushings which are to be used. Of course, the bushings in such a case should be numbered or marked in some way so as to facilitate the selection of the correct bushing for the particular tool with which it is used. If this system is put in force and used for simpler classes of jigs also, the operator will need few or no instructions from his foreman, outside of this operation sheet.

* * *

A summary of the available water powers of the world has been published by the *Revue Electrique*. It is stated that in the United States there is 1,500,000 horse-power possible of utilization. Among the European countries, France has an estimated available water power of 4,500,000 H. P., of which 800,000 H. P. is utilized. The region of the Alps extending into France brings the figure as high as mentioned. Italy, it is stated, has an equal amount of water power available, but only 300,000 H. P. is utilized as yet. In that country, falls of 10,000 H. P. are abundant. The estimate for the available water power in Switzerland is incomplete, but 300,000 H. P. is in use. The available power in Germany is 700,000 H. P., 100,000 H. P. being utilized. In Norway the estimated power is 900,000 H. P., and in Sweden 760,000, a large part of which is already developed in both countries. As regards available water power, Russia heads the list, it being estimated that 11,000,000 H. P. could be taken out of the Russian rivers, of which only 85,000 H. P. has been developed. Great Britain and Spain come last in the estimate, only 70,000 H. P. being utilized in either country. It is stated that Japan has available water power of 1,000,000 H. P., of which only 7 per cent has as yet been utilized. The estimate for the water power in the United States is without question considerably below the actual figures. It has been stated, on good authority, that there is already developed, or under development, in the United States, 4,500,000 H. P. from water sources, and the government's statistical figures indicate that the available water power in the country is nearly 10,000,000 H. P. In New England alone there is 1,000,000 H. P. developed, with probably another half million available.

CUTTING LONG LEAD-SCREWS ON THE THREAD MILLING MACHINE.

There is, perhaps, no work on which the convenience and economy of using the thread milling machine has been better exhibited than when cutting long lead-screws, which, if the thread should have been produced in an ordinary lathe, of about the same capacity as the thread milling machine, would have caused a great deal of trouble in order to obtain proper supports while cutting the thread. The accompanying half-tones, Figs. 1 and 2, show two long lead-screws being cut in thread milling machines. These lead-screws are used on the gun-barrel drilling machines built by the Pratt & Whitney Co., Hartford, Conn., and the photographs were taken when the lead-screws were being cut in thread milling machines in the company's shop.

The lead-screw shown being cut in Fig. 1 is shown in detail in the engraving, Fig. 3. It was not possible to include in the photograph the full length of the screw, as it extended a considerable distance from the left side of the machine. The length of the threaded portion of this lead-screw is 34 feet 8 inches, and the diameter of the thread is $2\frac{1}{2}$ inches, there being 3 Acme threads per inch. The thread

The lead-screw shown being cut in Fig. 1 is shown in detail company's 6 x 80-inch thread milling machines, and, on account of the length of the screw, it was required to move or shift the carriage back five times to complete the screw, so that the carriage traversed the full length of the machine six times in all before having completed the screw. The cutter, of course, milled the thread to its full depth and shape in one cut, no finishing cut or second operation whatever being required. The surface speed of the cutter, while cutting, was about 96 feet per minute, and the surface feed of the work 3.9 inches per minute, 42 hours being required to complete the cutting of the whole lead-screw.

The lead-screw shown in detail in Fig. 4 was cut on one of the company's thread milling machines, as shown in Fig. 2. This machine is of a far heavier construction than the one shown in Fig. 1, and is known as a 12 × 48-inch thread milling machine. As this machine does not permit as long travel of the carriage, on account of the bed being so much shorter, it was necessary to shift the carriage eight times, or to traverse the length of the bed nine times in all, in order to cut the full length of the thread, which, in this case, was 34 feet, $8\frac{7}{8}$ inches. This screw had but one Acme thread per inch, right-hand, single, the diameter of the lead-screw being $3\frac{1}{2}$ inches. The surface feed was $2\frac{1}{2}$ inches per minute, and the surface speed of the cutter was about 66 feet per minute.

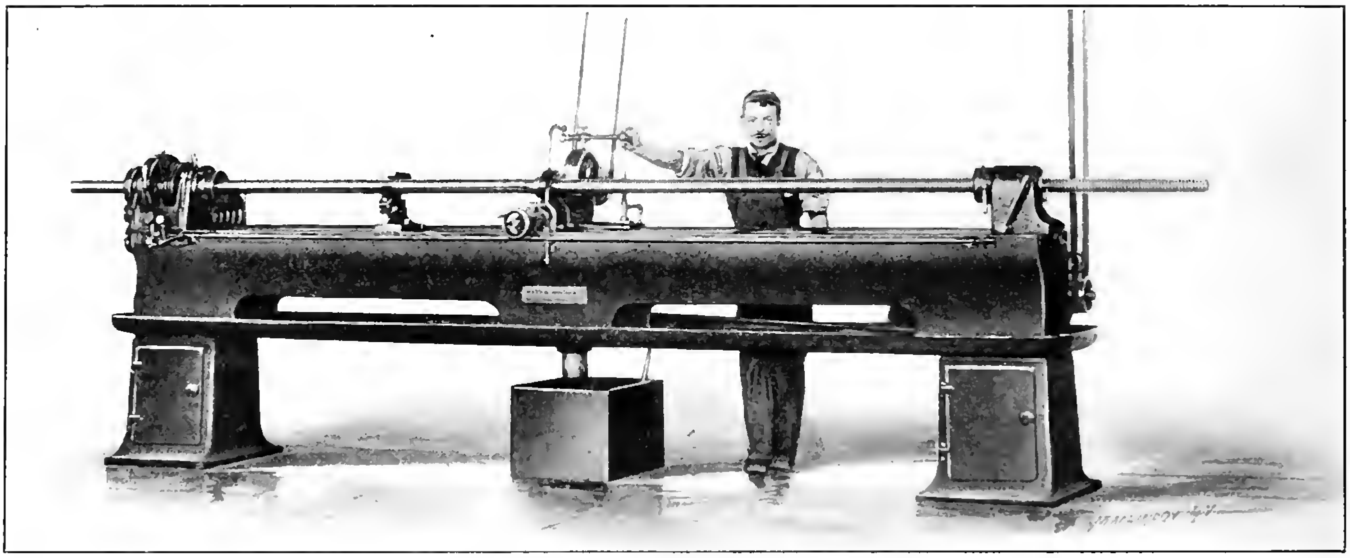


Fig. 1. Milling Lead-screw shown in Detail in Fig. 3.

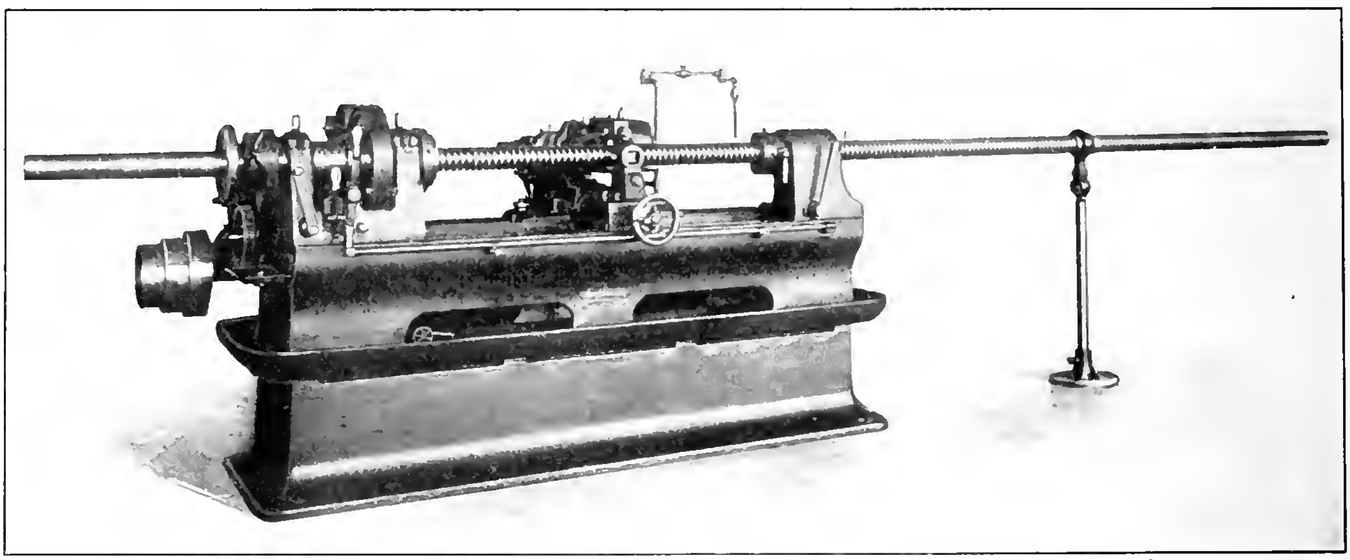


Fig. 2. Lead-screw shown in Detail in Fig. 4, cut in a Pratt & Whitney Thread Milling Machine.

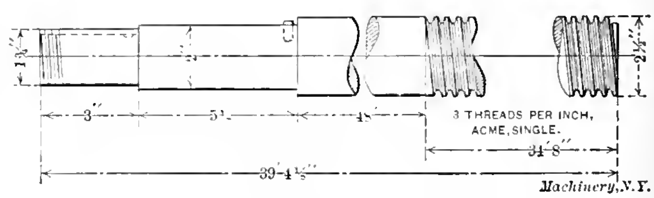


Fig. 3. Detail of Lead-screw for Pratt & Whitney No. 3 Gun-barrel Drilling Machine.

With the feed stated the actual cutting time was about $30\frac{1}{2}$ hours, but it would have been possible to cut with a heavier feed, at least 3 inches, in which case the time required would only have been $25\frac{1}{2}$ hours. The thread of this lead-screw, the same as the thread of the lead-screw previously referred to, was finished with a single cut, and it was considered that

the thread was fully as smooth and more perfect to shape than would have been the case if the thread had been cut with the greatest of care in an ordinary lathe.

We have no records on hand which intimate how long it would take to finish a screw on an ordinary lathe, with an equal degree of accuracy, but such comparative figures would be highly interesting. The thread miller requires less attendance, and outside of the operator's time gained, the convenience in doing the work, passing the bar right through

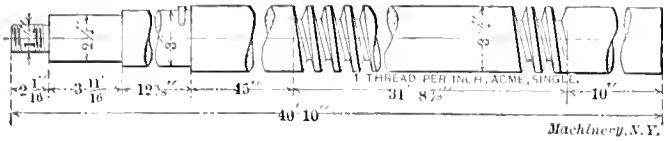


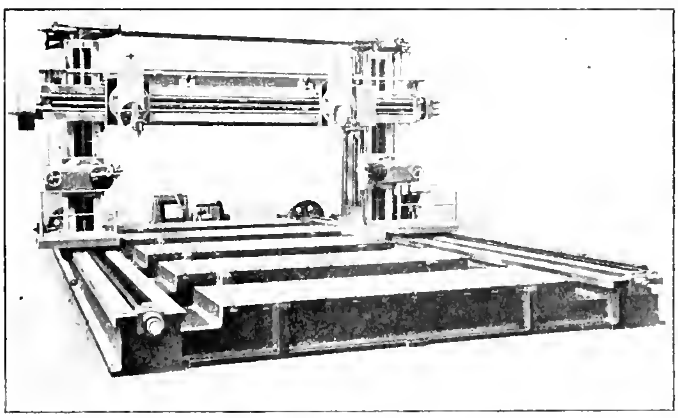
Fig. 4. Detail of Lead-screw for Pratt & Whitney No. 4 Gun-barrel Drilling Machine.

the spindle and foot-stock, and simply supplying standards for the support of the overhanging ends of the screw, is apparent to anybody who has seen or had experience with the difficulties attending the cutting of long lead-screws in ordinary lathes, where, for instance, sometimes portion after portion of the length of the screw has to be welded onto the previously completed part, in order to enable the length of the lathe bed to accommodate the excessive length of the lead-screw being cut.

* * *

A LARGE PLANER OF ENGLISH DESIGN.

The accompanying half-tone engraving illustrates an exceptionally large planer of a type built by Messrs. Joshua Buckton & Co., Ltd., of Leeds, England, which was described and illustrated in a recent issue of *Engineering*. This planer is intended, in particular, for planing the casings for large steam turbines, and for other work of a very heavy nature



A Large English Planer which takes Work 20 Feet Wide, 10 Feet High, and 30 Feet Long.

occurring in steam engine design. The particular feature of the machine, it will be noticed from the illustration, is that the standards or housings travel, while the bed proper is stationary. The machine is of exceptionally large dimensions, it having a capacity for planing work 20 feet wide, 10 feet high, and 30 feet long. The table of the machine is built in sections, separated by large gaps. On each side of the table are longitudinal flat ways on which the standards travel. These latter are driven by two screws of steep pitch, one for each housing. The screw in turn receives motion through a bevel gear connection with a cross-shaft at the back end of the bed. The sliding ways are furnished with roller lubricators, and the thrust of the screws is taken by ball bearings. In the machine illustrated the cross-slide is adjustable vertically, the same as in an ordinary type of planer, but another type is made by the same firm with fixed cross-slide, the work being placed in a pit in the center of the machine. The tool heads are fitted with double-cutting tool-holders, carrying two self-relieving tools for cutting on both the forward and the backward strokes of the machine. One of the heads on the cross-slide can be arranged for traverse planing, the tool traversing to and fro on the slide for this purpose, and cutting in both directions. The drive for this motion is obtained from a separate electric motor, mounted on the back of the cross-slide. When work is being planed in this manner, the feed is given to the cutting tools by a slow automatic travel of the standards on the ways along the bed. A headstock for drilling and milling is also provided which fits on the cross-slide. It is of interest to compare this planer with the one illustrated in the January, 1908, issue of MACHINERY, built by the Bement-Miles Works at Philadelphia. In this planer the distance between the uprights was 11 feet 1 inches, the maximum distance from the table to the bottom of the cross rail, 12 feet 2 inches, and the maximum stroke of the table 30 feet. In this planer the table moved while the housings were stationary, the same as in ordinary planers.

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LARGE HORIZONTAL BORING AND TURNING MILL.

The accompanying two half-tone engravings illustrate what is undoubtedly the largest boring mill ever built. This machine was completed some time ago in the works of the firm

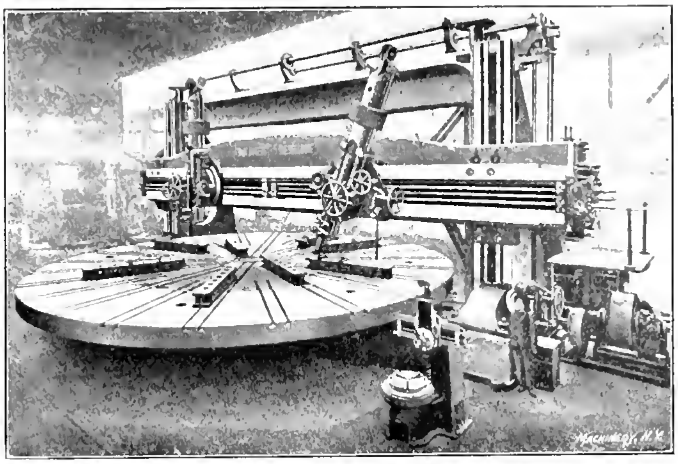

Fig. 1. A Mammoth Boring and Turning Mill with Table 36 Feet in Diameter.

of Ernst Schiess, A. G., Düsseldorf, Germany, and the illustrations are reproduced from the June 20 issue of the *Zeitschrift des Vereines deutscher Ingenieure*. The machine will take in work 39 feet 4 inches in diameter, and 11 feet 2 inches high, the table of the machine itself being 36 feet in diameter. The machine is motor-driven, and the speed of the table varies between the limits of 0.085 to 4 R. P. M. The control of the electrical motor, as well as the feed and speed changes, are all effected from devices placed on the traveling tool heads, in order to eliminate the necessity of the operator descending from the table whenever changes in this respect are to be made, or the machine started or stopped. The firm mentioned has built, in all, nine of these machines. The propor-

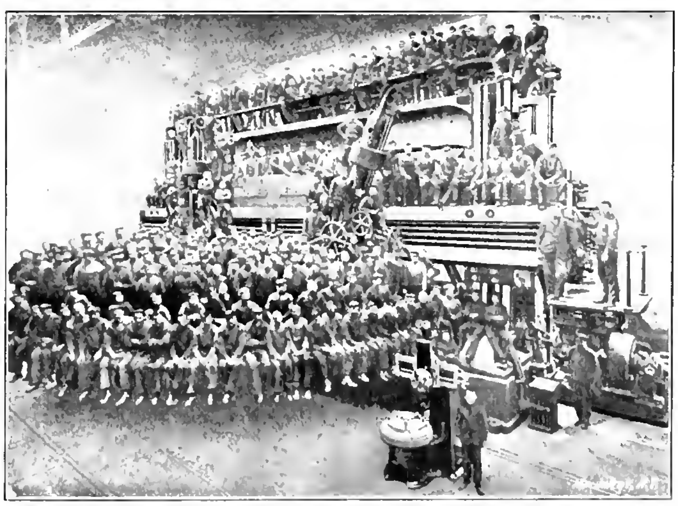

Fig. 2. A Group of 227 Men on the Machine.

tions of these machines are perhaps best exhibited in the half-tone, Fig. 2, this photograph being taken with 227 men sitting or standing on the machine. The total weight of the machine is 330 tons. In the foreground the smallest size of boring and turning mill built by the firm is shown for comparison.

HELPS AND DON'TS FOR GRINDING.*

Selection of Wheel.

Don't believe that all materials can be ground equally well with one and the same wheel.

Get the proper wheel for the work.

You would not expect to turn all kinds of lathe work with one tool having only one form of cutting edge. The grinding wheel is a tool for cutting.

Different shapes of work, different kinds of metal, require different cutting edges as well when grinding, as when turning. Different grades and grains of wheels are required for different kinds of work.

Grinding wheels are numbered from coarse to fine, and graded from soft to hard. The grade is denoted by the letters of the alphabet from E to Z.

Don't decide on the wheel without knowing the work.

Spindle speed and character of the material, shape of work to be ground, and surface of wheel in contact are prime factors.

In cylindrical grinding, speed of work, diameter of work and depth of cut must all be reckoned with in the selection of the right combination of grain and grade.

The condition of the machine affects the efficiency of the wheel. Heavy machines with large wheel spindles and massive wheel support call for a wheel different than lighter machines with smaller spindles.

Don't order a certain grade wheel merely because that grade is used on similar work in another plant.

Don't use a hard wheel to economize—it is production you are after.

A hard wheel is more likely to change the temperature of the work or to become glazed than a soft one; furthermore, it requires more power to do the same amount of work.

It is a common error to assume that a wheel for grinding steel and cast iron, chilled iron and hardened steel, must be as fine as the surface desired. A coarse wheel will produce a fine finish if the proper relations between grade, depth of cut, speed of work, speed of wheel, etc., are observed.

When grinding brass and the softer bronzes, the wheel must be as fine as the finish required. Bronzes with "manganese" or "phosphor" permit the use of coarser wheels.

Don't get a wheel made for soft steel for use on hard steel.

For a fine finish on hard stock, a coarse wheel may be necessary, and the harder the stock the coarser the wheel.

When ordering wheels, don't forget the diameter, width, style of face, arbor hole, description of work, speed of spindle, and the number and letter denoting the combination of grain and grade, if known.

The width of the wheel should be in proportion to the amount of the material to be removed with each revolution of the work.

If you reduce the width of the wheel, you must use a finer feed, and consequently do less work.

Mounting.

Never mount wheels without flanges.

Flanges should be, at least, one-third the diameter of the wheel; one-half is recommended. Flanges should be concave—never straight or convex.

Use fiber or rubber washers a trifle larger than the diameter of the flanges, or flanges with soft metal facings.

Hooded machines are desirable when practicable.

Truing.

Don't start work on a new wheel until you are sure it runs true.

Always have a wheel dresser handy for truing wheels for off-hand grinding.

Never use a dresser on wheels that grind circular work on centers.

For truing wheels used on plain cylindrical and universal grinding machines, cutter and reamer grinders, etc., the diamond is recommended. To obtain the best results it is absolutely necessary.

Never attempt to true a wheel for circular grinding unless the diamond is held in a rigid tool-post on the table of the machine. You cannot do good work with such a wheel when it is trued "by hand."

To get a truly ground surface, you must keep the face of the wheel true.

The quality of surface finish is dependent on the conditions of the wheel face and depth of cut.

Speed.

Don't start grinding until you know the speed is right—not "near enough," but right.

Even a slight variation in speed may be the cause of success or failure of any wheel.

Failure is sometimes turned into success by merely changing the speed of either the wheel or work.

Speed up the spindle as the diameter of the wheel is decreased. Approximately the same peripheral rate should be maintained as the wheel wears down.

Complaint is sometimes made that wheels appear to be softer toward the center. Usually this is because the same surface rate of speed is not maintained as the wheel is reduced in diameter. This causes the wheel to wear away faster and appear softer. It is also true that while the grade of the wheel may be uniform throughout, yet the smaller line of contact due to the smaller diameter will cause the wheel to appear softer.

Increasing the speed of a grinding wheel gives the effect of a harder wheel; decreasing the speed gives the effect of a softer wheel.

For surface grinding, it is customary to run wheels at a somewhat slower rate of speed than for general grinding. A speed of 4,000 to 5,000 surface feet is usually employed.

Wheels are run in actual practice from 4,000 to 6,000 feet per minute.

General Suggestions.

Transferring a wheel worn down to a small diameter, from a large machine to a small one, is good practice.

Keep the tickets or tags which are sent on the wheels in a record book, so that if a wheel is not satisfactory, reference can be made to order number when making complaint. It is equally valuable as a reference when ordering duplicate wheels.

Don't use the wrong wheel on a job because it will require a few minutes time to change wheels. A stop watch will prove to you that changing wheels is cheaper.

There is seldom a case where one and the same wheel can be used on all work without a greater loss of time than the change of wheel would involve. Many times, the time saved in grinding a single piece more than pays for changing the wheel.

Considerable difference in diameters of work will affect the cutting quality of a wheel on any given material.

A successful wheel on the small diameters may work much slower on the larger diameters.

The wheel most suitable for work of very large diameter may wear away too fast on work of smaller diameter.

A suitable wheel for small diameters may cause chatter on pieces of large diameters.

Don't grind circular work dry.

A good wheel will grind in water, soda water or oil.

Water keeps the wheel working cool, and increases grinding production.

Soda water keeps the work and the machine from rusting.

Oil in soda water increases the wheel's effectiveness.

The particles from a grinding wheel do not adhere to steel. Don't let any one convince you to the contrary.

Grinding is profitable for removing stock as well as for finishing.

Keep the face of the wheel true and parallel with axis of spindle.

Vibration makes grinding wheels wear.

Keep all rests adjusted close to the wheel, otherwise work is liable to be caught and injury result.

Keep boxes well oiled and adjusted.

When practicable, indicate on each machine the revolution of spindle and size of wheel to be run upon it.

Don't disregard the setting up instructions that go with the grinding machine.

* Extracts from booklet issued by the Norton Co., Worcester, Mass.

HOW TO HANDLE A FILE.*

W. A. KNIGHT.†

Probably no branch of the machinists' trade requires more skill than the proper handling of a file. To make a file cut smooth when desired, and to make it cut where you want it to, and at no other place, is an art worth cultivating by all the younger men of the trade. It is possible to train an apprentice to operate a lathe, planer, or milling machine, and do good work on it, in much less time than it takes to teach him to do good filing. Probably this is the reason that most of the filing and fitting is done in the shops by the older class of mechanics. This article is not directed to them, for doubtless there are many such who can handle a file much better than the writer, but it is assumed that the points herein mentioned may prove of value to some of the younger men of the trade.

Filing a Flat Surface.

In filing a flat surface the choice of file depends on the degree of flatness and finish required. For a really flat surface, the writer would use a square file with which to do the first

Fig. 1. Cross-filed Flat Surface.

filing, and a pillar for the finishing. If one has to get along with one kind of a file for all kinds of filing, the writer would prefer the square safe edge file to all others. The reason for this is that the square file has more "belly" to it, and possesses greater stiffness in the direction of applied pressure in proportion to its bearing surface on the work than any other, and, being narrow, requires less pressure to make it "bite" into the work.

In order to file straight it is necessary that the file "hold its cut," any slipping or sliding over the surface being fatal to straight filing. Whatever kind of a file is used, the downward pressure should be sufficient to cause the file to bite and hold its cut, and with a wide flat file such as a hand file, or one that has become dulled by use, this pressure becomes so great as to make straight filing extremely difficult. The square file requires less pressure, is under better control, and responds to the "touch" and "feel" of the operator better than any other. The pillar file is next to the square as regards the foregoing points, and for some cases might be preferred. The writer would here offer the suggestion to file makers that for flat surface filing, the hand and pillar files should have more "belly," being thicker in the center than as at present made, and that the curvature be made uniform from point to heel. With such a file we could do more and better work, and do it easier than with the present styles. Another point, but on which there may be some doubt, is that in a double-cut file the cuts across both ways should be of equal depth, so that the diamond shaped squares left by the chisel marks stand out sharp and distinct. The writer can give no definite reason for this, except that he instinctively prefers a file like that to one with teeth having somewhat the appearance of a single-cut file.

To file a surface flat it is necessary to "cross file" it, that is, file it in different directions until the tool marks are eliminated and the desired degree of flatness obtained. This cross filing is most important, and is a prime factor in the production of flat surfaces. By frequently changing the direction of file marks, the operator can see at all times just where the file is cutting. If it is desired to lower any part of the surface after testing with the square, straight-edge, or mating piece, the file should be made to cut across the marks left by the previous filing. The cross marks then serve as an indication of the amount being taken off. After cross filing, the surface will have the appearance shown in Fig. 1.

When using a square or pillar file for the cross filing, it should be given a slight side motion while making the cutting stroke. It should be lifted *clear* of the surface on the back stroke, care being taken not to have it come up with a sweep and down with a sweep, but the path should be like that indicated by Fig. 3. If the surface is to be finished, then go over it lightly in one direction just taking out the cross marks. For this purpose a new file is best, second cut, smooth or dead smooth, according to the finish desired, but previous to using the file, it should be rubbed down lightly with a flat Arkansas oil stone. A new file often has a few teeth projecting above the general surface, especially at the corners, and this light stoning takes them off so that the file is more likely to cut without scratching. It might be mentioned that the last cross filing should be done with as fine a toothed file as that used for finishing, so as not to have deep scratches to take out in the final filing. For this finishing, "straightaway" filing is to be preferred to draw filing, because of being quicker and leaving the corners in better shape than the draw filing; but, of course, there are many surfaces for which draw filing must be resorted to. If the surface has been properly filed, a very few strokes with emery cloth will "lay the grain," giving it a uniform appearance, and with corners sharp like knife edges.

Fig. 2. Example of Cohesion between Two Surfaces, One of which is scraped Flat and the other filed to fit it.

To prevent pinning when filing soft steel, some mechanics use chalk on the file, others use oil. In the writer's opinion, chalk is a poor substitute for oil; the only case where it would possibly have any advantage would be with a dull file. However, one might about as well think of shaving with a case knife as trying to file straight with a dull file. The file is like all other wood or metal cutting tools; if it is to cut where you want it, it must be sharp. Care should be taken, however, not to use too much oil; a good plan when using a fine file is to oil it and then draw it through a piece of waste. This at once cleans the teeth, and leaves sufficient oil on the file. After it has been used a little while, it should be again drawn through the waste to clean out the chips. No file card is necessary.

The half-tone Fig. 2 shows two pieces held together by atmospheric pressure. One piece is a small cast iron surface plate 3 x 2 inches, ribbed as shown, the other is a steel block of the same size, but 5/8 inch thick. The surface plate was scraped to a master plate and the steel block filed to fit it. These surfaces are *dry*, not wiped off with greasy waste, but washed with gasoline and dried with a clean cloth.

Nearly all of the foregoing can be summed up in a single sentence: *For flat surface filing use a sharp file and localize its cutting action.*

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* For additional information on this and kindred subjects see the following articles previously published in MACHINERY: British File-testing Machine, December, 1907, engineering edition; Examining and Testing Files, October, 1907; Making Swiss Files in America, September, 1907; The Making of Fine Toolmakers' Files by American Methods, April, 1905; File Cutting Machine, October, 1903, engineering edition; The File and Filing, February, 1898.

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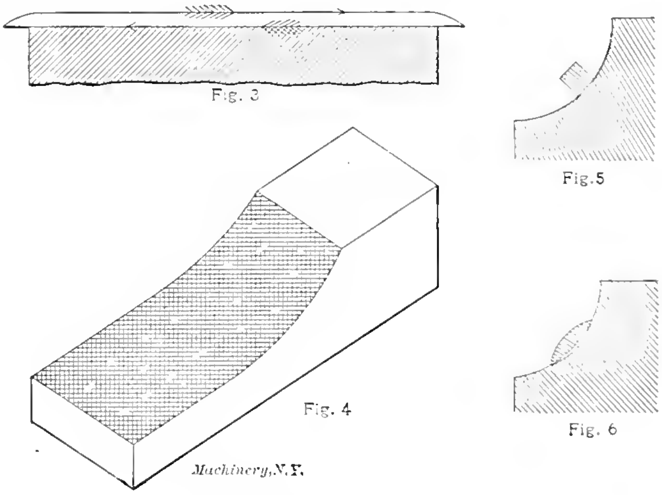
Filing a Concave Surface.

For filing a concave surface such as shown in Fig. 4, an ordinary half round file will do for roughing; outside of that it is a poor tool. A square file, as shown in Fig. 5, is much to be preferred, as it will "lay to the surface," and make it possible to get the surface straight cross-wise with much less effort than with the half round file. The file should be held straight across, and swept round the curve while it is being advanced, sweeping it both ways to insure a smooth curve. To be sure, the file is cutting only on its corners while being used this way, but it is surprising how much work these corners will do, how little pressure is required to make the file cut, and how easy it is to keep it from rocking.



Figs. 3 to 6. Methods and Tools for Filing Flat and Concave Surfaces

The crossing file is, however, a more scientific tool for this kind of work than the square. It should be used with the flattest side next to the surface, or, in other words, the radius of curvature of the file should be *greater* than that of the surface being swept out, as indicated in Fig. 6. The only difference between this file and the square file is that the former has more bearing surface on the work. The essential point is that the file has a bearing along its two edges, and *not in the center*. After the piece has been brought to shape and dimensions by cross filing, it can be finished by draw filing, using a half-round or crossing file with radius of curvature *less* than that of the surface. It will often be found a help, if there is any tendency to get the surface high in the center, to use a scraper made of a three-cornered file to ease

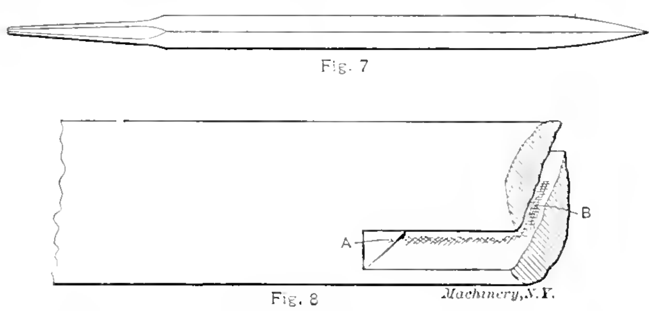


Fig. 7 Three-cornered Scraper made from Old File. Fig. 8. Filing a Rectangular Slot.

off the center a little. The scraper is ground as shown in Fig. 7, and used the same as when scraping out a babbited box. A little oil should be used when scraping steel.

Filing a Convex Surface.

The same general principles as just explained are adhered to in filing a convex surface. If the piece is of such shape that the file can be held at an angle with the axis of the curved surface, that is, not straight across, then the cross filing can be done by making the stroke of the file go partly round the curve as well as across, practically no side motion being given the file. If, however, the nature of the case prevents this kind of a stroke, the file should be held straight across, and then given a little side motion to carry it around the curve, while its motion in the direction of its length is straight across. When the surface is thus properly cross filed, it can be finished by draw filing, if the grain is to run with the curve, or by straightaway filing, if the grain is to be across.

Filing Out a Slot for Boring-bar.

Ordinarily it is a difficult job to file out a square hole or slot through a bar, principally for the reason that one cannot see the place of application of the file. It is a great help after the hole has been roughed out, to take a flat scraper with a good square end, and scrape out the corners and the central portion of the flat surfaces as at *A* and *B*, Fig. 8. The metal can be removed just about as fast with a scraper as with a file (sometimes faster), and by hollowing out the center and corners a little, the file will have a bearing on the outer edges, which renders it easy to prevent rocking. For this work the writer again prefers the square file, and always gives it a side motion whenever possible, cross filing the surface to keep it true. When filing through a hole, use the file without a handle, firstly, because of the danger to the eye should the file handle slip off, and secondly, because it is largely a matter of "touch" to ascertain what the file is doing, and the "touch" is much more sensitive without the handle.

A few good scrapers, say a half-round, triangular, square, flat, and round, of different sizes, with square ends, are very handy tools to have around when doing vise work. They can be used to help the filing along by squaring out corners, easing a place off a little here and there, and will prove time savers in many ways.

* * *

SOLDERING ALUMINUM.

The statement is frequently made that aluminum cannot be soldered, but this is a mistake, and the *Brass World* gives the following information in regard to this question, from an experience extending over the time that has elapsed since aluminum became extensively used. This experience has demonstrated in the first place that pieces of aluminum can be soldered together; but that aluminum cannot be readily and successfully soldered to other metals. The problem of soldering is not alone that of the solder, but account must be taken of the fact that the surface of aluminum is always covered with a film of aluminum oxide. Even when freshly cleaned, this oxide forms immediately, and being of nearly the same color as the metal itself, it is not visible to the eye.

There is no solder which allows aluminum to be soldered with the facility and success that attends the soldering of other metals. The best solder, however, consists of the following ingredients:

Tin	29 ounces
Zinc	11 ounces
Aluminum	1 ounce
5 per cent phosphor-tin	1 ounce

This solder, the Richard solder, was first made in 1892, and has withstood the test of time better than any others. Many of the so-called aluminum solders have disintegrated within a few years after the joint had been made. The solder may be applied to the parts to be soldered with a soldering iron or blowpipe. It is admitted that the operation of soldering aluminum leaves much to be desired, but the results obtained by the solder mentioned are as satisfactory as any that have hitherto been demonstrated.

* * *

The draftsman who can make satisfactory sketches and drawings without erasures is not yet born, but it is quite possible for all to learn to make sketches and use the rubber so little that erasers are not noticeable. In the first place, avoid the use of hard pencils and hard lines in the preliminary work. In the second place, use special sponge rubber, adapted to the cleaning of the surface of the paper, rather than its removal by friction. A coarse gritty rubber tears away the paper and destroys the surface. Fresh bread is good for cleaning off lines and grime from drawings, but ordinarily it is not convenient to use because of being hard to keep in the right condition, that is, neither too fresh nor too stale. For light erasing on water color work, small pieces of white kid leather from old gloves is recommended. These should be used once only and then thrown away.

SYSTEM FOR THE BLACKSMITH SHOP.

JAMES CRAN *

James Cran.†

It is not necessary that a system for the blacksmith shop be of the kind usually known as red tape, which often takes more time to handle than the time it saves; but a simple method of keeping track of work, tools, and material will save time and expense.

To begin with, the blacksmith shop ought to be large enough to provide a place for everything in the shape of tools and equipment, and permit everything to be in its place. Forges should be numbered with figures of size and color which can be easily seen from any part of the shop. The forges should be referred to by their numbers, instead of "so-and-so's" forge. This would insure work being taken to the place it was meant for. With each forge there ought to be a tool bench of size and design which would accommodate one full set of blacksmith's tools such as are used at the anvil. Each tool should be marked with its size and the number of the forge to which it belongs, so that each blacksmith will know the tools which form part of the set he is supposed to use, even if they should in any way get mixed up with others. To insure keeping a full set at each forge, it would be well to give each man a list of the tools belonging to the forge at which he is expected to work, with the understanding that he will be held responsible for all tools not worn out or accidentally broken. Any tool worn out or broken should be reported to the man in charge, so that they could be replaced as soon as possible. Having a full equipment at each forge would be a decided advantage to new men starting in to work, because, as anyone who has ever been employed in a blacksmith shop knows, as soon as a blacksmith leaves the shop in which he has been working, he is no sooner gone than there is a raid upon the tools he used, and it usually takes but a short time to have them exchanged for the poorest tools in the shop, or, perhaps, just removed without any attempt at replacing. When a new man comes along, he is heavily handicapped, having the worst tools in the place to work with, and it sometimes takes weeks before he has a chance of showing what he can do.

It would be well, in arranging forges, to have them so that light work could be done at one end of the shop, medium work in the center, and heavy work at the other end, so that trip- or steam-hammers could be installed in the most convenient places according to their capacities. Every shop ought to have one or more sets of hammer tools, such as spring swages, spring fullers, bolsters, V-blocks, drifts, hacks, and breaking-down tools, which could be classed as general tools and used at any hammer, and kept on a rack where they would be most convenient. Special and larger tools than those forming sets for forges could be given out on the check system, which is common in most manufacturing plants where tools are given out from the tool-room.

To keep track of stock, it would be well to have each kind or grade marked on the end of the bars with different colors. Thus wrought iron may be marked red; Norway iron, blue; machinery steel, white; and so on until all the different grades are marked, care being taken to cut from the end not painted. When a blacksmith starts on a new piece of work he should be furnished with a card for stock to be used, along with his time card. Stock cards could be printed forms to be filled in and signed by the various hands they would pass through. The following outline would cover the most essential points: Date of issue, order number, workman's number, name of pieces to be made, number of pieces to be made, grade of stock to be used, size of stock to be used, amount of stock issued, amount of stock returned, amount of stock used, and date when work is completed. The card should be signed by the man in charge of the stock and the foreman of the shop, before being sent to the stock clerk.

Piece work is preferable to day work when the number of pieces to be made is such that it can be done to advantage, as it insures the best men getting the most compensation, especially if there is no limit set on the amount they may earn. This is a very important point. It is by no means an uncommon occurrence for a piece of work to be done the same way, and remain at the same price for years until some one comes along who uses a little more common sense than the average man. He sees a way of doing it to save time, and will perhaps turn out double the amount of work as compared with what has been done in the same time before. The result is that he earns on piece work 100 per cent more than the other men have earned. He may be paid for the first lot without any comment being made, but by the time the next lot is to be made, more than likely the price is cut in two, and another man gets the job which is nothing but taking an unfair advantage of a good workman, and does not encourage him to bring out his best ideas. If a man can make two pieces in the time it used to take to make one piece, it means a saving of 100 per cent in fuel. If the manufacturer has a profit on one piece, it is doubled if two pieces are made at the cost of one piece, which, if looked at in the proper way, would be an advantage to both employer and employe.

When day work is the rule, it is quite common to have a scale of wages, and all men at the same class of work are paid at the same rate. One man might be capable of doing considerably more work than another, but at the end of the week they both receive the same amount of compensation, which is anything but encouraging for good workmen. To a great extent this is responsible for the blacksmith's present lack of pride in his work, a pride which used to be common amongst the old-time mechanics. On the other hand, some men seem to worry if they think they have done a little more than their pay calls for; but this class seldom has much pay to call for.

It is poor system where each piece of work is given out with instructions how each detail has to be done, as it leaves no chance for improvement or for getting the ideas of the workman. It is a foreman's place to help his men when he finds that they need assistance, and give them instructions when necessary.

To keep track of the different kinds of tools for lathes, planers, etc., which are usually forged and marked in the blacksmith shop, it would be well to have the different brands of steel of which they are made numbered instead of being marked with the initial of the brand. Quite often two or more brands have the same initial, and are liable to get mixed. If marked with numbers, there would practically be no limit to different brands which could be handled without confusion. The blacksmith who forges the tools should have a list of the brands of steel used with the numbers representing them, together with the working instructions which the makers of high-speed steel usually send out to their customers. The system here outlined may be added to or changed to suit circumstances. On the whole, it would take but little time to handle, would increase the efficiency of the blacksmith-shop, would save time and worry, and be an advantage to all concerned.

[In the course of his article, our contributor states that it is poor policy to have each piece of work given out with

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† James Cran was born on a farm in Aberdeenshire, Scotland, in 1868. At the age of eighteen he commenced to serve an apprenticeship in a small country blacksmith shop in Scotland, where he remained for two years after having finished his apprenticeship. After that he was employed by two Scottish makers of iron golf clubs, until he arrived in the United States in 1896, where he was at first employed with A. G. Spalding & Bros. for about four years, the greater part of the time as foreman of the blacksmith shop. He was one of the first, if not the first man, in the United States engaged in making forged iron golf clubs. Later he has been engaged with the Moore Drop Forging Co., Springfield, Mass., the Holt Mfg. Co., Stockton, Cal., and the Electric Vehicle Co., Hartford, Conn. At present he is foreman of the blacksmith shop at the Pond's Works of the Niles-Bement-Pond Co., Plainfield, N. J. Mr. Cran's specialty is machine blacksmithing, but he has had wide experience in almost all branches of forge shop work.

instructions as to how each detail is to be done. This seems to be diametrically opposed to the principle of the Taylor system of shop management. Examining the conditions and the subject our contributor deals with, however, we will find that his statement is not referring to shops having an actual planning department, such as is required by the Taylor system, but the ordinary shop organization is referred to. In such a case it is very seldom that the foreman has the time and the detailed information required to give instructions of such a character as would insure the highest efficiency; and, then, it would be better that no attempt be made to give detailed information unless the workman is likely to fail to carry out the work entrusted to him satisfactorily if not instructed.—EDITOR.]

* * *

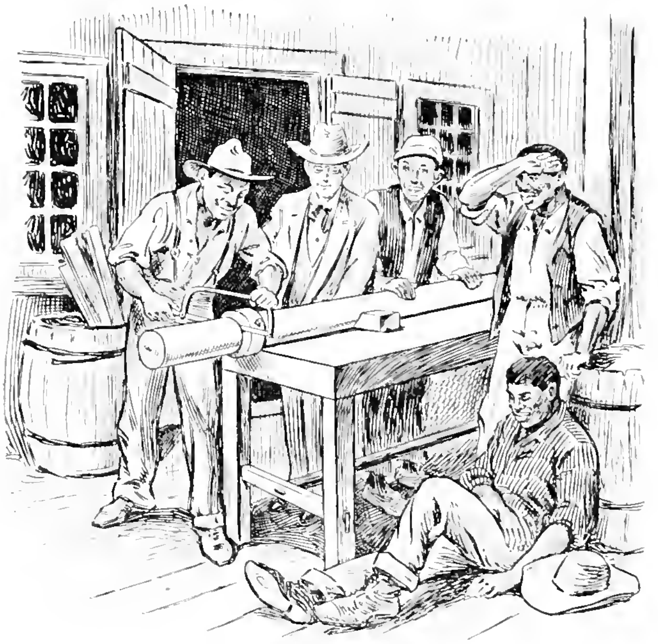
SAM AND HIS HACK-SAW MACHINE.

A. P. PRESS.

When I was working at the old Mason Machine Co. we had a man named Sam Graw, Sunny Sam, we used to call him. He was a rough-and-ready sort of a fellow, a good mechanic, and he could always crawl out of a cavity all right. He could use a micrometer as well as the best of them, but if he didn't have one handy a two-foot rule would do as well.

The firm used to do a lot of cotton work down South, and Sam was the "setter up," that is, he used to go for the firm with the first shipment to lay out the mill, set up the looms, and other machinery, as fast as they came along, and stay until everything was in good order.

Sam has just got back from a trip, and he told me this yarn. He had got most through on the job and one day about five o'clock they came over from the next mill and wanted him to come over at once. They had got into a mess. It seems they



"He worked them all night."

had ordered a 6-inch shaft 8 feet 10 inches long, and it had come 10 feet 8 inches long, and they could not use it without cutting it off. There was no shop within thirty miles that could handle a 6-inch shaft that could help them out anyway. Sam thought a minute and said: "Sure thing." "How long will it take?" "Ten hours or less." "What help do you want?" "Just four good darkies" (all the cheap help were negroes), said Sam, "and it will be ready at 7 o'clock to-morrow morning." "Well, that is easy,' said the superintendent, and he sent in the men.

Sam put a collar on the shaft, and started the first man at work with a 10-inch hack saw he had in his kit. He ran him fifteen minutes, and then took No. 2 and so on through the four; he worked them all night, while he sat on a keg and urged them on. When that 10-inch saw got in the center of the 6-inch shaft it was a pretty short pull, but Sam kept them at it, and at 6.30 A. M. the shaft came off.

The superintendent was a pleased man when he saw it. He gave the darkies all a day off, and Sam an X, and the whole gang was happy.

USING A SLIDE RULE FOR OBTAINING ANY ROOT OF NUMBERS.

HJALMAR FAGERSTROM.

Some years ago the writer found a convenient way for figuring out on a regular slide rule any root of any number, using for this means the scale of centimeters commonly found on the vertical edge of the slide rule. An example will best show how this is done. Suppose that it is required to find $\sqrt[5]{87}$. If there are no logarithmic tables at hand, it may be difficult to find the root, but it can be figured near enough for most cases with the slide rule, even without employing the logarithmic scale of the rule. Before, however, the root can be determined by the means the writer is about to explain, an improvement must be made on the slide rule runner in order to insure fair accuracy. The runner must be marked with an index line in line with what would be the zero line on the centimeter scale, the index line on the glass of runner being over the graduation 1 on the rule when this line is marked, as is plainly indicated in the accompanying

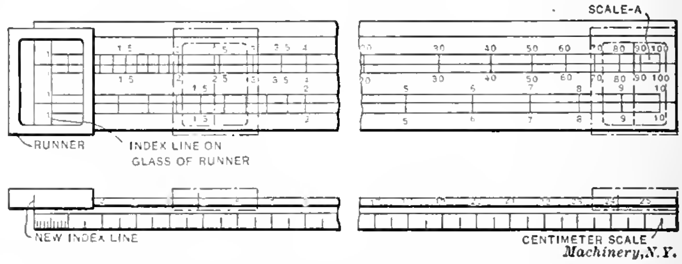


Illustration showing the Method of obtaining the Roots of Numbers.

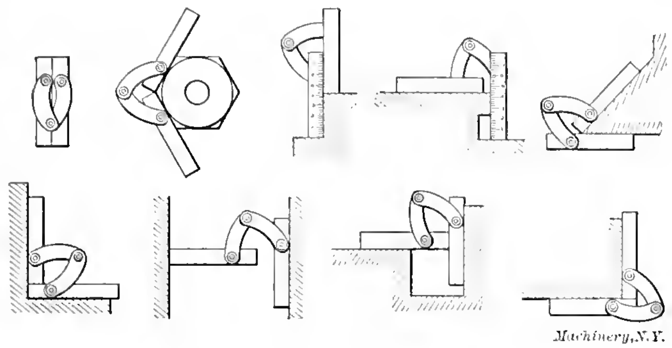
engraving. Now, if it is required to figure out $\sqrt[5]{87}$, move the runner until the index line comes over 87 on the scale A (see engraving). When this is done, turn the rule and read off on the centimeter scale the graduation in centimeters opposite that index line which has just been marked on the side of the runner. The graduation opposite this index line would be 24.25. Now assume that 24.25 is the logarithm for 87, then divide 24.25 by 5, in which case we obtain 4.85. Now move the runner until the index mark on its side points to 4.85 on the centimeter scale. On the scale *A* under the index line of the runner we can now read off the figure 2.44, which is equal to $\sqrt[5]{87}$.

[It may be interesting to point out the reason why the method employed by our correspondent will give the correct root of any number as indicated. The slide rule is so graduated that the various distances along the scales from the first graduation represent the logarithms of the various numbers marked on the slide rule. Consequently, when we move the slide from the figure 1 up to the figure 87, we move a distance corresponding to the logarithm of 87. To find the logarithm for $\sqrt[5]{87}$, we divide this distance in 5 equal parts, and one of these parts represents the logarithm for $\sqrt[5]{87}$. The distance we have moved the slide, when we moved from 1 to 87, is represented by the length of the centimeter scale from the end of the rule up to 24.25. Therefore, we divide this distance in 5 equal parts, which gives us 4.85, which corresponds to the position where the slide will have to stand in order to get the logarithm for $\sqrt[5]{87}$. It is clear that powers of certain numbers can be obtained in a similar way. Some improved slide rules would not permit this method to be used, however, with the ordinary runner, as the distance which the rule projects outside of the graduation 1 on the top of the rule is so long that the runner does not extend over the end of the rule when indicating 1; the graduations on the centimeter scale, however, commence at the end of the rule, and it is not possible to get an index line on the side of the runner, opposite the zero line in the centimeter scale. For numbers over 100 this method becomes rather complex, as it necessitates adding one full length of the scale, or 25 centimeters, to the figure read off on the centimeter scale, for each two additional figures in the original number given. It is rather unprofitable to discuss this complication of operations at length, as it is far easier to use the logarithmic scale of the slide rule, and obtain the actual logarithm required itself.—EDITOR.]

ITEMS OF MECHANICAL INTEREST.

A SIMPLE TOOL FOR MEASURING ANGLES.

The accompanying illustration shows a very simple, but at the same time, a very ingenious tool for measuring angles. Strictly speaking, the tool is not intended for measuring angles, but rather for comparing angles of the same size. The illustration shows so plainly both the construction and the application of the tool, that an explanation would be superfluous. It will be noticed that any angle conceivable can be obtained in an instant, and the tool can be clamped at this angle by means of screws passing through the joints between the straight and curved parts of which the tool consists. Linear measurements can also be taken conveniently,

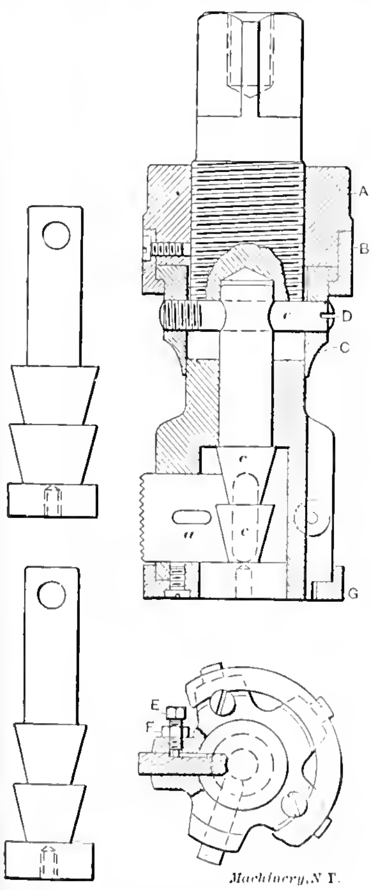


A German Tool for Comparing Angles

one of the straight arms of the tool being graduated. As both of the arms which constitute the actual angle comparator are in the same plane, it is all the easier to make accurate comparisons. This tool is of German design, and is manufactured by Carl Mahr, Esslingen a. N.

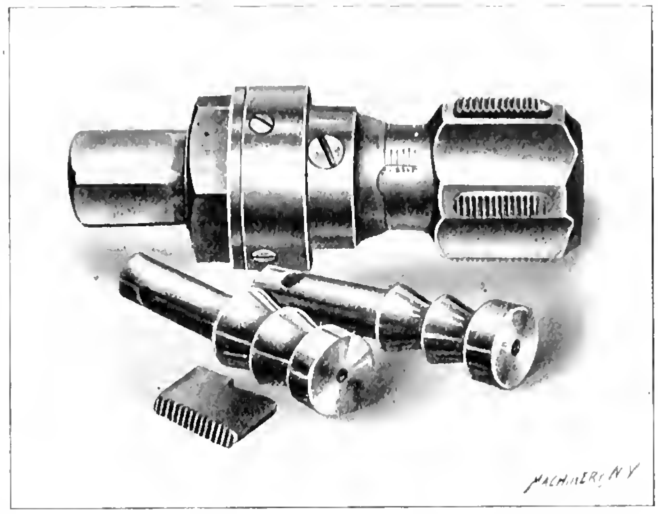
GERMAN DESIGN OF ADJUSTABLE TAP.

An interesting adjustable tap has been brought out by the Präzisions-Werkzeug und Maschinen-Fabrik Richard Weber & Co., Berlin, Germany, and has been illustrated and described by the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*. The general appearance and construction of this trap is illustrated in the accompanying halftone and line engraving. The principle of the tap is plainly shown in the line engraving, Fig. 2. The special feature of this tap is the use made of stems or spindles, having different sized steps, against which the back of the threaded chasers, which enter into slots in the tap, are placed. The taps are provided with five chasers or inserted blades. With simply a single set of chasers and a number of different stems or spindles, various sizes of tapped holes can be taken care of. The tap can also be adjusted within certain limits, using the same spindle, by turning the nut *A* on the shank of the tap, whereby,



Section and Elevation of the Tap.

through the action of the intermediate parts *B*, *C*, and *D*, the stem can be moved so as to force the chasers outward the required distance. The chasers are clamped in place, when adjusted, by screws *E*, provided with a check nut *F*. The ring *G* at the lower end of the tap, which may be provided in special cases, serves the purpose of guiding the tap concentric in the drilled hole. The neck of the tap is provided with graduations, so that the amount of adjustment can be read off directly, when made. While the principle of this tap merits

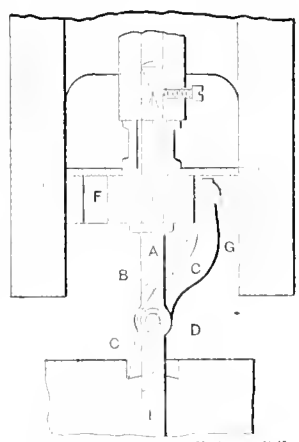


The Adjustable Tap, and Stepped Stems for Varying the Size.

attention and has certain points in its favor, it seems, however, that the design is rather complicated and that the expense of making taps of this type would be so high as to prevent them from coming into general use. No doubt, however, the principles could be employed to advantage in a simplified design, and in such a case it would not be impossible that a tap of this type would have a successful future.

DEVICE FOR DRILLING SQUARE OR IRREGULARLY SHAPED HOLES.

The accompanying illustration shows an interesting little device, described in the May 25, 1908, issue of the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*. The device, as shown, is attached to the spindle of a drilling machine, and consists, in main, of a cam *G*, a lever *C*, and a stiff guide bar *A* through which a slot *B* is cut. In this slot the lever *C* is inserted and held in place by the screw *D*. The lower end of this lever is ground so as present a cutting edge to the work, while the upper end is provided with a ball-shaped projection, which slides in the groove *F*, in cam *G*, this groove being a form corresponding to the outline of the hole to be machined, only on a larger scale. The cam is stationary, while the lever *C* is rotated by the arbor *A*. It is evident that when rotating, the upper end follows the path of the cam-groove *F*, thereby causing the lower end with its cutting edge, to follow a path similar to that of the cam-groove, and thereby producing a hole of the required form and of the size determined by the proportion between the lengths of the upper and lower lever arms. While the cam *G* is stationary as far as rotating motion is concerned, it follows, of course, the motion of the tool in an axial direction. A circular hole is first drilled in the piece where the irregular shaped hole is to be formed, in order to provide for the guiding of the bar *A* which enters into the hole *I* as indicated, and acts as a pilot.



Attachment for Drilling Holes, the Shape of which Depends upon the Shape of the Cam-groove F.

* * *

A concrete oil tank at San Antonio, Texas, has been in service at the San Antonio gas works, holding heavy Texas oil. It has shown no leakage whatever, which contradicts the general belief that oil destroys the cohesion of concrete.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

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REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

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AUGUST, 1908.

PAID CIRCULATION FOR JULY, 1908, 21,145 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE ECONOMICAL LIMIT OF INCREASED PRODUCTION.

In a letter published in the present number, a correspondent relates an experience intended to indicate that increased output at the expense of the tools employed is not always profitable to a manufacturing concern. The problem of increased output, and its economical relation to the best use of the machines and tools employed, is one of the most important in any successfully conducted shop; and, at the same time, it is one for which it is difficult to lay down absolute rules on account of the many different conditions involved. A case similar to the one referred to by the correspondent occurred in one of our largest manufacturing concerns. A new foreman was engaged to take charge of a certain department, who was known as a "hustler," and no doubt he well deserved the title. After having taken charge of his department, his first efforts were directed to increasing the output, as he received a certain percentage on the savings effected. There was no doubt that he did greatly increase the output, and that the labor cost of the articles manufactured was placed on the company's books in figures considerably smaller than before, but at the same time the "unproductive" labor cost of the shop increased materially. The number of tool-makers employed making tools and repairing machinery and fixtures for this particular department, had to be increased, and as they were paid considerably higher than the cheap help engaged directly in manufacturing, a considerable part of the profits of the increased output were required to pay the increased expense for tool-makers. It may also be surmised that the machines in the department had to be replaced with new ones several years earlier than would have been the case if they had not been worked somewhat beyond the limit of their normal capacity. Although machines are inanimate and not affected by fatigue, as is a human being, every machine seems to have a definite capacity limit, beyond which the expense of upkeep and loss of time because of breakdowns make the swifter pace unprofitable. The most successful shop foreman is not he who can increase the output indefinitely, but the one who understands when this economical limit has been reached, and possesses sense and independence enough to stop at that limit.

MAKERS OF SMALL TOOLS SHOULD KEEP IN CLOSE TOUCH WITH USERS.

We recently received a contribution on the construction of brass threading dies in which numerous points were brought out of practical value to tool makers and users of such dies. In the course of the contribution the writer stated that the company with which he was connected, although a large user of dies, had been unable to buy chasers which answered its requirements, and was forced to make its own chasers in order to get satisfactory results. The conditions affecting the action of brass threading dies are much different from those affecting dies used on steel or iron, which are of fairly uniform texture; for a die that will cut a smooth thread on a piece of machinery steel will, nine times out of ten, answer the requirements of most users of dies on steel or iron. This, however, is not the case with brass work. "Brass" is a term roughly covering a multitude of alloys. Its constituents are almost infinitely varied, and it runs in hardness from material so soft that it can be almost dented with the finger nail, to grades which can scarcely be touched with the best steel tools, so that a set of chasers which cut the soft grades easily and smoothly will not work well on other grades.

It is therefore advisable for manufacturers of thread-cutting tools to study carefully the actual conditions affecting the manufacture of brass goods. It is not sufficient to test their chasers on a piece of brass tubing of the best free-working stock, as that is a grade of metal seldom found in commercial brass work. The makers of standard small tools are apt to think they possess nearly all the knowledge on the construction of thread tools that is required for various shop conditions; but in some cases small-tool makers can perhaps obtain valuable information by keeping more closely in touch with the requirements of their customers. Instead of putting a customer down as a mere "kicker" because he complains that a tap or die does not work well, investigate his complaint and find out what the actual conditions are, so that the product can be improved to meet the requirements of all users.

* * *

DRAFTING AS PRODUCTIVE LABOR.

In the April issue of the engineering edition of MACHINERY, an editorial appeared entitled "Economy of Non-Productive Labor," and a specific case was cited to illustrate the argument advanced. There is one phase of machine shop work where we find that greater economy doubtless could be arrived at by introducing a slightly greater amount of non-productive labor, and eliminating a great deal of time wasted by the productive labor in the shop. The writer's experience in some large drafting-rooms, as well as information obtained in regard to others, indicates that it is quite common practice to make jig drawings in assembled views only, and to put all the dimensions directly on the assembly drawing, making no detail drawings whatever; and the argument advanced in favor of this practice is that experienced pattern-makers and tool-makers, who are, as a rule, the only mechanics who will work on the tools, will find no difficulty in reading the assembly drawing, and that, as the drawing is used but once, it would be a waste of time to have the draftsman detail the parts.

In the case of a very simple jig this is undoubtedly true, but in more complicated ones there can be little doubt that the comparatively small expense required for the draftsman to detail the jig will be many times saved in the shop, for the pattern-maker or tool-maker will not have to spend a number of hours puzzling over the drawing, and even then being liable to make a mistake. This is another case where a slight extra amount of non-productive labor, judiciously expended, will save a large amount of outlay for so-called productive labor.

In two large shops within the writer's own experience, the recent practice in one was to detail all jigs, and in the other to make assembly drawings only, and the difference was surprising in the number of questions asked by the shop regarding the design of the jig in cases when they were detailed and when they were not. When assembly drawings were sent directly into the shop, hardly a jig passed through its regular course through the shop without the foreman of the tool making department, or some of his men, coming into the drafting-room to ask half a dozen questions. When the drawings were detailed, hardly a question was ever asked.

SIMPLICITY IN MACHINE TOOL DESIGN.

W. T. SEARS *

Nearly every type of machine tool seems to have to go through at intervals, a period of extreme complication, in which it becomes loaded down with automatic trips, complicated devices for movements in various directions and numerous other mechanisms, the utility of which, in actual practice, is questionable, although for the time being, and in a great many cases, they undoubtedly make for the salesman good "talking points."

These devices, if inexpensive and not liable to get out of order, are oftentimes useful, and this may be particularly true where a great deal of duplicate work is to be done, especially if these devices are properly fitted for this repetition work. The fitting up of the machine in this manner is perhaps a good thing also, in that it may tend to advance the general usefulness or efficiency of the tool, even if, later, the complicated parts are omitted. It has at least helped to show how far to go, through having gone too far.

Unfortunately, however, in this last case the knowledge has been arrived at, at the expense of the purchaser of the machine, who, in place of getting a machine equipped with many improvements, receives on the contrary, one that is not as good as if the "improvements" had been omitted entirely. They thus represent additional money that has been spent to a disadvantage instead of to advantage, and have actually handicapped the more simple original machine that could have been obtained by a smaller investment. It is safe to say that no machine tool builder knowingly gives a purchaser something for nothing, and the improvements must be paid for. If the price is the same for the new machine with the new features, as for the old machine without them, the probabilities are that the former has been altered and cheapened in some other direction.

There are several points having considerable bearing on this subject which, I believe, have often been overlooked: for instance, when purchasing a machine costing say $2,000, the buyer may be convinced by salesmen that for $200 more he can get a machine which will more than pay for the additional investment. While this, of course, may be true, at the same time attention should be called to what is often the case, which is that it may be a device which would practically never be used, and therefore the $200 is virtually thrown away, in that no reasonable return is obtained for the investment.

Considering this along a little different line again, the purchaser may be convinced that it is a good device or be willing to take a chance, and the machine is ordered with the idea in the purchaser's mind that in case this $200 device did not work satisfactorily, it would simply be a loss of that amount and that would end it.

This is, perhaps, the view most commonly taken and is a very wrong one, for as a matter of fact, the $200 investment may have put a device on the machine which interferes with the regular movements, either by making them unhandy to get at or weakening them through change of design which the new device necessitates.

Another point is that by getting out of order it may lay up the whole machine. It may get out of order through use or abuse, but if this occurs at all frequently, it can readily be seen that the total efficiency has been reduced in place of being increased, unless the saving effected by it while in working order is very great indeed. It often takes considerable time for the testing or proving of the above statements, but that they are correct is proved every day in the history of machine tool design, if in no other way than by the returning of the tool designer to simple forms.

A number of concrete instances can easily be quoted from the writer's experience. For instance, take a planer design with a greatly increased speed on the idle part of the stroke which is obtained by changing from a moderately fast to a very fast speed shortly after the reciprocating part has been reversed. This, by figures, will show a saving for a long stroke, but it was found in actual practice, in the case in mind, that the work requiring a long stroke where this saving could be made, was the exception, and as a result the machine was returned at a moderately fast speed all the time, and the high speed not used at all.

In other words, the money invested for the high return was not only thrown away, but the return actually used was less than on a standard machine with a single return speed. The above is a case where additional money spent proved to be in actual practice, a handicap on what should have been the original investment.

On another machine which the writer has knowledge of, a fast power traverse was called for, for doing a certain class of work. In order to put this fast traverse on, it was absolutely necessary to change the design of the machine quite materially and add considerably to the cost. The machine itself was a simple one. It had gone through years of improving and testing, and its parts were all well proportioned and well designed. The additional parts required for the power traverse were also well designed, but from the nature of the machine they had to be somewhat complicated. The machine was small, and the advisability of the power traverse was much questioned. However, it was put on and worked very satisfactorily.

After the machine was put to work the operations were timed and it was found by actual experiment that the time saved by having this power traverse was about half a minute on a half hour's job. The amount saved in energy was, of course, also very slight, and while the impression conveyed to a casual observer was favorable, it is extremely doubtful if the fast traverse of this tool will prove economical in any way. Taking it in actual figures, and along one of the lines attention has been called to, if this additional mechanism lays up the machine for a day, as is quite possible, it will more than counter-balance the time saved in four months by the use of the power traverse.

Of course, if the machine were a large one and the amount of distance of travel of parts required, considerable, these figures would be entirely changed and the investment would unquestionably be a good one; but it is extremely doubtful if on the small machine it is either economical or advisable, and it is pretty safe to say that on such a machine it is a mistake. These are exceptional cases, but not by far as uncommon as many suppose, and these exceptional cases are the very ones that bring out the weaknesses of many so-called labor- and time-saving devices, and should act as warnings to any one about to purchase machinery and lead him to investigate such devices carefully and thoroughly.

A real improvement, one that actually saves time or labor and is neat and simple in design and operation, is one that can be easily recognized as such by any man capable of intelligently purchasing a machine tool. Such a device ought to command its proper price, and will pay good interest on such price.

Summarizing the above objections to new special features, we have: First, that a special device may be used but seldom; second, that it may break down and hold up the entire machine; and third, that its installation may be detrimental to the design of movements now on the machine, which are already recognized as good.

An arrangement which appears to come under any of the objections in the above summary should be bought with caution and only after very careful consideration.

* Address: 21st and Callowhill Sts., Philadelphia, Pa.

* * *

A quick installation of a steam heating equipment was recently made in a building at Trowbridge, England, in which some public meetings were to be held. As stated by the *Engineering Record*, the order for the work was given on Saturday at 9.45 A. M. and at 7.30 A. M. the following day the work was completed, including the installation of a steam boiler with an independent pump for the return of condensation, all necessary fittings, reducing valves, steam traps, etc., 1,080 feet of cast iron feed pipes with 40 fittings, and 1,140 feet of wrought iron pipe with 176 fittings. The work was accomplished by 30 men working continuously all the time, and involved the making of 159 joints in cast iron pipe, over 500 joints in wrought iron pipe, and the handling of 12 tons of material.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

The Cape Town to Cairo Railroad in Africa, which, when completed, will be one of the important Trans-Continental railways of the world, at the present time requires the completion of less than 700 miles to enable travelers to make the journey from Cairo to Cape Town by rail.

The Controller-General of Patents in Great Britain states that the great inventive activity in connection with the motor car industry which has produced such a large number of applications for patents in recent years, now shows signs of falling off. The decrease in the number of patents relating to automobile construction was not less than 35 per cent during last year.

New York City is spending $161,000,000 to increase its water supply. A great aqueduct will be built from the Catskills, and the water shed of a large area will be made available for the city water supply. In the matter of length, the aqueduct building for Los Angeles, Cal., is greater, however. It is to be 215 miles long and will tap the snow-fed Owens River and its tributaries. Its capacity will be 400 cubic feet of water per second.

As an example of the present realization of the value of the enormous water powers of the streams in northern Europe, it is stated by *Engineering* that the building of a large power station in Lapland, in the north of Sweden, is likely to be started during this summer. The power available at the falls near Brännland, which are to be utilized, is estimated at 81,000 H.P. It is not stated for what purpose the power is intended to be used.

An indication of the expense of repairs attending the running of motor cars and motor omnibuses is given by the report of the General Omnibus Company of Berlin, Germany, which is the largest transport undertaking of its kind in Germany, and which carries about 134,000,000 passengers a year. According to this report, the cost of maintenance and repairs of motor omnibuses reaches yearly nearly 50 per cent of the original purchase price.

A news dispatch states that the Southern Pacific R. R. is contemplating the boring of a long tunnel through the Sierra Nevadas, and that the surveys and estimates have been completed for some time. This tunnel will be between Truckee and Blue Canyon. It will be about 7 miles long and the total cost will aggregate $11,000,000, at least three years being required to complete the work. This will be the longest tunnel in the United States, and, with three exceptions, the longest tunnel in the world.

The Holland-American liner *Rotterdam* reached the port of New York City on June 22 on her maiden trip. This vessel is one of the largest that has ever been built, being 24,170 gross registered tons. The principal feature of the ship is the large amount of space placed at the convenience of the passengers. The state-rooms are said to be larger than those of any steamer that has entered New York harbor, and the promenade deck makes a record for size with 12,000 square feet of walking space. The total accommodations provided for are 525 first-class, 515 second-class, and 2,500 third-class passengers.

A very peculiar accident occurred on the Long Island R. R. June 22. A passenger train was approaching the Long Island City terminal when a brake-rod broke and the end falling down caught on the ties, doubled up, and twisted the handle of the train pipe valve around and closed it. When the engineer attempted to apply the brake he found that he had lost control of the train. Vigorous whistling alarmed the conductor and trainmen, who applied the emergency brakes, but too late to prevent disaster. The train crashed into the station, knocking down the bumping post, derailed the engine and demolished the side of the station. Fortunately no one was seriously injured.

The Singer Building tower, 612 feet high, and the Metropolitan Life Building tower, 693 feet high, are soon to be put in the shade by a building to be constructed on the site of the Equitable Life Assurance Society Building on the block bounded by Broadway, Nassau, Pine and Cedar Sts., New York. This building is to be 909 feet from the sidewalk, exclusive of the flagstaff. The flagstaff will be 150 feet higher, making the total height of the building from the sidewalk to the top of the flagstaff 1,059 feet. The main building will be thirty-four stories high. Superimposed on the main structure will be another with smaller base about fourteen stories high, and springing from the center will be a tower of another fourteen stories, making the total height in stories sixty-two. Thirty-eight passenger elevators will be provided.

Small producer power plants are growing in favor, especially in the Middle West. They have the merit of producing power at low cost for fuel and requiring a minimum of attention. An example is the plant driving the shop of the Mechanics Machine Tool Co., Rockford, Ill. A Fairbanks-Morse 50 horse-power motor was installed, and one of the mechanics working in the tool-room is paid 50 cents a day extra for running the machine. He comes to the shop half an hour before starting time and spends about another half hour during the day attending to the plant. Otherwise he works in the tool-room all day long. A car-load of anthracite pea-coal costing $163.24 was put in November 1, 1907, and lasted until June 1, 1908. Since January 1 the plant has run only five days a week. The cost for power in labor and fuel thus figures only about $260 for seven months power.

A Milan correspondent to the *Times Engineering Supplement* states that official trials of the De Forest wireless apparatus for telephonic service have recently been made in the presence of officers of the Italian navy. The apparatus was installed on one vessel, and the vessel put to sea, while communication was entered into with another vessel remaining at anchor in the harbor. Communication was maintained constantly, even when the vessel passed a chain of mountains enclosing the gulf where the harbor is situated. At intervals, several cannons were fired to ascertain if atmospheric disturbances had any influence on the working of the system. At a distance of 20 miles—the greatest distance tried—telephonic communication was regularly maintained. The results were satisfactory, and wireless telephone apparatus will be installed in some of the vessels of the Italian navy.

A hydro-electric power station, using the highest head of water in the world, has lately been designed by Aktiebolaget Vattenbyggnadsbyran, Stockholm, Sweden, for a large factory in Norway. The water is taken from a large mountain lake 3,536 feet over sea level, from which the water is brought by a tunnel 7 miles long, supplying six turbines of from 12,200 to 14,600 H.P. each. The total head is 3,287 feet, which is 72 feet more than the highest head hitherto used for power purposes. The largest diameter of pipe used for conducting the water will be 4 feet 6 inches, and the pipes will be of seamless tubing. The undertaking is one of the most remarkable engineering feats of our time. Norway is rapidly making use of its enormous natural resources in water power, another power station to supply 70,000 H.P. being built, the head here used, however, being only 84 feet.

Experiments carried on by the National Physical Laboratory, in Great Britain, indicate that steel imbedded in concrete is not influenced on its surface either by moisture or by the concrete itself. Specimens of both finished and rough steel were imbedded in concrete in December, 1906, and in

April this year one of the concrete blocks was broken up. On examination, the specimens of steel showed no trace of action by the cement or otherwise. The finished specimen was practically as bright as when put in, and the scale on the rough specimen was undisturbed. To test the possibility of any slight action, the surface of the turned specimen was polished and etched, and examined under a microscope side by side with the specimen of the same metal cut from the center of the bar, but no difference could be detected, and the conclusion is that in sixteen months, at least, no action takes place on steel when imbedded in concrete.

Some interesting experiments regarding the effect of artificial light on vegetation are related in the June issue of the *Electrical Magazine*. A French scientist has for the last two years made repeated experiments regarding the effect of various lights on the growth of plants which were subjected to red, green, blue, and white lights, the conditions otherwise being similar. Under the effect of red light it was found that certain vegetables grew fifteen times as fast as under blue light. On the other hand, the experiments proved that blue light has a remarkable preservative power on growing vegetation. It is recorded that an oak tree planted two years ago has kept its first leaves, which are now as fresh and vigorous as when they first appeared. In the same way, ripe fruit, it is declared, can be kept fresh under a blue screen for several weeks without decay. The facts disclosed by these experiments are expected to find a wide application, and to be of industrial importance.

Statistics collected by the United States government show that the nation has consumed about 7,000,000,000 tons of coal up to the present time. In 1908 the consumption was more than 400,000,000 tons. During the past ten years nearly as much coal was used as had been used during the preceding century. In view of the limitation of our coal resources and the enormous waste in the utilization of the heat energy of coal, there is no greater problem to-day than that of increasing the efficiency of coal utilization. As used at the present for heat, light and power, the losses are so great that less than 5 per cent of the total heat value of coal is converted into useful work in the manufacturing plant. The best and largest power plants utilize only about 10 per cent of the energy, while in railroad operation only from 3 to 5 per cent of the coal value is realized for hauling trains. It is estimated that only one-seventh of 1 per cent of the fuel value is actually converted into light in an electric incandescent lamp. Nearly 2,000,000 horse-power in the form of gas is allowed to escape from the blast furnaces of the country. This waste, however, is being rapidly checked by the installation of gas engines.

Comparatively little has been published in the United States regarding the Renard road train, intended for use on ordinary highways. Consul-General Robert P. Skinner, of Marseilles, states that Renard trains have been run from Paris to Marseilles over ordinary highways in order to supply the public with a demonstration of their efficiency. Each car receives the power necessary for its locomotion from the first vehicle or "locomotor" through a flexible transmission shaft, extending from one end of the train to the other, so that each car utilizes its own adhesion to the road surface as a means of advancement. Trains of this type, completely loaded, are able to maintain a speed of 13 miles per hour in the case of passenger trains, and 9 to 10 miles per hour in the case of freight trains, on a level road. It is also stated that freight trains of this type are able to maintain an average of from 6 to 7½ miles, fully loaded, in any kind of country. It should, however, be understood that the highways in Europe, in general, where these trains can be profitably used, are of a character that is only found in exceptional instances in the eastern part of the United States, and practically unknown all over the rest of the country. It seems possible that, in regions where railways would not prove profitable, this kind of transportation will have an important future ahead, but, of course, an extensive system of high grade, well-kept highways is a primary condition for its success.

FRICTION BRAKES.

H. D. James, in *The Electrical Journal*, May, 1908.

Although, at first thought, the brake may seem to be but a small detail in the construction of a crane, a hoist, or other device, a closer examination will show that it is a very important item, and one that may cause a great deal of trouble if improperly designed. The brake consumes mechanical energy in its friction surfaces and develops heat which must be radiated. Mr. H. D. James, and Mr. W. A. Paris, of the Westinghouse Electric & Mfg. Co., recently conducted a series of experiments extending over eighteen months to determine the best material to use for the friction surfaces in brakes. Endurance runs were made with cast iron shoes, and with shoes lined with wood, fiber, lignumvita, etc., on both cast iron and steel wheels. The best combination proved to be a cast iron shoe bearing on a cast iron wheel. Under heavy pressure the coefficient of friction was 0.3, and the wear on the brake wheel about one-sixteenth of the wear on the shoe. Cast iron shoes on cast iron wheels have been used for many years on freight cars and for street railway work, where the service is more severe and continuous than for most industrial applications. One advantage of using metal shoes bearing against a metal wheel is the increased radiating surface obtained. If an insulated lining is used, the heat from the rim of the wheel is not conducted directly to the brake shoe. This makes it necessary for the wheel to radiate most of the energy dissipated. Or, if a combustible lining is used, the permissible heating is limited, and a much larger brake wheel must be used to absorb a given amount of energy. These limiting conditions are obviated when a cast iron shoe is employed. Radiation may be improved by using a brake wheel ribbed on the inner side of the rim, and provided with fans for driving the heated air away from the motor bearings. The brake shoes should be provided with deep ribs to assist in radiation as well as to make them very stiff. Such a brake can be operated at a temperature which will turn cast iron to a blue color without in any way injuring the parts.

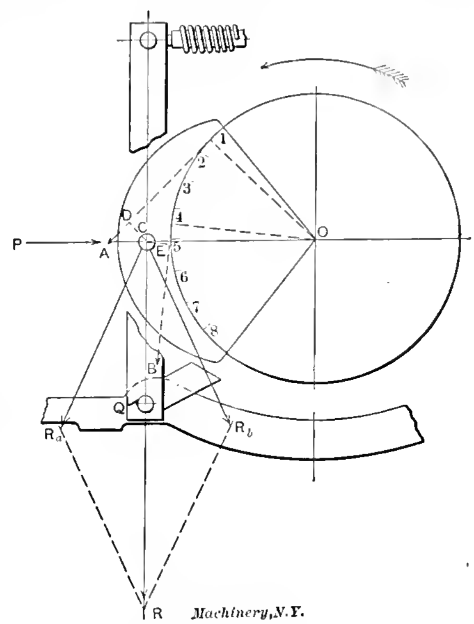


Fig. 1. Arrangement of Brake Rigging.

The usual method of suspending brake shoes causes them to exert an unequal pressure upon the brake wheel, because the resultant pressure produces a turning moment around the point of suspension, the shoes wear unequally, and the ends have a tendency to dig into the wheel when the brake is first applied, thus causing a severe strain on the motor shaft. This defect has been overcome by making the brake shoe stiff, so that the static pressure is uniform, and by selecting a point of suspension such as to eliminate the turning moment on the brake shoe. If the pressure is uniform and the surface of the shoe is considered as divided into a number of equal strips, the retarding force of each strip is the same, and may be considered as concentrated at the center of the strip, provided the number of strips is large. Selecting two strips, 1 and 4, Fig 1, the retarding force may be represented in amount and direction by the lines 1-*A* and 4-*B*, each at right angles with a line drawn from the center of the wheel to the center of the strip. Using a point of suspension, *C*, it may be seen that force 1-*A* tends to turn the shoe counter-clockwise around the point *C*, having a turning moment

equal to 1-*A* times *CD*, while the force 4-*B*, having a moment equal to 4-*B* times *CE*, tends to turn the shoe clockwise about point *C*. It is evident that point *C* may be so located that the sum of the moments for all the strips tending to produce counter-clockwise rotation is exactly balanced by the sum of the moments of those tending to produce clockwise rotation, and that the resultant pressure on the point of suspension due to the upper part of the shoe will be represented by a line such as R_a. In the same way the turning moments about point *C* for the lower part of the shoe will balance each other and produce a resultant pressure on *C* represented by a line R_b. The total resultant pressure of the shoe on the point of suspension *C* is represented by *R*, which acts directly along the hanger and through its pivot. There is, therefore, no tendency for the hanger to turn about its pivot, thus increasing or decreasing the pressure of the shoe as a whole against the wheel. If the point *C* is located in the manner described, it insures a uniform pressure per square inch on all parts of the brake surface, and freedom from any turning tendency about points *C* or the hanger pivot, and this is true for rotation in either direction. The results of this method of suspension are as follows:

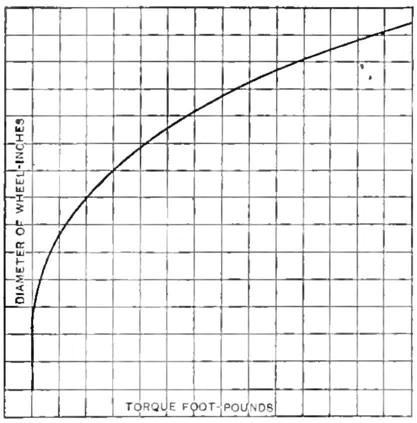


Fig. 2. Diagram showing Relation between Diameter of Wheel and Torque exerted by Brake.

a. The shoe is free to turn and find a true seat on the wheel.

b. The pressure of the shoe against the wheel is uniformly distributed.

c. The retarding force acts directly along the line of the brake hammer.

There is no tendency for the ends of the shoes to press harder against the wheel and thus wear away faster, and there is no tendency or possibility of one shoe pressing harder than the other, thus producing a side thrust on the shaft bearings. This insures an even wear on the shoe and wheel and long life for both.

The relation between the diameter of the wheel and the torque exerted by the brake is expressed by the following formula:

$$D = 24\sqrt[3]{\frac{1}{144\,B\,C\,f\,p}} \times \sqrt[3]{\text{torque}}$$

where *D* equals diameter of wheel in inches; *B* equals angle (in radians) covered by two shoes; *C* equals width of wheel divided by the radius; *f* equals coefficient of friction; and *p* equals pressure in pounds per square inch.

By assuming fixed values for *B*, *f* and *p*, the curve shown in Fig. 2 was plotted. This shows that for small wheels the torque increases very slowly with the diameter of the wheel. As the size of the wheel approaches eighteen or twenty inches, the torque increases more rapidly than the size of the wheel, so that large brakes are more compact than small ones.

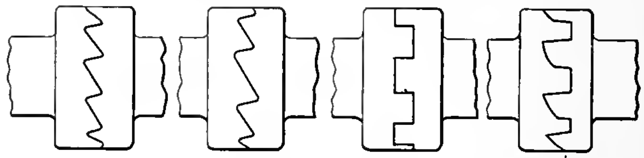
CLUTCHES.

Abstract of paper by Mr. Henry Souther before the Detroit Meeting of the American Society of Mechanical Engineers.

Clutches, in one form or another, have always constituted an important detail of machine construction. In general, however, engineers have not given clutches very great attention until recently, but now, when these devices have been called upon to do the delicate work required in connection with them in cotton mill machinery, printing presses, electric cranes, and automobiles, the real importance of clutch design has become apparent.

Positive Clutches.

The positive, or jaw clutch, is necessarily used only where a sudden starting action is immaterial, and where the inertia of the originally stationary or driven parts is relatively small. The different forms of positive clutches are modified merely in the angle of the engaging surfaces. The least positive form is one where the planes of engagement are inclined backward, as regards the direction of motion. The tendency of such a clutch is to disengage under load, and it must be held up to its work by axial pressure. This pressure may be regulated to perform normal duty, permitting the clutch to slip and disengage when overloaded. Positive clutches with the engaging planes parallel to the axis of rotation, must be held up to their work in order to prevent their natural tendency to jar out of engagement, but they present no safety features against overload. So called undercut clutches will engage tighter when loaded, and can be disengaged only when absolutely free from load, and in a condition permitting them to be rotated in a reverse direction sufficiently so that the undercut angular surfaces can clear each other. Some simple forms of positive clutches, embodying the fundamental principles, are shown in Figs. 1 to 4.



Figs. 1 to 4. Examples of Positive Clutches.

Friction Clutches.

While there is an infinite variety of detail in construction and manipulation of friction clutches, they might all be classified as belonging to one of the following four types: contracting band friction clutches, friction cone clutches, friction sector clutches, and friction disk clutches.

The most simple form of clutch is, perhaps, the Ramsbottom clutch, used for rolling mill work. It is, in reality, a friction coupling in which one flange is squeezed in between two other flanges, tightly bolted together. This clutch is shown in Fig. 5. The flange *A* is firmly clamped between the wood-lined surfaces of *B*, the bolts clamping these parts together, so that the friction will resist normal torque, but yield to abnormal torque.

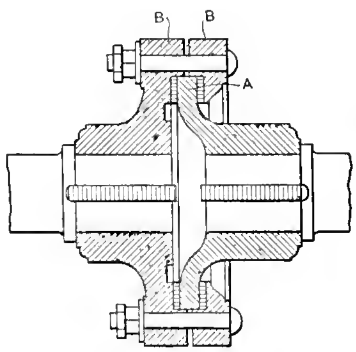


Fig. 5. Ramsbottom Clutch.

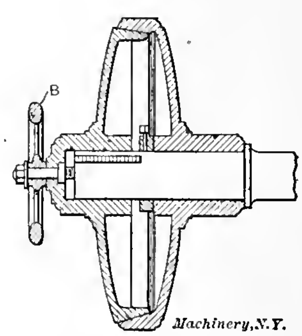


Fig. 6. Simple Form of Cone Clutch.

In Fig. 6 is shown the simplest form of cone coupling, where the two parts are being forced into engagement by a screw and a hand-wheel *B*. The angle of the cone should not be less than 10 degrees. The coefficient of friction for two iron surfaces in a clutch of this character is about 0.15. The mean radius of the cone should be kept within 3 to 6 times the diameter of the shaft, in order to keep the axial pressure within reasonable limits.

A further development of the friction cone clutch is shown in Fig. 7. This clutch may be termed the multi-cone friction clutch, being provided, as it is, with a series of concentric cone-shaped rings, of 20 degrees included angle. The design shown in the engraving requires that the collar on the shaft and the yoke in the engaging sleeve resist the pressure due to the axial pressure necessary for proper engagement, which causes serious wear. Such wear, however, is avoided in heavy or high speed machines by making the axial pressure

self-contained on the rotating members. A modification intended for this purpose is shown in Fig. 8. The pressure required for engaging the two clutch halves *A* and *B* is obtained by tightening hand-wheel *C*, the thrust being taken by collars on the respective shafts in such a manner that the ends of the shafts are forced together.

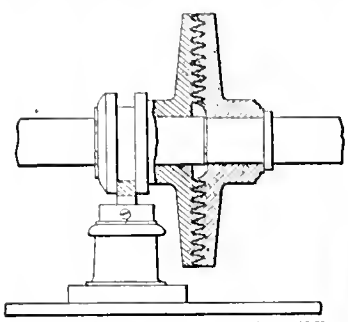


Fig. 7. Multi-cone Clutch of Objectionable Design for Heavy Work.

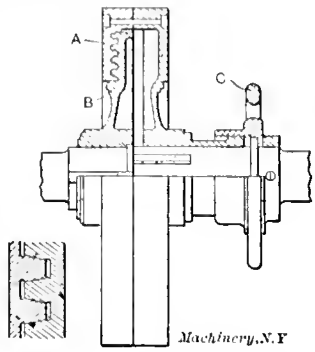


Fig. 8. Principle of Self-contained Multi-cone Clutch.

Another fundamental type of clutch is shown in Fig. 9. This is of the internal expanding type, three internal clamping pieces *A*, fitted with bronze shoes, being thrust out against the enclosing cylindrical drum *B*, by means of lever and screw action. There is no danger of wedging in this clutch, as exists in connection with the cone clutch.

In Fig. 10 is shown the well-known Weston clutch, which is based on the fourth fundamental principle mentioned above, that of multiple plate friction. The plates are alternately wood and iron, the wooden ones engaging with the outside cylindrical case *A*, and the iron ones with the shaft *B*. In the form shown, the plates are pressed together by springs *D* and disengaged by drawing back a collar-sleeve *C*, which releases the spring pressure.

Machine Shop Clutches.

The clutches shown so far have been intended simply to indicate basic types. The following examples will illustrate

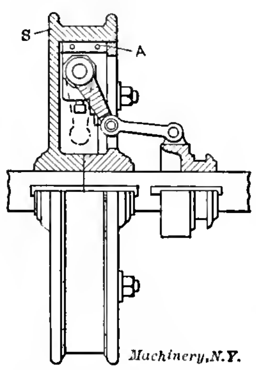


Fig. 9. Internal Expanding Type of Clutch.

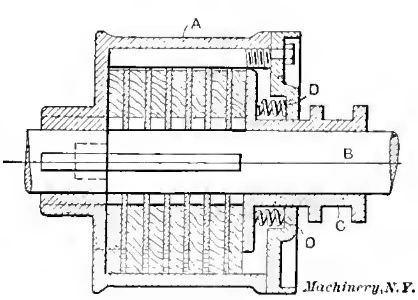


Fig. 10. Disk Clutch, Weston Type.

the development of present practical machine shop clutches. The simplest type is one in which one flat disk presses against another, the surfaces being either leather against iron, bronze against iron, or wood against iron. Such a type is shown in Fig. 11. The wooden disk *A*, attached to the casing *B*, is gripped between two iron surfaces *C*, keyed to the driving shaft. In order to prevent a drag when disengaged, separating springs *D* are placed between the iron disks. An interesting clutch, formerly known as the Frisby clutch, was designed many years ago. This clutch is shown in Fig. 12, and in this one flat surface *A* and the cone surface *B* are used in combination. The gripping of the surfaces is accomplished in a manner similar to that of the clutch in Fig. 11. It is apparent that this clutch would require less axial pressure for any given horse-power transmitted than the foregoing type, because of the cone; or, in other words, for a given axial pressure it would transmit more power and therefore would be smaller and more compact, all other things being equal. But here we meet with the uncertainty of the coefficient of friction. This clutch, for example, might throw its oil to the frictional surfaces more than the previous example, which oil would more than offset the effect of the cone engagement.

Very little information is obtainable in regard to the frictional capacity of this class of clutches and the knowledge at hand is of an empirical character. The Dodge Manufacturing Co., Mishawaka, Ind., gives some experimental data on the capacity of this class of clutches. The results are obtained from clutches fitted with maple blocks, and calculations are based on a coefficient of friction of 0.37 and a speed of 100 R.P.M.

TABLE OF HORSE-POWER TRANSMITTED BY FRICTION CLUTCHES.

Horse-power.	Block Area.	Diameter at Block, inches	Circumferential Pull at Block Center.	Total Pressure.	Total Pressure per sq. in.
25	120	16	1960	5300	44
32	141	18	2240	6000	44½
50	208	21½	2900	7800	37½
98	280	27½	4500	12200	43½

A modern development of the expanding ring clutch is shown in Fig. 13. These clutches are largely used for heavy work and are made by the A. & F. Brown Co., Elizabethport, N. J., in sizes up to 48 inches in diameter, capable of transmitting 320 H.P., at 100 R.P.M. The frictional surfaces are of wood, especially prepared for the purpose, the casing being of iron.

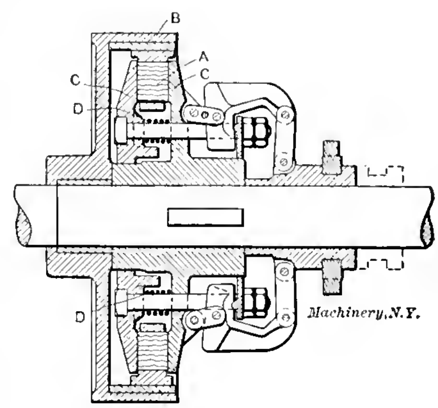


Fig. 11. Simple Form of Single Disk Clutch.

One of the oldest usages made of clutches is in wire drawing manufacture. The iron drum, around which the wire is wrapped, as a rule contains some form of clutch within it. A recent development of this class of clutch is shown in Fig. 14, being a clutch made by the Morgan Construction Co., Worcester, Mass. This clutch is working on the compound principle, the main driving effort being furnished by a wrapping coil on a chilled iron surface, the initial engagement of the coil being brought about by a modified cone or ring, slipping down onto a cone which drags the free end of the coil into engagement. When once seized, the wrapping continues until tight. In Fig. 14, *A* is the tapered friction surface of the chilled drum on which the friction ring bears, and below this is the coil, which is submerged in oil in an annular oil chamber. The drum is 12 inches in diameter by 7 inches high, and the coil, made of soft steel, is 1½ inch square at the large end and ⅜ by ⅝ inch at the small end.

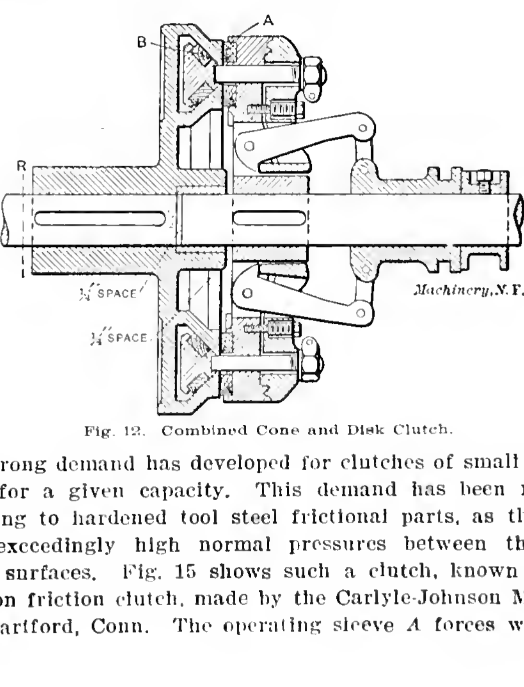


Fig. 12. Combined Cone and Disk Clutch.

A strong demand has developed for clutches of small dimensions for a given capacity. This demand has been met by resorting to hardened tool steel frictional parts, as this permits exceedingly high normal pressures between the frictional surfaces. Fig. 15 shows such a clutch, known as the Johnson friction clutch, made by the Carlyle-Johnson Machine Co., Hartford, Conn. The operating sleeve *A* forces wedge *B*

between the two long arms of the levers *C*, thereby spreading them in such a manner that they expand the friction ring *D* against the hardened drum *E*, enclosing the friction ring. This enclosing ring is an integral part of, or connected with, the driven pulley or shaft. As much as 100 H.P. has been transmitted, at 1,000 R.P.M., with a clutch of this type, having friction rings 5¼ inches in diameter and 1½ inch wide.

Clutches with Cork Inserts in the Frictional Surfaces.

Commercial clutches of the form now discussed have recently been designed with cork friction surfaces, with considerable success. Cork has a high coefficient of friction, probably double that of wood or leather on iron. As a rule the cork is forced into suitable cavities formed in one of the

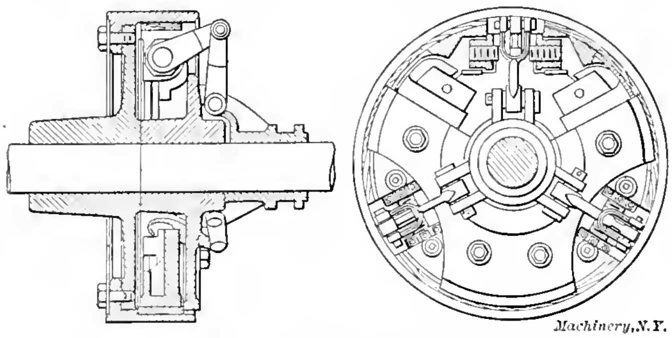


Fig. 13. Modern Application of Expanding Clutch.

metallic frictional surfaces. The cork is previously boiled, and thereby softened, before being pressed into the cavities. When so inserted in a metal surface, it normally protrudes above the surrounding surface, and engages first when the surfaces are brought together. If sufficient pressure is applied to the clutch, the cork is forced down flush with the metal surface and acts with it in carrying the load. When the clutch is released, the cork will again protrude beyond the surrounding metal surface.

Two forms of cork are used, one being the cork in its natural condition, the other prepared as follows: Small pieces are compressed into sheets and blocks of any desired shape under very great pressure and under enough heat to cause the natural gums of the cork to exude and act as a binder. This form of prepared cork is really more enduring than the natural, being stronger, firmer and yet possessing much elasticity, but it is expensive and has not had wide use for this reason. Nevertheless, it has been most successful in performing service beyond the capacity of other materials.

As an example of this, it may be mentioned that a Dodge friction clutch carrying 500 H.P. gave much trouble on account

COMPARATIVE TESTS OF LOOM CLUTCHES.

Average results of eight positions.
Torque measured in pounds-feet.

Pressure on Clutch, pounds.	Torque.	
	"Compo" Clutch with Cork Inserts.	Leather-faced Clutch.
89.5	19.50	16.95
151.5	34.20	17.66
213.0	46.43	23.09
275.0	57.05	29.46
337.0	73 33	36.09
398.0	82.24	41.31
460.0	96.48	47.56

of being overloaded. This clutch was strained up as tight as possible, and it was all a man could do to throw it. The maple blocks used were replaced with compressed cork. It was then possible to loosen the adjustment of the clutch to such an extent that the operator could throw it with little effort. Following this change it was found that a set of cork blocks outlasted the maple ones five to one.

Prof. I. N. Hollis of Harvard University has determined the coefficient of friction of cork on metal. He found that the coefficient of friction for plain cast iron on cast iron is about 0.16; similarly, for plain bronze on cast iron the coefficient of friction is 0.14. The coefficient of friction of the cork on the cast iron, however, was found to be from 0.33 to 0.37, the former, 0.33, being the value for the heavier loads.

It is apparent that the coefficient of cork on iron or steel is about double that of iron on iron. It is further claimed that the coefficient of friction is not very much less when the cork is lubricated. Cork has much advantage in a moist atmosphere, being very slightly affected by moisture, as compared with maple blocks ordinarily used.

Tests have been made by Prof. C. M. Allen of the Worcester Polytechnic Institute in connection with loom clutches, showing that for a given dimension of clutch the torque for cork inserts is nearly double that of a leather-faced clutch.

Automobile Clutches.

The latest development in clutches has been due to the development of the automobile. In clutches for this purpose, the matter of absolute disengagement is perhaps the most important. An important feature in the clutch is also the question of its weight, especially as affecting its inertia. A clutch having high fly-wheel effect spins to such an extent as to cause violent clashing of idle gears. Consequently, clutches are made as light as possible, and the smaller in diameter the better. Aluminum enters largely into clutch construction for this reason.

One of the simplest forms of clutch, which is commonly used for small machines, and in connection with the planetary system of change gearing, has one disk covered with leather, bronze, or copper, and is pressed against another, of iron or steel. The engagement of this clutch is soft and gradual, but it is open to the objection that a small amount of oil coming in between the surfaces renders it absolutely useless. Such a clutch, when reasonably dry, will drive a car up a grade

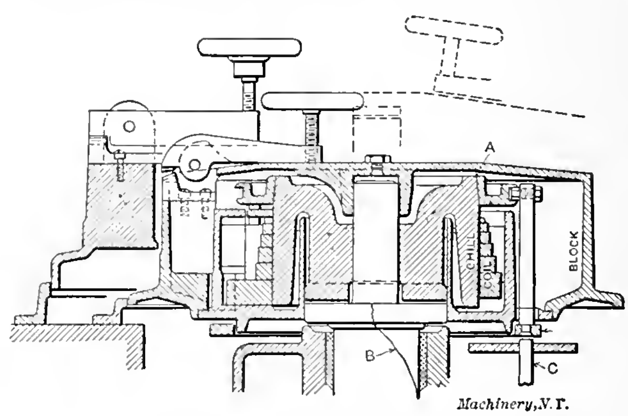


Fig. 14. Clutch for Wire Drawing, permitting Gradual Application.

sufficient to stall the engine. The same clutch, with too much oil between the friction surfaces, will not drive a car up a half per cent grade on asphalt. This is a good illustration of the uncertainty in clutch design, as far as frictional capacity is concerned.

For automobile clutches, all things considered, the best form when properly designed and mounted is the cone clutch. It has the advantage of engaging and disengaging with very small axial motion. The axial pressure may be low, because the normal pressure between frictional surfaces is multiplied by the angularity of the cone. This clutch may also be small, and the disengagement may be made perfect. Proper engagement, however, has proved to be a very difficult problem, and the cone clutch must therefore be absolutely free to center itself and seat itself uniformly.

Leather riveted onto an aluminum cone usually forms one of the rubbing surfaces and gray cast iron the other. It is desirable that the leather shall be kept soft by neatsfoot or castor oil. Some builders boil the leather in tallow before applying to the clutch surface; others do not, but this matter is of minor importance. With leather ¼ inch to ⅜ inch thick, properly softened, engagement may be sufficiently mild, but an improvement is obtained by placing under the leather at six or eight points on the periphery of the cone, flat or spiral springs that cause the leather to engage at these points a little bit before engaging elsewhere.

It is obvious that the construction surrounding the clutch must be such that, by no means, can an unusual supply of

lubricant find its way to the frictional surfaces of the clutch. With proper usage, cone clutches with leather faces seem to last indefinitely.

There has been a considerable variety of opinion as to the proper cone angle. Various authorities have placed it all the way from 7 degrees to 20 degrees. The French have settled down on an 8-degree to 9-degree angle as being about right

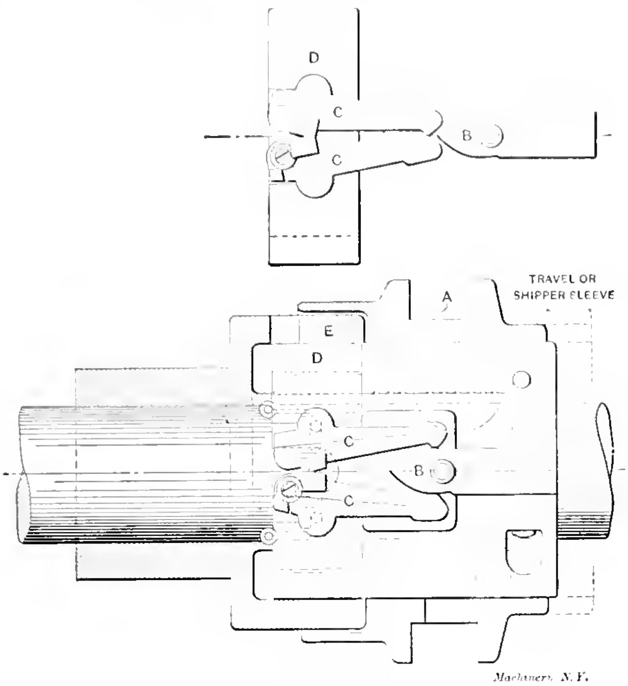


Fig. 15. The Johnson Clutch, used largely on Machine Tools and on Counter-shafts.

for a leather-faced cone. Several important American makers are using 12 degrees to 13 degrees, several 10 degrees, and others 8 degrees.

In general, these clutches present no difference in design from the types already illustrated. Some clutches have been brought out, however, of rather novel construction. An interesting form is shown in Fig. 16. This may be called a multi-cone clutch. When the clutch engages, the smallest cone seizes first and commences to revolve, and subjects thereby the spiral spring between the next two clutches to a torsional movement, which draws the springs together and brings the two outside clutches into action. The principle of the clutch is that the small clutch shall slip when the car starts and that the medium clutch shall behave in a similar manner when engaged, and that finally, the large clutch, when it

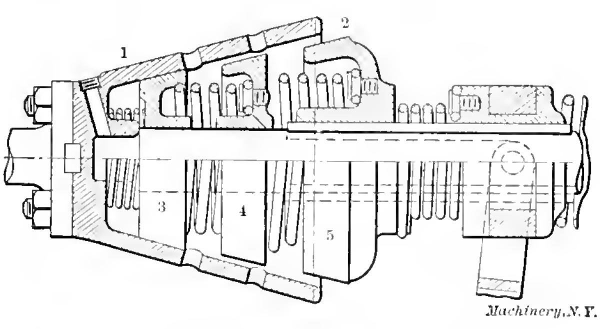


Fig. 16. Multi-cone Clutch of Novel Design.

comes into play, shall present sufficient frictional resistance to take up the full load in combination with the other clutches. It does not appear that this clutch has been tried out sufficiently to say whether it is a practical success, but the idea is a rather ingenious one.

Theory has not entered largely in clutch design, but in Fig. 17 is shown a simple clutch embodying the tractrix curve. This curve is adopted, because it is of such a form that by the calculated relation of pressures and peripheral speed, the wear ought to take place uniformly at all points, regardless of the distance of the point from the center. On account of this it is claimed that the clearance required is very small; that there is no wedging action between the two members of the clutch; and that there is no chance for it to bind.

A simple formula for calculating the ordinary cone clutch is the following:

$$\text{H.P.} = \frac{PfrR}{63{,}000 \sin \theta}$$

P = assumed pressure of engaging spring in pounds,
f = coefficient of friction, which in ordinary practice is about 0.25,
r = mean radius of the cone in inches,
R = revolutions of the motor per minute,
$\sin \theta$ = sine of the angle of the clutch.

To obtain the size of spring when the horse-power is known, the following formula may be used with good results:

$$P = \frac{\text{H.P. } 63{,}000 \sin \theta}{frR}$$

the same symbols being used as in the preceding formula. It will be noted that the coefficient of friction used is 0.25. This is probably near enough for a properly lubricated leather-iron clutch.

Expanding and contracting band clutches are used to some extent in automobile construction. The principle involved in all these is that a friction ring with sufficient flexibility either expands on the inside of a drum, or casing, or contracts on the outside of a drum, transmitting power by the friction between the expanding or contracting band and the drum. The mechanical designs to accomplish this have been greatly varied, but the designs are rather complicated. Clutches of this type are not greatly in favor in successful automobile designs.

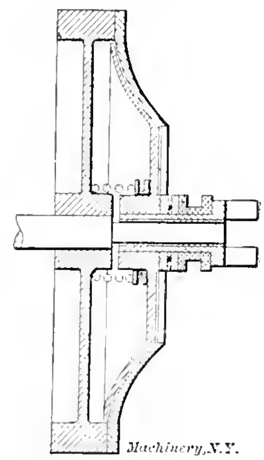


Fig 17. Clutch Designed for Uniform Wear.

Disk clutches on the other hand, are widely used. The principle involved in these clutches is a simple one, and has already been referred to in connection with our general classification of clutches. Cork inserts may be used in these clutches to considerable advantage. The question of lubrication is very important in these clutches, and in fact, it would seem that the principal problem in connection with the multi-disk clutch in particular is proper lubrication.

A modification of the multi-disk clutch, in which the cone and the disk are combined, is attracting much attention. This clutch is known as the Hele-Shaw clutch and has previously been described in these columns (see MACHINERY, October, 1903, engineering edition, and May, 1908, engineering and shop edition). With this clutch, 1,000 H.P. is being transmitted at 700 or 800 R.P.M., the clutch being 18 inches in diameter. The following table gives the dimensions and number of plates used for clutches transmitting different H.P.

	Bronze.	Steel
25 H.P., 27 plates of 6½ in.	14 outer	13 inner
40 H.P., 25 plates of 8¼ in.	13 outer	12 inner
60 H.P., 21 plates of 11 in.	11 outer	10 inner

Pneumatic clutches have been developed, but have not been widely used, because of their cost. In these a plain, leather-faced disk is pressed against a metal plate. The air deflects the leather, and causes it to bear against the metal disk, which is given a slight, endwise motion. Hydraulic clutches have also been used, but are not very popular.

Magnetic clutches are in use and are fairly successful. One complication in magnetic clutches arises in the fact that one of the parts of the magnet must rotate continuously, the gears being always in mesh; consequently the exciting current must be carried to it by a brush. These clutches usually seize rather abruptly unless carefully controlled. A considerable current is also necessary on the car for the operation of the clutch. These complications rather interfere with its extended usage.

DIMENSIONS OF SCREW HEADS AND NUTS.

A great many attempts have been made to standardize the dimensions of screw heads and nuts, but none so far has been undertaken under the auspices of any sufficiently recognized agency to command, for the particular standard in question, universal recognition. Strictly speaking, therefore, there are no standard dimensions for screw heads or nuts. The most prominent firms in this country, however, have adopted for their own use standards which do not materially differ from one another. In the following, dimensions are given for a number of different types of screw heads and nuts, these dimensions agreeing, in most particulars, with those in use at the Pratt & Whitney Co., Hartford, Conn.

In the tables in the Supplement, giving the sizes, no dimension has been given for the length of the screw itself, nor for the length of the thread, because these dimensions depend, of course, entirely upon the conditions for which the screws are to be used. In order to give a convenient rule to follow, however, for the length of the thread, it may be said that the length of the thread should equal two times its diameter, whenever the total length of the screw below the head is more than two times the diameter. When the total length of the screw is less than two times the diameter, the screw is threaded practically all the way up to the head.

In Table I in the Supplement, dimensions for the heads of screws with fillister heads are given. Two styles are shown; in the one it will be noted that the upper end of the head is rounded, whereas in the other the corner is sharp. The one kind of head is used when the screw head is permitted to project slightly above the surface of the work, which is common, particularly when the surface of the work is not finished. The other style shown, having a sharp corner at the upper edge, is intended for use where the screw comes flush with the surface of the work, which, in this case, always is finished. All dimensions for both types of heads are the same, excepting those which are influenced by the slight rounding of the corner. Dimensions are given for the width and depth of the slot for the screw-driver. It will be noticed that in order to prevent getting too many different widths of slots, several sizes are provided with the same dimensions for the slot.

In cases where the screw heads are not standard, it is a good rule to make the width of the slot according to the formula

$W = 0.135 \times D$,

where W = width of slot for screw-driver, and

D = diameter of bolt or screw.

A mistake which is often committed is to make the screw slot in proportion to the diameter of the head, irrespective of the diameter of the screw. This, however, is not correct, and often results in screws being twisted off by too large a screw-driver inserted in the slot in a special large head, the slot being proportioned according to the head, and not according to the screw to be tightened. While this would have no reference to screws with standard heads, it may not be out of place to mention it in this connection.

In Table II in the Supplement are given dimensions for the heads of standard square head screws. These screws are most commonly provided with a flat point as shown in the upper view, the screws being used for binding or set-screws; but not infrequently these binding screws are made with an angular point, as shown in the lower right-hand view in Table II, the included angle of the point being 90 degrees. At the left is shown still another form of point frequently used.

In Table III dimensions are given for headless set-screws. The dimension D is for the slight round at the upper end of the screw. Of course, the dimensions given in this case refer practically only to the size of the slot for the screw-driver. Three different types are indicated, one having a flat point and the two others being pointed, one to a 120-degree included angle, and the other to a 90-degree included angle.

In Table IV is shown a kind of screw known as a collar-head screw, having a square head and circular collar, which latter binds up against a surface of the work. These are commonly made with different sized heads for the same size bolt, in order to permit different sized bolts to be used, all of which would have the same size head, so that the same wrench may be employed for the different screws. These screws are usually threaded as near to the shoulder as possible, when the total length below the shoulder or collar is one inch or less; for screws longer than one inch, and up to 1½ inch, one inch length of thread is sufficient. For longer screws five-eighths of the length under the shoulder is usually threaded.

In Table V standard hexagon head screws are shown and dimensioned. These are used, as a rule, only in sizes larger than ¾ inch, the smaller sizes of screws for similar purpose being of the collar-head type. In the former, when the length under the head is longer than two times the diameter of the bolt, the length of the threaded portion should equal two times the diameter.

In Table VI dimensions are given for regular hexagon nuts, and in Table VII for hexagon nuts having less than the standard number of threads per inch, in this case 16 threads. These nuts, of course, can be made considerably thinner than the standard nuts. The thickness of these nuts is purely arbitrary, and there is no really good reason why a ¾ nut, for instance, should be only 5/16 inch thick, and a 2-inch nut 5/8 inch thick, if both are provided with 16 threads per inch. The figures given, however, embody common practice. In Table VIII are given dimensions for hexagon check nuts with regular standard threads. These check nuts are rounded on both sides, and are considerably thinner than the standard nut.

In Table IX dimensions are given for washers used in connection with standard bolts and nuts. It will be noted, upon examination of the table, that these are proportioned according to certain definite rules, and these rules are embodied in the following formulas:

$B = 2A + \frac{1}{8}$ inch, for A less than one inch.

$B = 2A$, for A equal to one inch or over.

$C = \frac{A}{4} + 1/32$, for A less than one inch.

$C = \frac{A}{4}$, for A equal to one inch or over.

In these formulas

A = hole through washer,

B = diameter of washer, and

C = thickness of washer.

While the nominal size of the hole through the washer is A, the hole should be made from 0.002 to 0.005 inch larger than the nominal sizes of the bolt for which they are intended.

Square heads for bolts intended for standard T-slots should be made to dimensions given in Table X. This table also gives the dimensions of the T-slots, in accordance with the dimensions of standard T-slot cutters, as manufactured by the Pratt & Whitney Company and the Brown & Sharpe Mfg. Co. The dimensions for nuts used in standard T-slots are given in Table XI.

* * *

A convenient rule for calculating the weight of cold-rolled shafting has been expressed in formula by Mr. H. E. Roush, Marion, Ohio, as follows: Weight per foot $= \frac{(\text{diameter} \times 4)^2}{6}$, or $\frac{8\,d^2}{3}$, in which d is the diameter, in inches. For example, the weight of a 3-inch shaft is $\frac{8 \times 3 \times 3}{3} = 24$ pounds. A rule of some value in certain cases for calculating the weight of steel plates is: The continued product of the length (in feet), the breadth (in inches), the thickness (in inches) and 3.4 is the weight in pounds. For example, what is the weight of a steel plate 5 feet long, 40 inches wide and ¾ inch thick? $5 \times 40 \times \frac{3}{4} \times 3.4 = 510$ pounds, answer. In both cases the weight of rolled steel is assumed to be 489.6 pounds per cubic foot, which agrees closely with standard authorities.

HOW TO OBTAIN APPROXIMATE FRACTIONS BY THE METHOD OF CONTINUED FRACTIONS.

MITCHELL DAWES *

Mitchell Dawes.†

Having exceptional opportunities for observation, I think it would not be untruthful to say that not more than 2 per cent of the men hired as being capable machinists and operatives on general work, understand the subject of continued fractions well enough to use them in obtaining approximate fractions. And having been repeatedly requested to put the subject in such shape that the ordinary man might understand it, I send herewith an article which I trust will be helpful to that extent.

In a work published by the Brown & Sharpe Mfg. Co., entitled "Practical Treatise on Gearing," the subject of continued fractions is taken up and explained in detail, and yet many machinists and apprenticed machinists are not well enough posted in mathematics to apply these rules in their regular shop practice. The reason for my sending this article is more for their enlightenment than any other purpose.

Now, I do not propose to enter into an explanation of what continued fractions are, as that is fully explained in the treatise above mentioned. When we have a fraction that cannot be factored and we resolve it into other fractions by the process of continued fractions, these fractions are called approximate fractions.

An Example for Illustration.

As an illustration, I will work out an example and show each successive step in its solution. If the reader will follow this explanation and apply it to like problems that he desires to solve, I think he will have very little trouble in obtaining satisfactory results in the future. Suppose, for example, that it is required to cut a spiral worm by means of a B. & S. milling machine, and the lead of said worm is to be 7.29 inches; find the necessary gears.

The required lead being 7.29 inches, then expressed as a fraction, it will read $\frac{7.29}{10}$ (the 10 being the ratio between the spiral head spindle and the table feed-screw of the milling machine, when the driving and driven gears are alike). For every decimal place in the numerator, add one cipher to the denominator and remove the decimal point from the numerator, thus making it a common fraction; it will then read $\frac{729}{1000}$. Reduce this fraction by the process of "continued fractions as follows:

$\frac{729}{1000}$

```
729)1000(1
     729
     ---
     271)729(2
         542
         ---
         187)271(1
             187
             ---
              84)187(2
                 168
                 ---
                  19)84(4
                     76
                     --
                      8)19(2
                        16
                        --
                         3)8(2
                           6
                           -
                           2)3(1
                             2
                             -
                             1)2(2
                               2
                               -
                               0
```

(In solving this example, it will be noticed that each divisor is divided in its turn by the last remainder.)

Now take the several partial quotients and arrange them in a line,

```
      + — + — + — + — 0
thus: 1 2 1 2 4 2 2 1 2.
```

Starting with the first one on the left, we call it plus (+) because when formed into its fraction it will be more than the original fraction $\frac{729}{1000}$ and the second will be minus (—) because it will be less than the $\frac{729}{1000}$ and so on, alternately plus and minus, each successive fraction being a little nearer the exact fraction $\frac{729}{1000}$ as it approaches the last one which is 0, or the fraction itself.

The Approximate Fractions.

To obtain the first fraction:

Take (1) the first partial quotient for a denominator and 1 or unity for its numerator, thus $\frac{1}{1}$. In relation to this first partial quotient and its connection with the first approximate fraction, I would state that no matter what the first partial quotient was found to be, say 1 or 5 or 7 or 10, in *all* cases it is taken for the first denominator, and 1 placed over it for a numerator, making it $\frac{1}{1}$ or $\frac{1}{5}$ or $\frac{1}{7}$ or $\frac{1}{10}$ as the case might be.

To obtain the second fraction:

Multiply (1) the numerator of the first fraction by (2) the second partial quotient, thus $2 \times 1 = 2$, which is the numerator of the second fraction, then multiply (1) the denominator of the first fraction by (2) the second partial quotient, thus $2 \times 1 = 2$, and to this product add (1) the numerator of the first fraction, thus $2 \times 1 + 1 = 3$, the result being the denominator of the second fraction; complete, it is $\frac{2}{3}$.

To obtain the third fraction:

Multiply (2) the numerator of the second fraction by (1) the third partial quotient and to the product add (1) the numerator of first fraction. Thus $2 \times 1 + 1 = 3$, which will be its numerator; then multiply (3) the denominator of the second fraction by (1) the third partial quotient and to the product add (1) the denominator of first fraction, thus $3 \times 1 + 1 = 4$, which will be its denominator; complete, it is $\frac{3}{4}$.

To obtain the fourth fraction:

Multiply (3) the third numerator by (2) the fourth partial quotient and to the product add (2) the second numerator, thus $3 \times 2 + 2 = 8$, which will be its numerator; then multiply (4) the denominator of the third fraction by (2) the fourth partial quotient and to product add (3) the second denominator, thus $4 \times 2 + 3 = 11$, which will be its denominator; complete, it is $\frac{8}{11}$.

The remaining fractions are found, as were the third and fourth, thus:

To obtain the fifth fraction $8 \times 4 + 3 = 35$, its numerator, and $11 \times 4 + 4 = 48$, its denominator.

To obtain the sixth fraction $35 \times 2 + 8 = 78$, its numerator, and $48 \times 2 + 11 = 107$, its denominator.

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To obtain the seventh fraction $78 \times 2 + 35 = 191$, its numerator, and $107 \times 2 + 48 = 262$, its denominator.

To obtain the eighth fraction $191 \times 1 + 78 = 269$, its numerator, and $262 \times 1 + 107 = 369$, its denominator.

To obtain the ninth and last fraction $269 \times 2 + 191 = 729$, its numerator, and $369 \times 2 + 262 = 1000$, its denominator.

The following are the approximate fractions as they have worked out in this example:

1	2	1	2	4	2	2	1	2	= partial quotients.
+	—	+	—	+	—	+	—	0	
$\frac{1}{1}$	$\frac{2}{3}$	$\frac{3}{4}$	$\frac{8}{11}$	$\frac{35}{48}$	$\frac{78}{107}$	$\frac{191}{262}$	$\frac{269}{369}$	$\frac{729}{1000}$	= the approximate fractions.

After the first and second approximate fractions have been found, the remaining fractions can be obtained by working according to the following rule. Multiply the numerator of the last fraction found, by the next partial quotient, and to this product add the numerator of the preceding fraction; the sum will be the numerator for the next fraction. Take a similar course for the denominator, that is, multiply the denominator of the last fraction found, by the same partial quotient as was used to obtain the numerator just found and to this product add the denominator of the preceding fraction; the sum will be the denominator for the uncompleted fraction. Continue in this manner until all the partial quotients have been used, and fractions obtained. The last fraction will be the original fraction, or a fraction of equal value. In this case, it is 729/1000.

The fraction 35/48 derived from the fifth partial quotient in the continued fractions, has been selected as the one which can best be used, and being factored and raised to higher terms, thus:

$$\frac{35}{48} = \frac{7 \times 5}{6 \times 8} = \frac{56 \times 40}{48 \times 64} = \text{the gears chosen.}$$

Proof: $56 \times 40 \times 10 \div 48 \times 64 = 7.2916 +$ inches, an error of 0.0016 inch, which is near enough for all practical purposes.

Proving an Approximation.

By continued fractions you may be in doubt whether or not a chosen approximate fraction will be near enough to the required one to allow its use. Then prove it.

Example:

Suppose you should desire to cut a screw of 2.243 turns per inch, and being unable to factor it, you obtain approximate fractions, thus:

```
243)1000(4
     972
     ---
      28)243(8
         224
         ---
          19)28(1
             19
             --
              9)19(2
                18
                --
                 1)9(9
                   9
                   -
                   0
```

+	—	+	—	0
4	8	1	2	9
$\frac{1}{4}$	$\frac{8}{33}$	$\frac{9}{37}$	$\frac{26}{107}$	$\frac{243}{1000}$

Selecting 9/37 you decide to cut 2.9/37 turns per inch, instead of 2.243/1000 turns per inch. Then to find how near this selected fraction is to what was first wanted, you reduce it to thirty-sevenths, thus, $2.9/37 = 83/37$ and dividing the numerator by the denominator, the quotient will show how near this selected approximate fraction is to the required thread, thus:

$$83 \div 37 = 2.243243 +$$

What we obtain by this selection is....	2.243243
What we wanted was..................	2.243000
	0.000243

This error is so slight that for all practical purposes it may be used.

Supposing your lathe has a lead of 4 turns per inch, your ratio would be thus expressed: $\dfrac{4}{\frac{83}{37}}$. Reducing the lead of the lathe to the same terms (*viz.*, thirty-sevenths) you obtain $\frac{148}{37}$, then $\dfrac{\frac{148}{37}}{\frac{83}{37}} = \dfrac{148}{83}$ which being factored equals

$$\frac{74 \times 2}{83 \times 1} = \frac{74 \times 70}{83 \times 35} = \frac{\text{Drivers.}}{\text{Driven.}}$$

General Proof.

Product of driven gears by lead of lathe, thus, $83 \times 35 \times 4 = 11620$.

Product of driving gears $74 \times 70 = 5180$, and $11620 \div 5180 = 2.243243 +$ or the turns per inch this combination will cut.

It will be noticed that one example is for the lead, while the other is for the turns per inch.

No doubt some of your readers will say that this article is entirely too elementary, and enters too much into detail. Should that be the case, my reply would be that it was written for those who needed just such details.

* * *

MACHINE SHOP PRACTICE.*

RE-PLANING A LOCOMOTIVE DRIVING-BOX.

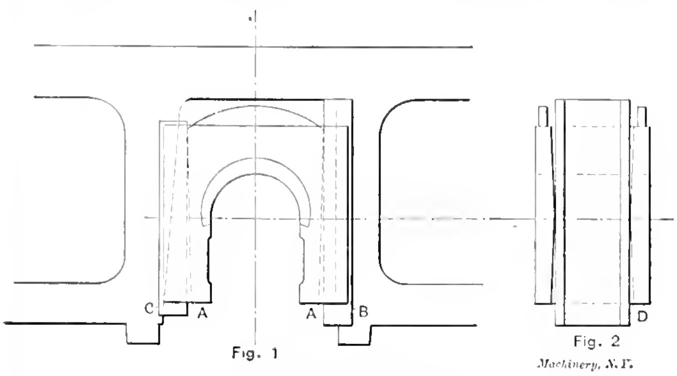
When a locomotive is being repaired, particular attention should be given to the driving-boxes, for if this part of the work is slighted and the boxes overhauled improperly, the result will be manifest, after the engine goes into service, in the shape of pounds which are difficult to overcome. As is well known, each driving-box is held in its place by a shoe and wedge which are fitted to the jaws of the locomotive frame. The usual construction is to have one of these jaws tapering, as shown in the illustration, Fig. 1, with a corresponding taper on the back of the wedge so that as the wedge is raised or lowered the distance between the faces of the shoe and wedge can be varied. When the box is in its place, the wedge is adjusted until the box is just free enough so that it can be moved up and down, for when the engine is in motion there is more or less of this vertical movement which would be impossible if the wedge were set up too tightly. This continual movement of the box results in more or less wear on its shoe and wedge bearing faces, and, consequently, it finally becomes necessary to replane these faces in order that the boxes may have a free movement with a minimum amount of lost motion.

When the brasses are considerably worn and need to be renewed, the new ones should be put in the boxes and bored before the shoe and wedge bearing faces are planed. The brasses are usually forced into place under considerable pressure, the ultimate pressure ranging from 10 to 18 or 20 tons, depending upon the sizes of the boxes, and the result is that the bottoms of the boxes generally spread apart, sometimes as much as 1/16 inch. Obviously, if the shoe and wedge faces of the box had been planed previously, the insertion of a new brass would render them unparallel. The boring of the brass for the journal should also be done prior to the planing operation, as the removal of the metal when boring has a tendency to cause the sides of the box to spring inward or toward its original shape. The dotted lines *A* in Fig. 1 show in an exaggerated manner the shape of a box planed prior to boring. It will be seen that if the faces of the shoe *B* and wedge *C* are parallel with each other, the bearing between them and the box will be at the top, leaving the bottom of the box free to move back and forth. This lost motion will result in a pound when the engine is in service, and this will increase as the springs weaken, causing the frame with the shoe and wedge to lower. Trouble of this kind, however, is not always

* With Shop Operation Sheet Supplement.

due to improperly planed boxes, for, as the brass wears, the sides of the box tend to close in, especially if equipped with poorly-fitting cellars.

When a locomotive is to be equipped with a new set of boxes, it is the usual practice to do the planing work on all of them at the same time, which is, of course, the most economical way. When re-planing, however, it is often impracticable to plane more than one or two boxes at a time because of variations in their size, unless it is desired that there be no such variations. Of course a set of boxes of different sizes might be lined up to prevent removing too much metal from the larger ones, but this would require considerable time, and



Figs. 1 and 2. Views showing Effect of planing Box prior to Boring, and Box with Tapered Flanges.

it is doubtful if the work could be accomplished as quickly in this way as when planing the boxes in pairs, taking care to select those most evenly matched.

In Shop Operation Sheet No. 70, accompanying this issue, the method of laying out a box preparatory to planing has been described. It is the common practice on railways to bore the brasses of all boxes central with the shoe and wedge bearing faces. Therefore, when planing these faces, the boxes are laid out from the bore or, from what is practically the same thing, the surfaces t and u. The points J and K should be located so that the minimum amount of metal required to make the shoe and wedge bearing faces central and parallel, is removed. In setting the box on the planer the sides which come next to the wheel hub should be set at right angles to the platen, or the bore may be set parallel with it by testing the side of the bearing with a surface gage. The finishing cuts should leave the faces smooth and flat to insure a good bearing, thus reducing the wear of the box to a minimum.

Frequently, locomotives are equipped with boxes having flanges which taper from the center toward each end, as shown in Fig. 2. When planing boxes of this kind, it will often be necessary to shift them in order to plane out the tapered portion D of the faces, which the tool could not reach on the first cut. It is necessary that these corners be removed so that when the shoe or wedge is placed between the flanges, as shown in the illustration, it can be given a rotary movement, the centers of the flanges acting as a pivot. The reason why box flanges are tapered for the purpose of giving this play between the box and the shoe and wedge, is to prevent the flanges from breaking, and the tapering flange is especially desirable on rough roads. When a locomotive running at a high rate of speed strikes a curve, the relative positions of the wheels and the engine frame are momentarily changed. This change is caused by the elevated track and the inertia of the mass supported upon the springs and the flexibility of the springs. When the wheels come to a curve, the outer ones ascend the elevated outer rail so quickly that the driving-boxes are forced upward against the tension of the springs. If the box flanges were not tapered, permitting this movement, there would be danger of their being broken. Therefore, in re-planing the shoe and wedge bearing faces of a box, the importance of planing out the tapered portions of the faces will be understood.

* * *

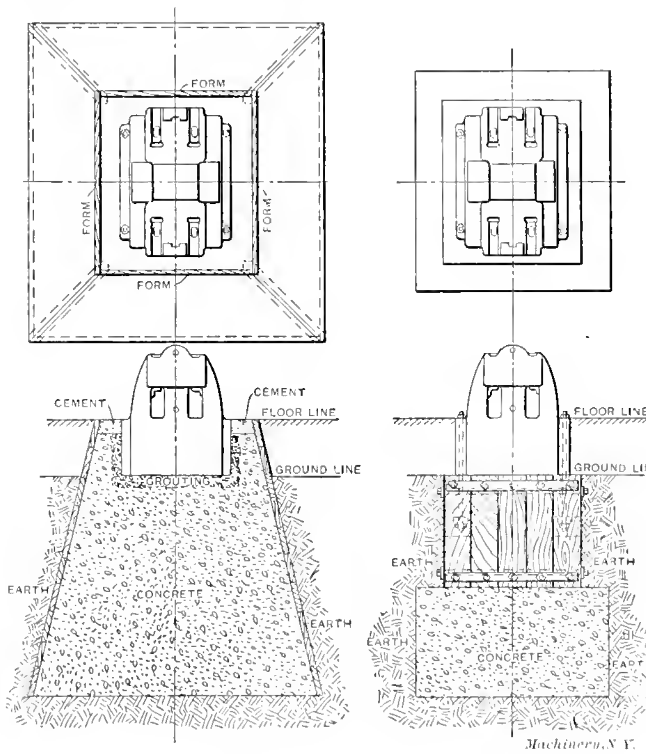
The motor car trade of Germany in 1907 is stated in the British Consular report to be somewhat less than was expected. The supply greatly exceeded the demand, and the heavy cost of repairs is stated to have contributed largely to the bad condition of the trade.

DROP-HAMMER FOUNDATIONS.

The E. W. Bliss Co., Brooklyn, N. Y., builder of drop forge hammers, contributed the following information regarding the construction of drop-hammer foundations.

The endurance and effectiveness of drop-hammers depend in no small degree upon the proper ratio between the weight of the base and the weight of the hammer. It has been demonstrated that 12 to 1 is decidedly better than a smaller ratio, and that the best results are obtained with a ratio of 15 to 1 or 16 to 1 with all parts made in proportion; the extra cost of the heavier machine being more than compensated for by the larger quantity and better quality of the finished product and by the comparative freedom from breakdowns.

For the successful operation of drop-hammers, it is very essential to have a good foundation. Both of the types here illustrated have been found to give good results. The wood cushion foundation, as shown in Fig. 2, is used where the bottom is not good and where the jarring of the surrounding buildings is objectionable. The solid concrete foundation shown in Fig. 1 is recommended as best when it can be used, as it is like a continuation of the base on the hammer, and therefore makes the drop more efficient. In deciding the depth of foundation of either of the above types, care should be taken to determine the best point to stop the excavation. Bed rock is the best bottom, cement gravel next best, and a strata of sand or clay, say 4 feet thick, and in its original



Figs. 1 and 2. Drop-hammer Foundations of Solid Concrete, and with Wood Cushion.

and undisturbed condition, also makes a good bottom. The trouble with sand or clay is that on account of the heat of a drop forge shop drying the soil and a continual jar, they are apt to shift provided they get an outlet in the shape of other near excavations. By spreading the bottom of the foundation the desired result is sometimes obtained without going very deep, but for any size of drop-hammer the concrete should not be less than 4 feet thick, whether the wood cushion is used or not.

* * *

In an interesting little pamphlet, published by a German investigator, Mr. Hermann Nelkes, regarding the unit of measurement and the system according to which the Cheops pyramid in Egypt was built, the author mentions that he finds that the dimensions of the pyramid and its integral parts are in such proportions as to indicate that the unit of measurement employed was identical with the English foot or, in other words, that the standard length of the English foot has its origin in, and came down to our time from, the standard of length in Egypt about six thousand years ago.

COMPARATIVE TEST OF ABRASIVE DISKS ON CAST IRON.

This test was made at the shops of the Gardner Machine Co., Beloit, Wis., to determine the comparative efficiency for grinding cast iron, of different kinds and makes of disks, such as are commonly used in connection with disk grinders. In the following table the different kinds of disks are indicated by figures:

No. 1 indicates the Gardner improved abrasive disk No. 126, which is further described in this article. No. 5 is the regular No. 24 commercial emery cloth. No. 6 is the same in emery paper. Nos. 2, 3 and 4 are proprietary articles of excellent quality as compared to commercial emery cloth, and all are well known by trade names, being extensively used.

The disks tested were all 20 inches in diameter and all excepting Nos. 5 and 6 were No. 16 grain. The grinding was done on the ends of hollow blocks of cast iron as shown in Figs. 1 and 2. The area ground at the end of blocks was 5 square inches. Reducing the blocks one inch in length, indicated the removal of 5 cubic inches of metal. The grinding was all done on the same machine by the same operator. Fig. 3 shows the method of handling the work, and twelve blocks which have been considerably reduced from original length. Usually twelve blocks were operated on together.

TEST OF EFFICIENCY OF ABRASIVE DISKS.

Disk Number.	Time Used in Minutes.	Stock Removed in cubic inches.	Number of Times Dressed.	Average Cutting Rate, cubic inches per min.	Cutting Rate, First Half of Time Used.	Cutting Rate, Second Half of Time Used.	Life of Disk, Based on Disk No. 1.	Stock Removed, Based on Disk No. 1.
1	754	349.85	0	0.464	0.442	0.486	100. %	100.0%
2	137	42.13	6	0.307	0.344	0.270	18.1%	12.4%
3	540	113.95	0	0.211	0.238	0.184	71.6%	32.3%
4	68	27.97	2	0.411	0.546	0.276	9 0%	8.0%
5	71	2.41	4	0.034	0.062	0.006	9.4%	0.7%
6	73	12.48	2	0.171	0.273	0 069	9.7%	3.5%

The micrometer stop at the back of the table was set to grind off a fixed amount, usually 0.050 inch, and the twelve blocks ground to the stop. The stop was then moved back 0.050 inch and the operation repeated until the blocks became too warm for efficient grinding, when they were cooled, and the time of grinding and the amount of metal removed, noted. This was repeated until the disk was worn out or the blocks all ground up. In the latter case, new blocks were substituted and the operation continued until the disk was worn out. By reversing the blocks they were ground down until the wheel touched the handles on both sides. During this test several hundred pounds of these blocks were converted into cast iron chips.

In the table given above it will be noted that it was necessary to use a Huntington emery wheel dresser on all disks tested except Nos. 1 and 3. The dresser was used whenever

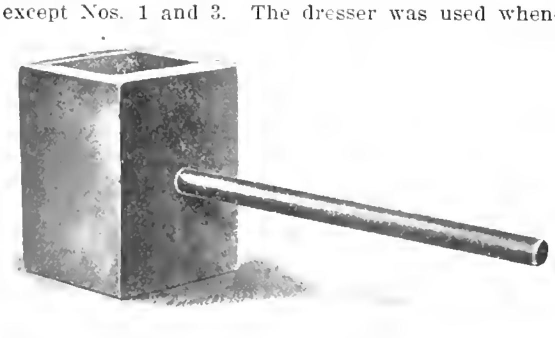


Fig. 1 Form of Hollow Cast Iron Block used for Test.

the surface of the disk became dull and glazed so that it would not cut cast iron readily. The use of a dresser shortens the life of the disk, but it was absolutely necessary. The results obtained are given in the foregoing table.

The disk called No. 1 in the table is made by an entirely new process. The abrasive grains are mixed with required bond and the mixture is cemented to a cloth backing. While in a plastic condition the abrasive grains are *mechanically* tilted to an efficient cutting angle. Careful examination of a disk treated by the tilting process will fail to show any large grains with large flat faces fixed parallel to the plane of rotation. On the other hand, before being subjected to this tilting process a great majority of the grains present their largest flat surfaces parallel to the plane of rotation, *i. e.*, the surface of the work being ground. It is obvious that the flat side of a grain will not cut so freely as a

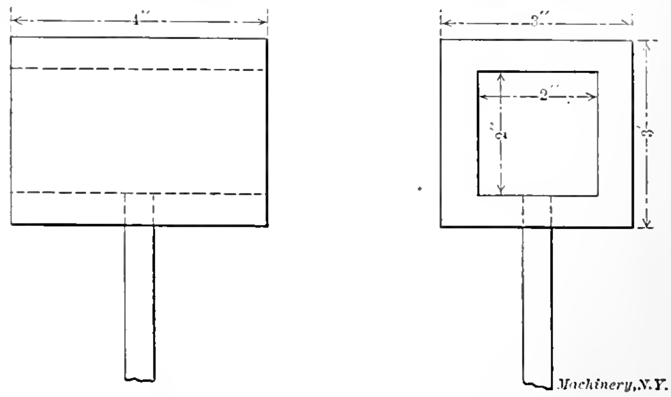


Fig. 2. Hollow Cast Iron Block used for Test.

sharp edge. The truth of this is evident from results shown in the table.

Another very noticeable feature of the No. 1 disk is the uniformity of its cutting efficiency from start to finish. As shown in the table, the disk removed stock just as fast during the last six hours as it did the first six.

All the other disks tested are made by depositing a heavy coating of glue on the backing sheet and then spreading a quantity of dry abrasive grains onto the glue. The abrasive grains settle into the glue and so become firmly attached to the backing sheet. By this process the grains and glue are

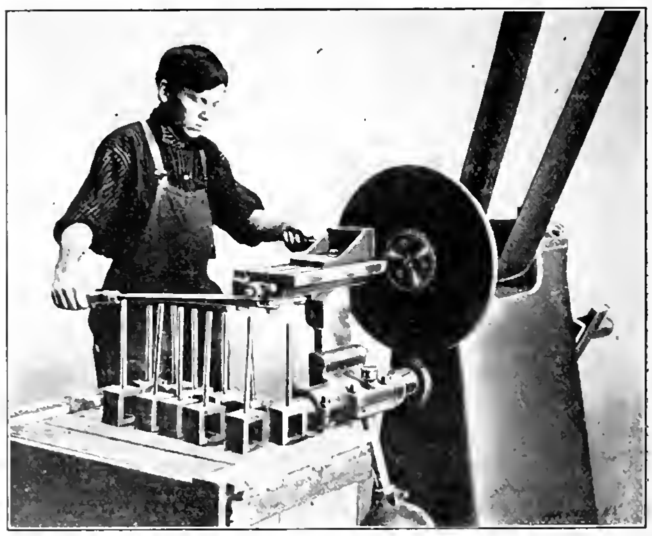


Fig. 3. Method of Grinding Blocks in Test.

not evenly mixed from face to back. Disks made in this way cut freely and rapidly at first, but soon wear down to a point where there is too much glue and not enough of the abrasive grains. This fact is plainly evidenced by record of disk No. 5, in the columns giving average cutting speed for first and second half of the time used.

The illustrations Figs. 4 and 5 show operations on work done with disk No. 1. Fig. 4 shows grinding of impellers for centrifugal pumps. These are gray iron castings and are very rough and hard in places, making them difficult to machine in a lathe. The diameter is 26 inches, and the area of surface ground is about 50 square inches on each side. It was necessary to remove ¼ inch thickness of metal at some points. The rate of grinding these impellers on both sides was fifteen minutes for each impeller. The former time for turning in a lathe was three hours and thirty minutes for each impeller. The pieces are ground at an angle of seven degrees to the axis, and the surface of the blades being curved and not radial, necessitates their being revolved while grinding. This develops the surface of a cone. The impellers are mounted on a spindle driven by a worm gear and worm connected with a hand-wheel, as shown. This fixture is mounted

on a lever feed table set at the required angle with the face of the disk wheel, and the impeller is slowly revolved by means of a hand-wheel while the lever is used to bring it against the disk wheel.

Fig. 5 shows a rather interesting job of disk grinding of special cast iron latticed plates. These plates are used in the manufacturing of the grinding disks No. 1 in the foregoing table, and are required to be accurately flat and of uniform thickness. They are 23 inches diameter by 7/8 inch deep. The rings and spokes that go to make up the plates are 5/32 inch thick. The castings being so thin, it was found to be impracticable to machine them in a lathe or boring mill, but results obtained with a disk grinder are entirely satisfactory.

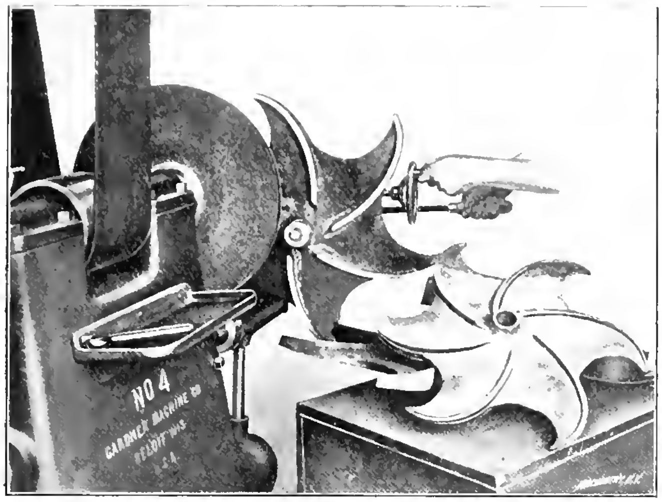


Fig. 4. Grinding Vanes of Cast Iron Impellers.

The plates are chucked at the inner circle, which is about 6 inches diameter, on a metal disk having heads of set-screws projecting from its periphery. This disk has a 3/4 inch hole in the center, fitting a stud in the angle plate which is bolted to the top of the lever table, as shown. The latticed plates are hung on this stud, bearing against the angle plate, and are pressed against the disk wheel by the lever. They are, of course, free to revolve with the wheel, but the speed of this revolution is easily controlled by changing the relative position of the stud to the axis of the machine spindle, and also by the hand of the operator, as shown. By changing pressure on the lever and by swinging the table on the rocker shaft the revolution of the plates can be increased, stopped entirely or reversed at the will of the operator.

The castings for the plates are made in a stove foundry and are quite accurate to pattern, but too hard to turn. The amount of metal to be removed to make them accurately flat, is small, averaging less than 1/32 inch each side. By the method shown, they are finished to the required size and made flat on both sides in about fifteen minutes.

Figs. 6 and 7 are reproduced from a photograph of Gardner's improved abrasive disks. Fig. 6 shows No. 1 disk used in the grinding test. Fig. 7 is the same kind of disk, but made of a much finer abrasive and being lighter in color, shows very plainly the corrugated surface which produces the mechanical tilting of the abrasive grains.

* * *

A correspondent of the *Engineering News* says that the greatest inventor and engineer of the nineteenth century, whose inventions have spread over the civilized world, once said to him: "If people knew how little I know, they wouldn't come to me for advice." Think of a lawyer or doctor or a "man of affairs," whatever that may mean, making such an admission to a client. Does the experience and training of the engineer, which constantly forces him to honestly deal with the laws of nature which underlie all his work, produce a type of man that is more honest, simply on account of his technical training and the influence of the work to which he devotes himself?

* * *

Tracings and drawings that have been rolled up can be flattened by rolling them in the reverse direction from that in which they have been kept, forming the roll into a conical funnel shape, and holding the wide end over the flame of a lamp, so that the hot air can circulate over the surface of the drawing. When unrolled, the drawing will be found to lie flat.

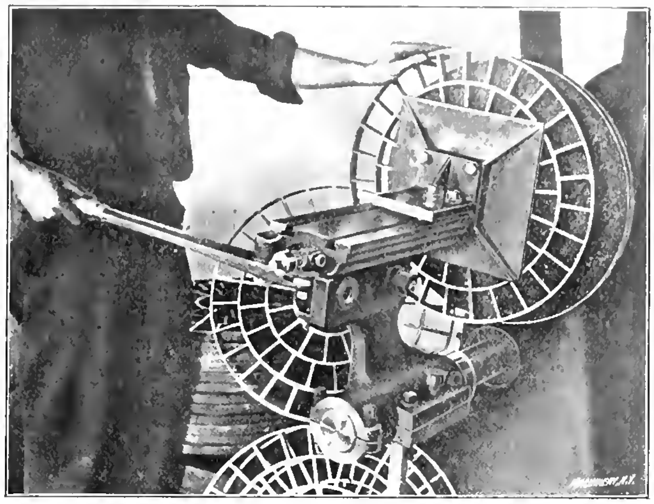


Fig. 5. Grinding Sides of Latticed Plates.

Fig. 6. Improved Grinding Disk with Coarse Abrasive Grains Mechanically Tilted.

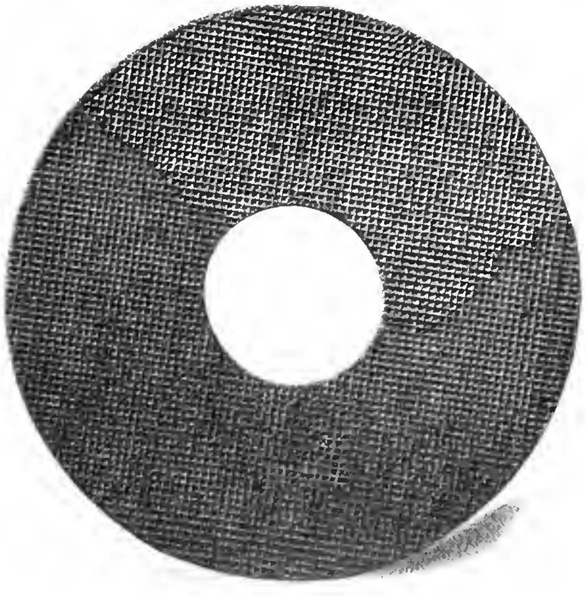


Fig. 7. Same Type of Grinding Disk as shown in Fig. 6, but with Finer Abrasive.

LETTERS UPON PRACTICAL SUBJECTS.

SHEET METAL DRAWING.

Only those who have made a specialty of drawing sheet metal know just how to proceed to lay out a die so that the desired result will be a certainty the first time it is tried. Recently the writer has had quite a little experience on this class of work and a few of the kinks that I discovered and some which I had explained to me by others, follow.

First, we are confronted with finding the diameter of the blank. There are several methods by which we can determine the size of the blank. One way is to cut out a blank of the same thickness as the stock of which the model shell is made, and then keep reducing the diameter until the blank balances the model. Another way is to multiply the circumference by the height and add the area of the bottom, which gives the area of the blank, then find the diameter of a circle whose area is equal to the area found. This latter rule applies to blanks that must be of a uniform thickness on the sides and bottom. But if the article should be an ordinary box or something allowing a variation of thickness, the size of the blanking die can be much smaller. By this, I mean that a shell 3 inches long can be drawn from a blank 3 inches diameter, or from a 2-inch blank. The sides and bottom will, of course, be thinner. A good rule to follow is to make the height of the shell at first draw, one-third the diameter of the blank, that is, a 3-inch blank, for best results, should produce a shell 1 inch long at first draw. The shells should be annealed if drawn to any length.

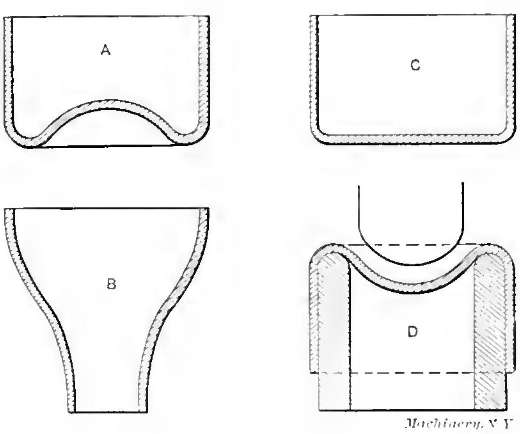
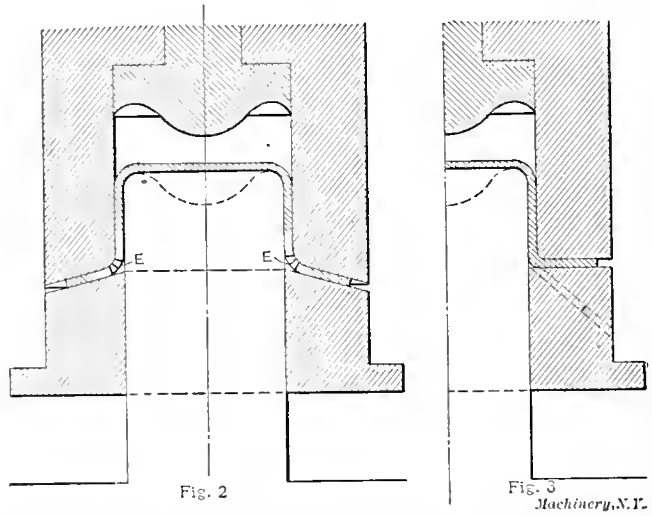


Fig 1. Method of Drawing Shells which gives a Minimum Variation in Wall Thickness and a More Even Distribution of Stretch

Fig. 1 shows a novel kink when the blank is to be drawn into a shell of length or into a shape as shown at *B*. The first operation leaves the shell as shown at *A*, and this will save at least one drawing operation. It will be noted that the indented end in the shell bottom presents surplus stock, so to speak, whereas, if it is drawn at the first operation in the ordinary way as shown at *C*, the succeeding operations must be gentle to prevent a greater reduction in the thickness of the walls on the angular sides of the shell. Another advantage in shaping the first shell as shown at *A*, is that when drawing it to the angular shape, the stretch or draw of metal is more evenly distributed over the entire surface and the strain on the metal is not as great as if the draw commenced at the corner. Another novel feature (to the writer) is to shape the blank as at *A* (if the shell is to be a long one) and then use a die for the second operation, as illustrated at *D*. The blank, when forced through, is actually turned inside out. This operation presents two good points to the writer. First, we are enabled to get a suitable amount of stock in the shell in such a shape as to draw to the best advantage. Second, if the shell is to be a long one, the diameter of the blank must of necessity be large, therefore the stock is distorted considerably in changing from a flat blank to a shell of much smaller diameter, and if we could see the grain of the stock as it passes over the die, it would present an appearance similar to that shown by the lines *E* in Fig. 2. That is, the inside of the stock stretches and the outside compresses. Therefore, by turning the shell inside out, the stock is apparently restored somewhat to its original texture of close grain, which will allow further stretching.

A very important point which must not be overlooked is the angle on the face of the stripper and blanking punch. I have found that in making long, small diameter shells, that if the angle on the stripper and blanking punch is, say 8 degrees, every shell would break out at the corner; but by changing the angle to 10 or 12 degrees, that they would come out without breaking. This point can be better understood by referring to the half section, Fig. 3. It would be almost impossible to draw the shell when the edges of the blank were at right angles to the shell, but by making the angle of the punch and stripper as shown, exaggerated by the dotted lines, the shell is practically drawn by the blanking punch, and leaves very little work for the drawing punch.

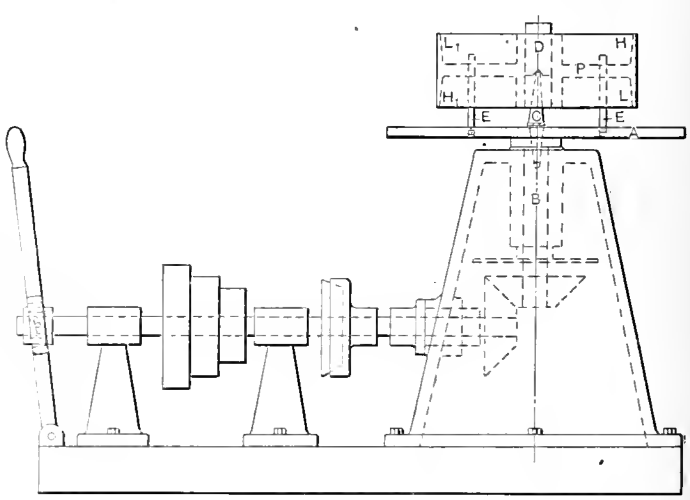


Figs. 2 and 3. Diagrammatical Views illustrating the Stretch of the Metal and the Effect of Angular Punch and Stripper Faces.

Pittsfield, Mass. FRANK E. SHAILOR.

PULLEY BALANCING DEVICE.

Most machinists have, at some time or other, met with problems in balancing which have been difficult to solve. It is easy to obtain a fairly accurate static balance on a pair of parallel ways, in the ordinary manner, but if the pulley or other part to be balanced is wide, and runs at a high speed, this method is not altogether satisfactory, as one edge may be heavy on one side of the pulley, and the other edge on the opposite side. When this condition is present, there is a vibration when the pulley is running at high speed, which causes unnecessary strain on the shaft on which the pulley is mounted, and on the adjacent bearings. The writer lately saw an old machine designed for obtaining a running balance, which may be of interest to some of the readers of MACHINERY.



Device for the Dynamic Balancing of Pulleys.

An outline of this machine is shown in the accompanying line engraving.

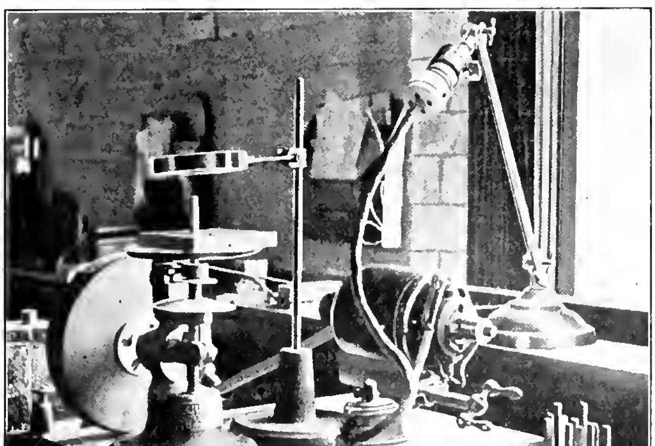
The lower part of the illustration shows the frame and the driving details. At the right-hand end is a stand on which is mounted a plate A, which is, by suitable means, fastened solidly to the shaft B, and revolves with it. Into this plate and shaft is inserted a taper pin C, having a round point at its upper end. In the plate are further inserted two rods or pins E, which are screwed into holes about half-way between the center and the outside periphery of the disk A. These pins serve to drive the pulley P being balanced.

In balancing a pulley, the static balance is first approximated by the usual methods. A plug D with a large center is then driven into the bore in the pulley, so as to extend about half way through the hole, and the work is then placed on the machine in the position shown in the engraving, the center of D resting on the round point of C, so as to bring the latter approximately to the center of gravity of the pulley. If we now assume that the points H and H_1 are the heavy points, then, when the machine is started, these points will throw outward, on account of centrifugal force, and the pulley will assume a tilted position, H moving downward, and H_1 rising until a state of equilibrium is reached. The pulley can then be marked by a piece of chalk. After marking the pulley, the machine is stopped, and weights added in equal quantities on opposite sides at L and L_1, or metal may be removed at H and H_1, whichever is most convenient. If either H or H_1 comes in line with the weights used for static balance, these weights can be moved up or down, whichever is required, producing the same results. Now the machine is started, and the pulley is tried again, and the balancing process repeated until it will run truly balanced at full speed.

ALLAN.

A HANDY FILING MACHINE.

The engraving illustrates a very convenient filing machine which is in use in the Remington-Sholes typewriter factory, for filing dies. It consists of a small filing machine to which an old center grinder has been attached by means of a couple of wood pulleys and a belt. The whole thing is mounted on



The Filing Machine with a Reading Glass mounted above it.

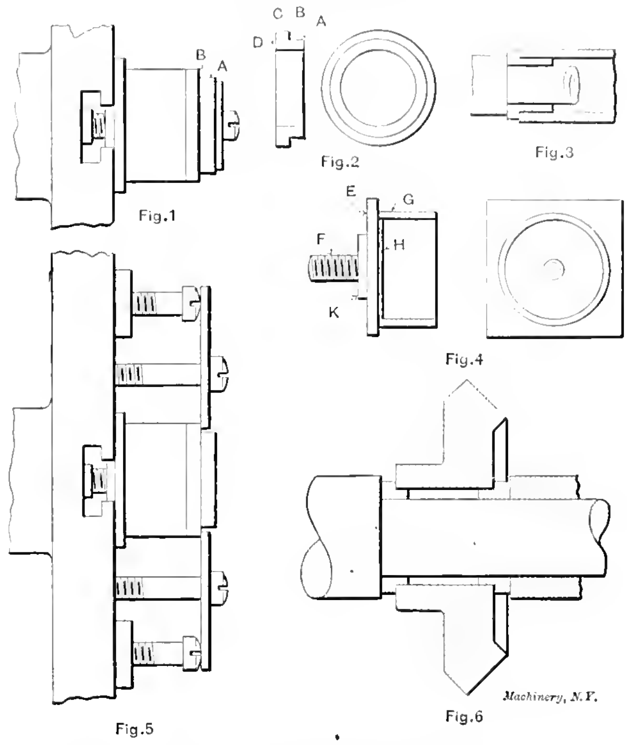
a cast-iron base and may be moved anywhere and attached to an electric light socket, and it is ready for use. The engraving also shows a very good way of using a large reading glass. The mount for this, of course, being movable.

Decatur, Ill. ETHAN VIALL.

SMALL ACCURATE FACE-PLATE WORK.

Not long ago I had some soft steel bushings to make, as shown in Fig. 2, where the part A was to be concentric with the hole, and the faces B and D flat and parallel, and square with the hole. The part C was not particular, and was left with the finish of the original surface of the cold rolled shafting of which they were made. There were four sizes of these bushings, and only two of each size to be made. They were to be put on milling machine arbors used for holding bevel gear blanks when cutting the teeth, as shown in Fig. 6, thus making each size of arbor do for more than one size of hole. I wanted to make a rather accurate job of them, and not let an error of over 0.0002 inch creep in, if I could help it. As this is not an unusual type of job, I thought a few simple fixtures could be made that might afterwards be used on similar jobs where considerable accuracy was required.

For ordinary work these bushings would be turned on an arbor between centers, as the holes were standard sizes, but I thought a more accurate job could be done on the face-plate of a bench lathe, so that was the way I adopted. My draw-in chuck for the bench lathe was fitted some time ago with a



Miscellaneous Views showing Piece to be machined, its Use, and Method of holding to Face-plate.

reducer and auxiliary draw-spindle to take the smaller sized chucks of a watchmaker's lathe, and I found that by taking out the main draw-spindle and putting in the auxiliary draw-spindle alone, the front end of it fell a little short of coming through to the front of the face-plate, so I made a bushing as shown in Fig. 3, making the hole to fit over the auxiliary draw-spindle, and the outside of the bushing to fit the back end of the hole in the lathe spindle. This bushing kept the auxiliary draw-spindle central, and gave it a shoulder to work against. The piece shown in Fig. 4 I have called a false face-plate, for want of a better name, and of these I have three different diameters at present. E is made of square brass rod for the small sizes, and thick sheet brass for the larger sizes. It has a round hub K turned on the back that is an easy fit in the regular face-plate. There is a hole tapped all the way through E the same size as the threaded part of the auxiliary draw-spindle. The steel stud F is threaded its entire length, screwed through E, and sweated and riveted tightly into it. The front end of F has a small hole tapped in it, while the front end of E has a boss turned on it which is an easy fit in the bore of the short piece of seamless brass tubing G which is sweated fast to E. In use, the false face-plate is held tightly against the regular face-plate by the auxiliary draw-spindle taking hold of the stud F, and a light cut is taken over the outer face of G just before clamping the work on it. This gives a face-plate that is easily trued up just before using, and on which work may be clamped either by four clamps on the outside or by a large washer and screw inside. The bushing shown in Fig. 2 was first held in a cast iron step chuck, bored to size with a slide rest tool, and D was faced, after which the shoulder was roughed out on an arbor between centers. The bushing was then lightly held against one of the false face-plates by a screw and washer, as shown in Fig. 1, and shifted about until it ran

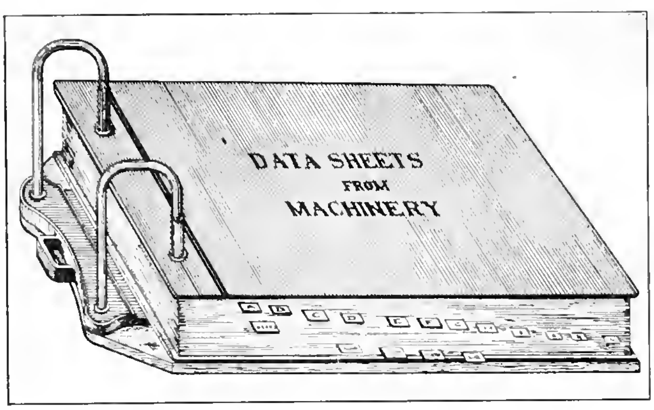
approximately true, after which four clamps were arranged around the outside, one for each T-slot; two of these clamps are shown in Fig. 5. The central screw and washer were now removed. This gave free access to the hole, and a dial indicator applied to the bore told when that ran true. Then the outer clamps were tightened and another look was taken at the indicator to make sure that nothing had shifted during the final tightening of the clamps, after which the central screw and washer were replaced, screwed home tightly, and the outer clamps removed, which gave free access to the outside, so the diameter *A* and face *B* (Fig. 2) could be turned.

Of course, in doing work in this way, only light cuts can be taken, for a heavy cut might cause the work to shift. The brass tube *G*, Fig. 4, is a piece generally taken from the scrap box. After considerable use, tube *G* will be gradually turned off until the outer end is about flush with the front of *H*. When this occurs, the remains of *G* can be "soldered off," as a Teutonic friend of mine used to say, and another piece of tubing soldered on in its place, thus giving the device a new lease of life. *G* is made of brass because it solders easier than steel, and also because a more accurate cut can be taken from brass, as less pressure is required to keep the tool to the work. The lack of durability is of no importance, as the working face of *G* is supposed to be trued up immediately before using. WALTER GRIBBEN.

Brooklyn, N. Y.

FILE FOR MACHINERY'S DATA SHEETS.

The accompanying engraving illustrates a scheme which I have found very useful for filing and indexing, in a systematic manner, MACHINERY'S data sheets. An ordinary arch file is used, small, rectangular pieces of paper pasted at the edge of the data sheets being used for indexing purposes. In the



Convenient Method of filing Machinery's Data Sheets.

front of the file is placed the alphabetical index of contents supplied with the data sheets, and in addition to this index I have a supplementary alphabetical index for the sheets that arrive from month to month. This gives all the advantages of a loose-leaf notebook, permitting new sheets to be conveniently added and indexed. SAMUEL G. ARONSON.

Philadelphia, Pa.

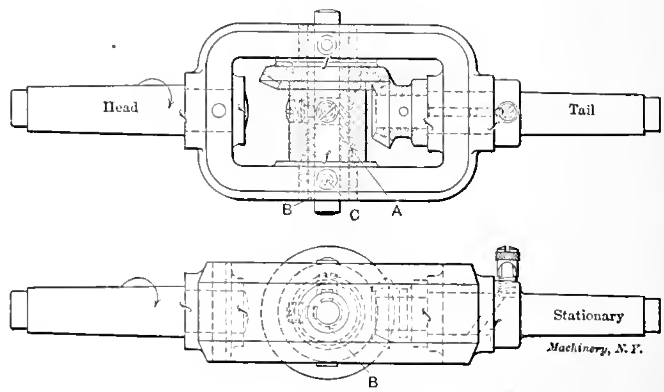
DOES PREMIUM WORK ALWAYS PAY?

The writer asks the question, Does premium work always pay? because of a case which recently occurred in the factory where he is employed. One of the articles manufactured consists of drawn steel pieces from which the bottom end is cut off after the drawing process. The shape of the drawn part or cup is elliptical, the long axis 3½ inches, the short axis 2 inches, and the thickness of the metal 0.109 inch. The operation of cutting off the bottoms from these cups is performed on a plain milling machine, using saws made from Novo high-speed steel, the saws being about 8 inches in diameter and ¼ inch thick. While being cut off, the pieces are held in a fixture, and a single movement of the lever locks or releases them, so that very little time is consumed in putting them in the machine and taking them out.

The rate fixed for the cutting off of these pieces was 50 per hour, and a bonus was offered at the rate of ¼ of a cent for each additional piece. Recently one operator cut off 2,050 pieces in a day of 10 hours. This, of course, looks all right on the face of it, but in doing so he dulled three saws, and it takes four hours' work for the tool-maker to recut one of them. Therefore, the point I raise is this: Is it profitable to allow a man to work the tools beyond their limit of endurance in this way? It is actually costing more to do the work at this speed than it would working at the speed at which the saws would stand up to the work for a longer time. W. ALTON.

GRINDING FIXTURE FOR END MEASURE RODS.

The fixture shown in the illustration was made to grind spherical end measuring rods 3 inches long, and over. There were three diameters of these rods, ⅜, ½ and ⅝ inch, and three sizes of fixtures were also made to suit. Steel sleeves *B* were made of various lengths for each fixture, to stiffen the rods near the end when grinding. These sleeves had a bearing at each end in hardened bushings which were driven



Fixture for Grinding Spherical End Measuring Rods.

into the fixture body. The sleeves were kept from turning and from sliding endways, independently of the gear, by the tit-screws shown. These screws, in addition, held the rod being ground. Member *A* was a tight fit in the large bevel gear, being made separate to allow of cutting the gear teeth. The flush oilers *C* were placed on opposite sides of the body, so the tendency to throw oil would be done away with as much as possible.

A feature apt to be overlooked is that the numbers of teeth in the two gears must be prime to each other. If not, every certain number of revolutions, depending on the gears used, the wheel will grind into one of the previous cuts. The fixtures were arranged to be used on a bench-lathe, with a tool-post grinding fixture.

Brooklyn, N. Y. G. R. RICHARDS.

VALUE OF COOPERATION.

In a drafting-room in which I have been employed, there were five draftsmen, including myself, and being interested in many technical magazines and in the habit of subscribing for them, I thought of a method by which I could benefit my fellow draftsmen as well as myself. I proposed that we each give 25 cents a month, and, when a sufficient amount was obtained, subscribe for one of the many technical magazines. In this way, at the end of a year, we had a total of $15 worth of magazines at a cost of only $3 a person. The magazines that we subscribed for were: MACHINERY, *American Machinist*, *Industrial Magazine*, *Popular Mechanics*, and *Engineering News*. We made the agreement that if any of us left at any time we should waive all claim on the magazines and leave them as the property of the office, the inference being that we received our money value in the number of magazines we each had an option on for the time we were employed, and for the money expended. If this cooperation was instituted in large drafting-rooms where there are from ten to twenty-five or more draftsmen, one can readily see how much could be collected and how many magazines could be subscribed for. There would soon be established a small library of magazines, which, if kept properly indexed, would form the foundation of a valuable information bureau, which I think the employers would not object to providing a space for, and they might even

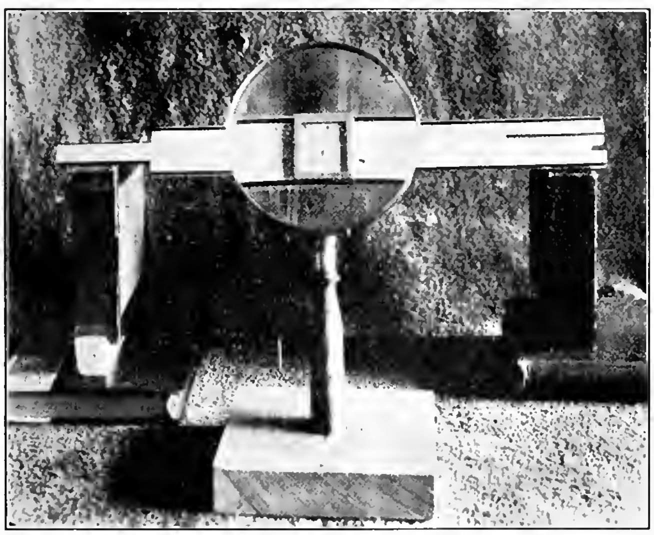
cooperate in the matter. This method could also be instituted in the machine shop, and where there are from one to two or three hundred men they would only be required to give 10 cents a month. The management could be placed in charge of a committee who would take care of all money and the necessary details. It is surprising to see how this idea will develop, and the enthusiasm felt among the men. I have never seen this method in operation except in the drafting-room where I was employed. It is a case where an investment is repaid many fold, and shows the value of cooperation.

Roxbury, Mass. WALTER J. BITTERLICH.

[It is quite evident that the cooperative scheme which has been suggested is not as valuable as it might appear on the surface. Of course, a number of publications can in this way be secured at a low cost per capita, and, in time, there would be a valuable collection of technical literature which would be useful for reference purposes, but, unfortunately, draftsmen and mechanics are not in the habit of staying in one place a lifetime, and consequently the firm alone would be permanently benefited. The man who does not file a technical publication for which he subscribes loses a large part of its value, and while the cooperative method enables him to see a number of good magazines, he is deprived of their use as soon as he goes to work elsewhere. For this reason we believe that it is better to subscribe outright for one first-class technical paper than to have a part interest in half a dozen.—EDITOR.]

READING THE SLIDE RULE ACCURATELY.

A simple device for reading the slide rule more accurately than can be done with the naked eye is shown in the accompanying photograph. The magnifying glass is set in a base,



Stand with Magnifying Glass for Reading the Slide Rule accurately.

as shown, at an angle of 60 degrees. The base is of wood 4¼ inches square and ⅞ inch thick. I have found this a very convenient method for getting closer readings.

Lockport, N. Y. C. H. CORNES.

METHOD OF LEVELING A LINE SHAFT.

We once had a job of putting up a line shaft in a long building, and it was quite necessary that the bearings should be level. There were no engineering instruments about the plant with which to level the shaft, and it was thought that a long wooden straight-edge with an ordinary level was not accurate enough. We were about 400 miles from home and in a small town where we could not get an engineer's level, and were at our wits' end to know what to do without sending to our factory for, or renting one from the nearest city, about 25 miles distant.

We finally got a length of ½-inch hose about 20 feet long, and fastened a regular boiler gage glass to each end. Then we poured in water until it showed about half way up in either gage. One gage glass was then held with the water level at the required height of the center of the shaft and the next hanger set with its center even with the level of water in the other glass. This gave us a very accurate way of setting our brackets, as we had practically a U-tube 20 feet between glasses. When our line shaft was put up, it worked splendidly, and we never heard any complaints.

This was the first time I had ever heard of such an apparatus being used, but there is no reason why it could not be used for getting levels for setting new machinery, piping, or, in fact, anything where the distances are at all long between supports. It can also be used to set shafting at the same level in different rooms, around a corner where the view directly across is obstructed, or in almost any place imaginable. JULIAN D. PAGE.

Youngstown, O.

METHOD OF ACCURATE DRILLING.

Although much time can be saved by the use of drill sockets so constructed that drills can be slipped in while the spindle is revolving, the work does not always come out satisfactorily accurate unless the bushing in the jig is exactly central with the drill spindle. In the shop where the

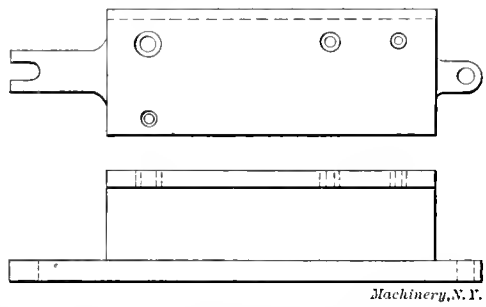


Fig. 1. Outline of Jig for which Jig Plate in Fig. 2 is used.

writer is employed, such sockets are used almost exclusively, but trouble has been experienced with the holes not always being in alignment.

To overcome this trouble, a jig plate, such as is shown in Fig. 2, was made for the jigs, and the work comes out much better, and fewer drills and reamers are broken, because this jig plate makes it possible to have the bushings for each hole, when drilled, in perfect alignment with the spindle. Fig. 1 shows a lay-out of a jig used in drilling exhaust rockers for small gas engines. All the holes are reamed, removable bushings being used for this purpose. The jig is cast with an extension at each end on the bottom side. One of these extensions is slotted, and fits over short pins, shown at A, A_1, A_2 and A_3, Fig. 2. The other end has a hole, to take a taper pin, which enters into the holes A',

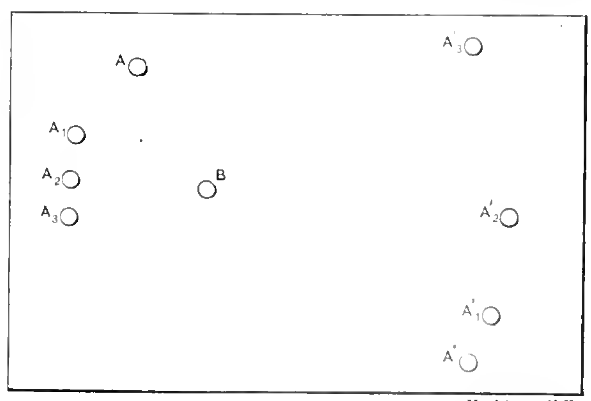


Fig. 2. Jig Plate used for Locating Jig in Fig. 1 on Drill Press Table.

A'_1, A'_2 and A'_3 in the plate, when the slotted end has been placed with the corresponding pin on the other side of the jig plate.

These pins and holes are so located that the jig, when placed between correspondingly located pins and pin holes, will be held in such a position that one of the bushings in the jig will be exactly in line with the drill spindle, provided the plate is originally clamped on the drill table correctly, so that the position of the small hole B is exactly in line with the center of the spindle. When this plate is in use, the jig is first put on the plate with the pin A en-

tering the slot, and the hole in the other lug of the jig is placed over hole A', and the taper pin put in to hold the jig in position. The corresponding hole in the work is then drilled and reamed. The jig is then changed so that the slot in the lug fits over pin A_1, and the taper pin in the other end of the jig is changed to the location A_1', the second hole then being drilled and reamed. In the same manner, any number of holes may be drilled. Jigs with holes at right angles to each other must, of course, have lugs cast on two sides. In the engraving, no binding devices have been shown, as it is not necessary to indicate the design of the jig itself in order to explain the principles of this jig plate.

Y. ZIEGLER.

RACK FOR CHANGE GEARS.

The way we mount change gears in our lathe legs is illustrated in the half-tone and line engraving. There are two lugs cast in the leg, and the change gears are held on a steel rod

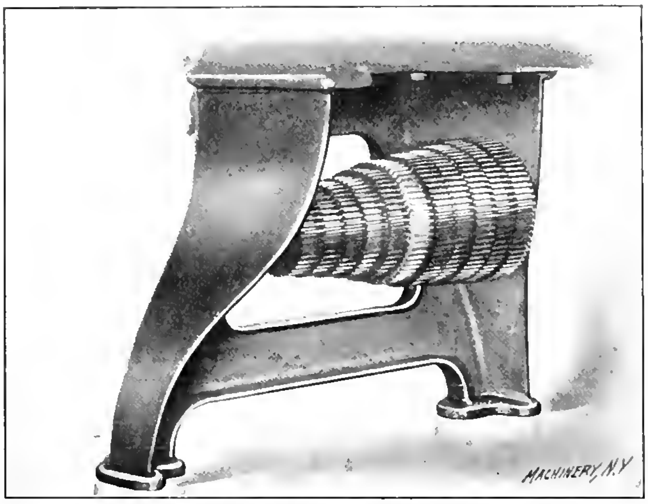
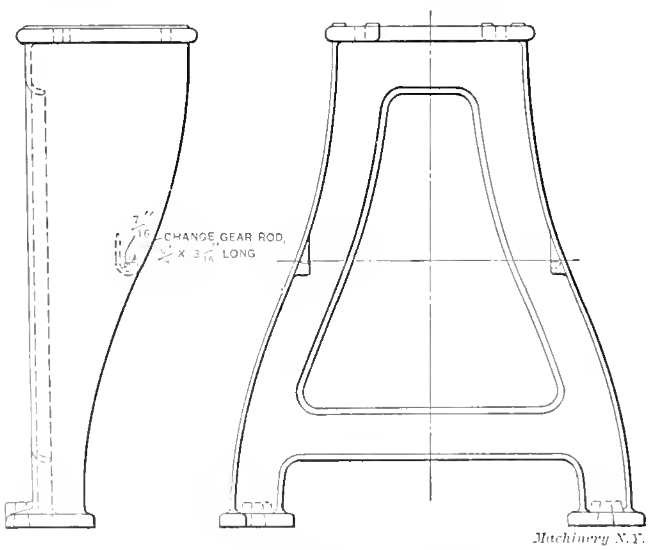


Fig. 1. View showing the Change Gears stored beneath the Lathe.

which hangs on these lugs. This makes a very convenient method of keeping the gears clean and at the same time in position where they can be quickly taken off for use. This scheme is new to me, and I thought that perhaps some of the



Lugs for Holding the Rack in Place.

readers of MACHINERY might use this device on their lathes. Of course, they could bolt little hooks to the legs instead of casting lugs on them as we have.

WM. F. GROENE.

Cincinnati, O. R. K. Le Blond Machine Tool Co.

OBTAINING THE HEIGHT OF THE MIDDLE ORDINATE OF AN ARC.

In the March issue F. M. S. gave a method for finding the length of the middle ordinate of a circular arc, given the chord and the central angle. The Editor's note remarked the fact that there are three operations in the solution, of which two are divisions. It was also, and very justly, stated that it is generally easier to multiply numbers than to divide them. By a slightly different method it is possible to reduce the operations to two, of which one is still a subtraction, and the other is a multiplication. The rule given by F. M. S., written as a formula, says:

$$h = \frac{C}{2 \sin x/2} - \frac{C}{2 \tan x/2} \quad \text{where}$$

C = length of chord,

h = length of middle ordinate,

x = central angle.

Substituting for $\sin x/2$ its equal $1/\operatorname{cosec} x/2$ and for $\tan x/2$, $1/\cot x/2$, the equation becomes

$h = C/2 \operatorname{cosec} x/2 - C/2 \cot x/2$, or putting $C/2$ outside a parenthesis,

$h = C/2 (\operatorname{cosec} x/2 - \cot x/2)$, or, expressed in words, the height of the middle ordinate equals the difference between the cosecant and the cotangent of half the central angle, multiplied by half the chord length.

New York. H. S. QUACKENBUSH, JR.

SELF-OILING MACHINERY.

It is always somewhat dangerous to differ with an editor, but to go against an editor and against self-oiling machinery at the same time is a piece of pure devilish recklessness. However, human nature is such that recklessness appeals occasionally even to the most timid, and this, in short, is the reason why I am trying to lift my voice in protest to your editorial under the above heading in the July issue.

Self-oiling machinery is very nice. There is hardly anything in the whole machinery line which can so easily be talked up, and for that reason alone it deserves the appreciation of machinery salesmen if of nobody else. Like a great many other things, the trouble comes afterwards. If I had a shop of my own and a lot of self-oiling machinery in that shop and also an oil-can, I would send the first man I hired for that oil-can and have him go carefully over the self-oiling machinery. Of course, I know that a great many of the most improved steam engines, air-compressors, pumps, and other machines, are made self-oiling. But one should not forget that there is a man in charge of this machinery whose main duty it is to inspect the machinery, practically speaking, constantly, and if anything goes wrong with the self-oiling system, the man is there with an oil-can ready to take the place of the automatic device. If things were arranged in the same way in the machine shop, I would not object so strongly, but this would mean that there must be a man going constantly from machine to machine, inspecting not only the self-oiling device, but especially the gears, bearings, shafts, and so forth, and who must be ready to oil the machines or any parts of the machine if the oiling mechanism has broken down.

Of course, the salesman may tell you that there is really no possibility of the self-oiling system breaking down, but you and I who have been "up against it" know better. We know that there is nothing in this world, and especially in a machine, that will not break down occasionally. The oil-pump may break, or may wear, or spring a leak, the oil pipe may get clogged up, a bug may be forced in one of the pipes, and a thousand other things may happen which temporarily throw the oiling system out of commission, and there is no way of finding it out except when the machine stalls on account of a hot bearing.

From the above, it may seem that I am in favor of having every machine operator hover all the time over his machine, looking to the left and squirting oil to the right, but this is not the case. Personally I am in favor of having the system of oiling machines well regulated; and employing a man whose sole duty it is to look after the oiling of the machines, and to see that the man actually oils the machine and not the floor space around it. And I would have one or two or three men according to the size of the shop, doing this work, become expert at it, and be held responsible for every hot bearing in the place, and as I said before, if I had self-oiling machinery I would have the man just the same.

There are certain advantages connected with self-oiling machines in a power plant, which recommend this arrangement,

but if the engineer in charge of the plant ever gets into the habit of thinking that the automatic oiling arrangement will do the work and that he can read his newspaper in peace, he will soon find out in which corner trouble brews, and it will not be very long before his name will be known no more in that power plant. The main advantages are: saving of oil, uniform, constant, and abundant lubrication. In fact, the main advantage is the flooded lubrication which cannot possibly be given by means of the oil-can. As far as machine tools are concerned, these same advantages would be worth a great deal, but they would be as nothing compared with the trouble of the machine stalling, even once, on account of some little defect in the oiling system.

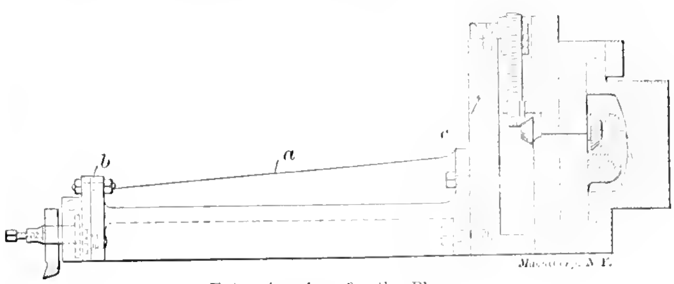
I am not much of a mind reader, but I am willing any time to bet five cents against a nickel that in writing the editorial, the editor had in mind a certain machine advertised in the technical papers mainly for its self-oiling features. The advertisement states that this machine needs to be oiled only once or twice a year, and I presume that the advertisement meant to express the idea that once a year is a good deal better than twice. Now I am of the opinion that to oil a machine only twice a year is bad enough, but to oil it only once is simply horrid. It seems to me that the oil must be so badly deteriorated at the end of a few months that it is absolutely worthless for lubrication, though it may still be good for advertising. Just think of how well bearing No. 6 is lubricated by oil which has been pumped over a lot of bearing surfaces for nearly a year and which carried with it all the grit and dirt and general unrighteousness of the five bearings situated above. And apropos of this machine I notice that the "ad" called the machine self-oiling, whereas in fact, the greater part of the machine must be still treated with homeopathic doses of oil administered by Dr. Oil-Can. I wonder if this same thing would not be the case with practically all machine tools if the so-called self-oiling system were applied to them.

I would like to go into this matter more thoroughly, but this would require more space than I can expect MACHINERY to give when I am hammering at an editorial, and I prefer to call this matter to the attention of the reader and get his opinion. This much I am prepared to say without hesitation: "No self-oiling arrangement for me, except where all the parts to the self-oiling system are constantly and absolutely accessible, and are located in such a way as to be readily inspected and repaired; simple means provided for frequent renewals of the oil, and further, no self-oiling arrangement unless there are also the old-fashioned means for oiling in the old-fashioned way with the old-fashioned oil-can.

Cincinnati, Ohio. A. L. DELEEUW.

EXTENSION ARMS FOR PLANING WIDE WORK.

The article in January issue of MACHINERY entitled, "How a Large Casting was Planed on a Small Planer" recalls to the writer's mind his experience in planing a somewhat similar casting on a 24 x 24-inch Gray planer a few years ago. The



Extension Arm for the Planer.

overhanging end of the casting was guided by rollers in the same manner as was the casting referred to in the January issue, but the length of the surface to be planed in the direction of the planer travel was so great as to necessitate the use of an extension arm on the planer cross-head. The accompanying engraving shows the design of the arm. This design is not original, but is merely one of those old ideas which need to be resurrected occasionally, in order that the rising generation may have the benefit of past experience. These arms, or extension heads, as some mechanics would call them, may be constructed with so little expense that there is small excuse for the bent forgings that are sometimes used instead. The writer found use for two, one about 10 inches long, and the other 20 inches long. The pattern may be produced very quickly as follows: Glue together three boards in the form of an inverted rectangular trough, using boards about ⅜ to ⅝ inch thick, and of suitable length to answer for the job in hand, or any prospective job of reasonable dimensions. The width of the trough should be about equal to the width of the rectangular part of the clapper-box, and its depth may be about the same as the depth (vertical dimension) of the latter. The trough should be closed at the two ends with rectangular pieces about ⅞ to 1⅛ inch thick, and of such width and length as will give ample room for the bolts, as indicated in the engraving. If the pattern be parted in the plane of the top surface of the trough, a light rib *a* will hold the loose pieces *b* and *c* together, and at the same time add strength to the casting. But if the upper portion be given plenty of taper, the cope may be lifted without making the pattern in two parts.

The work of machining the casting is as simple as that of making the pattern. The two ends may be faced in the lathe, on centers, and they should be marked for drilling by the holes in the clapper-box. The bolts which are ordinarily used to hold the clapper-box to the vertical slide will serve to hold it to the outer end of the arm, other bolts being used to secure the arm to the slide. W. S. LEONARD.

Atlanta, Ga.

INFORMATION FOR CUTTING SPIRAL GEARS.

The engraving shows a facsimile of a blue-print blank which I have found to be very handy in giving information to milling machine hands when cutting spiral gears. As will be seen, all necessary information concerning both gears and

Mach. No. 60	Part No. 60-109	
Open Hearth Steel	100 Gears	
	100 Pinions	
For:- October 13. 1908	Gear	Pinion
No. of teeth	20	17
Pitch dia.	2.857"	2.428"
Blank	3.101"	2.672"
Angle of teeth with axis	30°	30°
Normal cir. pitch	.3885"	.3885"
Pitch of cutter (dia.)	8.086	8.086
Depth of tooth (D"+f)	.2654"	2654"
No. of cutter	4	4
Exact lead of spiral	15.543"	13.211"
Gears on Milling Mach. to cut spiral	B&S Mill. Mach.	
Gear on worm	64	72
1st. Gear on stud	32	24
2nd. " "	56	44
Gear " screw	72	100

Card giving Information for the cutting of Spiral Gears.

pinions is given, together with the required change gears for the machine. In this way all confusion is avoided and the work facilitated. L. H. GEORGER.

Buffalo, N. Y.

PATENT RIGHTS IN TECHNICAL DESCRIPTIONS.

I wish to say a few words regarding a practice which seems to be increasing in the technical press, and that is the growing custom among writers of illustrating and describing patented tools or other articles without mentioning the name of the patentee or maker, or without referring in any way to the fact that they are patented. Not only is this practice an injustice to the inventor or manufacturer because of not giving credit for what he has done—corresponding to plagiarism in literature—but it tends to break down the little protection now afforded by the patent laws. It carries to the mind of the reader the impression that there is no patent on the article described. This is not fair to those who have spent time and money in developing an article and placing it on the market.

An illustration of this practice is found in the July issue of MACHINERY in the article "Special and Adjustable Taps" by your associate editor, Mr. Erik Oberg. Fig. 9 shows the Pratt & Whitney method of securing the blades in its expanding reamers, and Fig. 10 shows the way the inserted blades are held in its large milling cutters. Both of these constructions, I understand, are covered by unexpired patents.

Cleveland, Ohio. J. G. MATTHEWS, Cleveland Twist Drill Co.

[It is not practicable for the editor of MACHINERY to investigate the status of patent rights on all the tools and devices illustrated in its columns. In fact, it is difficult enough for a court of law to decide these perplexing matters, oftentimes. To avoid complications we generally ignore patent rights, leaving them to the investigation of parties interested in the manufacture and sale of the device shown. Scrupulous and prudent manufacturers would not engage in the making of any tool or device without knowing its status in the patent office, while the unscrupulous are not likely to take much heed of the warning "Patented ———" if they think an infringement can be successfully made and sold without prosecution. In the case referred to by Mr. Matthews, the fact that the reamer construction is patented was mentioned in the article "Adjustable Reamers and Taps with Inserted Blades," July, 1907, this article being referred to in the July, 1908, issue. Our contributors will confer a favor by always mentioning the status of patent rights on devices described, if known to them.—EDITOR.]

LAPS AND LAPPING.

I sometimes wonder why we do not see more printed matter on laps and lapping, especially on rotary laps, how to charge them, and their construction. Some time ago I spoke to a very competent tool-maker who was a fellow workman in the tool-room, in regard to laps, and when I mentioned a rotary lap he wouldn't believe that accurate work could be done on such a contrivance without jabbing the corners into the lap or spoiling the edges of the work; and he also stated that he had not seen any, and had been employed in some of the best shops in the country. Well, he had a knife-edge square

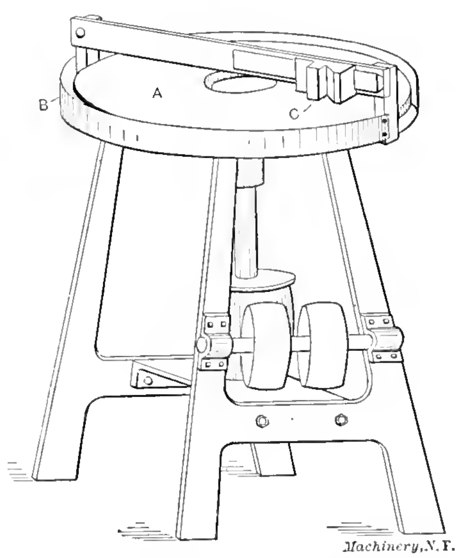


Fig. 1. The Rotary Lap.

that he had lapped on a hand lap, and I had a knife-edge square that I had lapped on a rotary lap, and we found that one was as accurate as the other.

In a small shop where I learned how to use laps, we had a rotary and a hand lap. The rotary was 24 inches in diameter, and the speed about 300 revolutions per minute. The hand lap was about 18 by 20 inches. The engraving, Fig. 1, will give a clear idea as to the construction of the rotary lap. I have found that some men who have used laps have an idea that they should be made with grooves and checks, which I think are fallacies, for I have proved to my own satisfaction that they are not essential for keeping the surfaces from filling with "bird's-eyes." Again, I have noticed that some men think that if the lap has a true, flat surface, anyone can produce true work, but such is not the case; it requires considerable skill, and that skill can be acquired only by trying it yourself. Many machine operations can be shown to another person and the principle grasped readily, but not so with lapping. I know that on many occasions I had the boss show me how he did the lapping, and yet, when I went at it, I could see that there was something that I had to feel and experience for myself. The boss used to say, "You must get in touch with your work." A great deal of skill is required in lapping thin pieces, small straight-edges or long narrow bars. It is possible, and requires no skill at all, to lap a thin piece of steel, convex or concave, by using a little more pressure in one place than another, and if the surface of the lap is not kept sharp it will soon heat and warp the work out of true. I have used soda water, but find that kerosene and gasoline used together give the best results; the hand lap I always used dry. Keeping the surface of the rotary lap straight and true is very important and requires good judgment in using it. The outer edge runs so much faster than the inside that it is obvious that if it is used too much, either in the middle, inside, or outside, hollow places will be worn in the surface, so that it is a good plan to use the lap all over and try the surface frequently with a straight-edge, favoring the high places when using it.

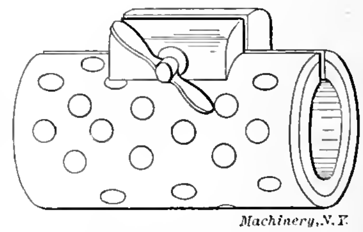


Fig. 2. Lap for Cylindrical Work.

The rotary lap is charged by sprinkling carborundum over the surface when not in motion, and then pressing it in by rubbing with a piece of round iron held in both hands. An old pepper box with a perforated top is just the thing to use for sprinkling the carborundum. The lap I used was made of an ordinary cast iron disk *A* (Fig. 1) with ribs on the bottom and anchor grooves on the top. It is also provided with a hub and a shaft. The end of the shaft supports the whole weight of the lap and runs on a hardened convex disk. A coating of lead is cast over the surface of the lap, and then hammered to make it compact. A galvanized iron pan *B* is provided, the edges of which project above the surface of the lap to prevent the liquid, or whatever is used, from flying off, and onto everything around. Another handy device on this lap is a bar which is provided with ways and a sliding head *C* which can be pushed from the outer edge to the center of the lap. The bar is fastened to lugs which project on opposite sides of the frame, and can readily be removed when not in use. The bar is also provided with adjusting screws to set it parallel with the surface of the lap or to set the sliding head square with the surface. The sliding head has a square corner and an angle groove which can be used for lapping the ends of round or square pieces. I faced the disk by belting it to the slowest speed of the drill press. A piece of self-hardening steel, for a tool, was clamped on the sliding head, and a threaded ¼-inch rod fastened so that it would work through a stationary nut, and by turning the screw slowly, the tool was fed across the disk.

The engraving Fig. 2 shows how I usually make a lap for cylindrical work in the lathe. A piece of wrought iron pipe about 2 inches long, with a number of 5/16-inch holes drilled through will answer the purpose. Face one end of the pipe so that it will stand level on a surface plate; wrap a piece of heavy paper around the outside, using rubber bands to hold it on, then form a square with pasteboard and clamp that on any side of the pipe so that several of the holes open into it; secure a mandrel the same size as the piece to be lapped, twist a piece of string in a spiral around the mandrel, insert it in the center of the pipe, and we are ready to pour the molten lead in. When cool, drive out the mandrel and proceed to drill and tap a hole for a thumb-screw in the center of the lug; then slit one side through the center of the lug with a hack saw, and file off all sharp edges and burrs so that it will not injure the hands. In lapping, the faster the lap is drawn back and forth over the work the more nearly

straight it will be, and as the lap wears and works easy, the thumb-screw is given a slight turn to keep it in contact with the work. I always had considerable trouble with "bird's-eyes" forming on spindles when lapping them, and found that by draw-filing the eyes a little they would disappear, and the frequent scraping of the bright spots in the lap will help immensely. In using flour of emery, I found that by putting a small quantity in a bottle half filled with machine oil, I could get the coarsest emery by dipping a swab down to the bottom, or finer by shaking the bottle a little and using the oil only for finishing, as the coarser particles sink to the bottom while the finest particles are held in suspension in the oil. Taper lapping is very difficult and requires a great

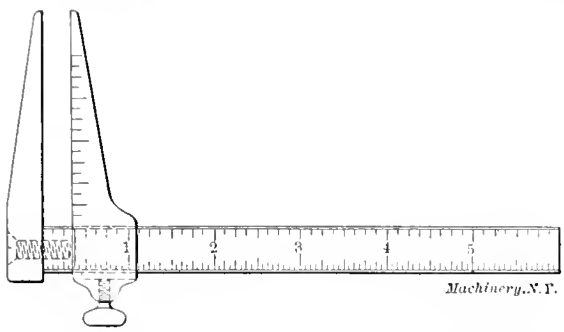


Fig. 3. Tool used when Lapping for Sizing Duplicate Parts.

deal of care. The cast iron lap must be constantly trimmed, kept straight, and the taper the same as the desired taper in the piece being lapped; it must also be kept well lubricated and not be crowded any. A very handy tool, which is shown in Fig. 3, is almost indispensable in doing work with the rotary and hand laps; it is a home-made caliper square. The taper between the hardened jaws is 0.001 inch in the whole length, and a 6-inch flexible scale is inserted in the beam. One jaw is graduated, which enables one to see how far the piece will slide up in the jaws. This caliper is not used so much for accurate measurements as for accurate sizing for parallelism or duplicating sizes.

Minneapolis, Minn. A. J. DeLille.

PATENTS AND INVENTORS.

In an article in the June issue, Mr. E. C. Smith makes some statements to which the writer permits himself to take exception. Mr. Smith seems to think that the inventor has no proprietary right to his own invention, except in as far as the government grants it to him. However, that the right of ownership of an invention exists independently of the government, cannot be questioned; the inventor owns his own invention because it is his; he may or may not be able to enforce his claims. About 1843, Henry Bessemer invented a mechanical process for making bronze powder. His finished powder cost him less than $1.50 per pound, and he sold it for $20 per pound, making over 1,300 per cent profit. He kept the process a secret for thirty-two years, and collected profits at the above rate for that time. Did he own the invention, or did he not? If he did not, who did?

Most inventions are not of such a nature that they can be kept secret, but the question of ownership does not change. Had the Bessemer process been patented, and thrown open to the public at the end of 14 years (length of English term), the users of bronze powders would have been saved expenses amounting to many hundred thousand dollars. From this instance, the enormous value to the country of inventions, the patents of which are expired, may be estimated. Other inventions just as important are thrown open to the public every year.

In my previous article published in the March issue of Machinery, I stated that some of the examiners were incompetent. Mr. Smith says: "To me the showing is not one of incompetency, but of exceptional merit under adverse conditions," but then in the next sentence he says: "The commissioner states that the work of some of his force is frivolous, and otherwise lacking in essential qualities." I certainly believe that the patent office staff is working under exceedingly adverse conditions, and that there is fine work being done by many good men on it, but these good men are so handicapped by the congested state of the work and surrounded by so many men who are not as competent, that the quality of the work in general is far below what it should be. The adverse conditions referred to ought to have been changed long ago.

Large companies, as a rule, do not find much complaint about the conduct in the patent office, for the reason that the present practice suits the corporations quite well. They do not object to long postponed divisions of applications, or continual dropping of old and bringing forward of new references, because the longer the delay the longer is the effective life of the patent, but these things make a great difference to the ordinary applicant. They mean a difference of loss or gain of time of several months.

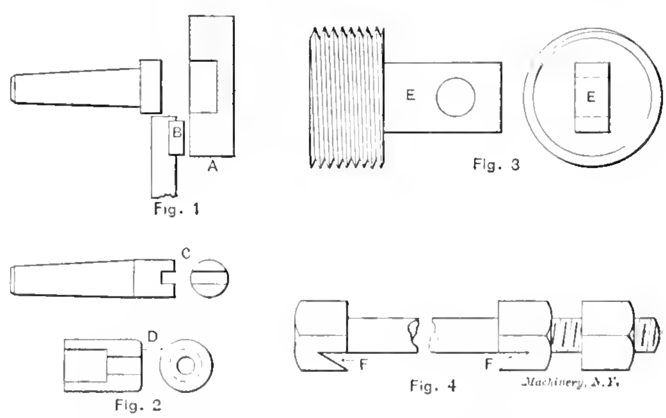
Reasons have been put forth why delay in a patent application would be advantageous to the inventor, due deliberation being preferable to undue haste, but when, as now, each application receives "due deliberation" resting in a pigeonhole in the patent office for several months, it is difficult to see what value it adds to the examiner's action in the case when he eventually reaches the application and is so pushed for time that he cannot go thoroughly into the matter, because he must hurry on to the next case. It is a mistake to suppose that a long delayed application gives the inventor a chance to further develop his invention, and fortify his case if his original claims are inadequate. The patent office rules prohibit the adding of material to a pending application.

The whole underlying cause of complaint against the patent office may be expressed in a few words—lack of money. Without sufficient help, congestion of work and delay in action is inevitable. Were it not for the delays, patentees would not find the mistakes of which complaints are now made, so unbearable. If the office were in such condition that applications would not be delayed more than two or three weeks at each action, it would not be necessary to find fault, but under the present system when actions occur at intervals of from six months to a year, there is entirely too much time wasted.

Toronto, Canada. H. Addison Johnston.

A FEW HANDY KINKS.

A number of pieces, as shown at *A*, in Fig. 1, were to be finished true all over, and, as the hole did not go clear through, an ordinary arbor could not be used, so the following scheme was devised: A piece of machine steel was turned to fit in the lathe spindle and the end made a press fit in the hole in the work. After being pressed on by the



Figs. 1 to 4. Miscellaneous Appliances for the Lathe.

tail-stock and turned up, the piece was taken off as follows: The tool was reversed in the tool-post, and a piece of lead placed between the back of the work and the tool, as at *B*, and the lathe started up. The heat generated by the friction of the lead against the iron caused the latter to expand and drop off in a very short time without marring the work in the least.

The method described in the January issue of Machinery for holding a reamer, calls to mind a handy device for a tap-holder. A piece of machine steel is fitted to the tail spindle and has a slot cut through end *C*, Fig. 2, the width of the tap's square. The piece *D* of cast iron is bored at one end a press fit for the end *C*, and the other end is a loose fit for

the tap's shank. This device prevents the tap from turning, and keeps it in line with the hole, even if the tail-stock is not kept up tight against it.

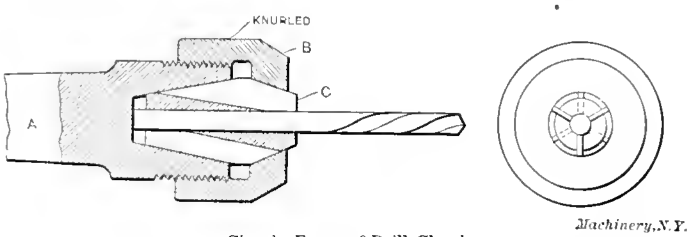
In setting a taper attachment it is very hard to get it exactly right and to get the work perfect. It is a good idea to move the tail-stock over a very small amount, and the screws make a very fine adjustment. If a thin collar is shrunk on the front tail-stock screw and then graduated, it makes a handy micrometer for setting the tail-stock accurately.

Some time ago we had several awkward and heavy jigs to fit to the lathe spindle and in order to make them a good fit without relying on calipers, we laid a face-plate on a block and filled the hole with babbitt, having the flat bar of iron *E*, Fig. 3, in the center to turn it out by. In this way a very satisfactory templet was made.

A stop for the lathe cross-slide can be quickly made of a bolt, and nut with the thread drilled out, by sawing a piece out of the face of each as shown at *F*, Fig. 4. VIM.

A SPECIAL DRILL CHUCK.

The chuck shown in the engraving is not difficult to make and is useful where there is a great deal of drilling to do with drills of one size. It consists of a taper shank *A* having a fine thread on the outside of the large end, and a taper hole bored in the end as shown. The jaws *C* consist of a piece of steel, one end of which is tapered to fit the hole in *A*, and the other end to fit the taper in knurled clamping nut *B*. A

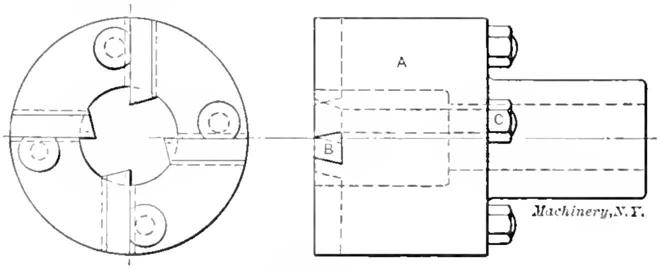


Simple Form of Drill Chuck.

hole is drilled in the jaws *C* the size of the drill the chuck is made for, and from each end three grooves are milled completely splitting the ends of piece *C* into three parts, but the cuts run back on an angle so that metal is left to hold the parts together. The clamping is done by the knurled nut *B*. By making extra jaws *C*, the chuck can be made to take drills of different sizes. W. ALTON.

ADJUSTABLE HOLLOW MILL.

The accompanying engraving shows an adjustable hollow mill which has proved very efficient. This tool consists of a machine steel body *A*, in which four dove-tail slots are cut, into which the four cutters *B* are inserted. These cutters are clamped in place by the taper-headed bolts *C*, which have one side flattened, as shown in the engraving, to permit a rigid



Adjustable Hollow Mill.

hold on the inserted cutter. This tool has stood the test of hard usage very well. It has proved to be practically as rigid as a solid hollow mill, and at the same time, it can be quickly adjusted for different sizes. W. ALTON.

[It will be noticed that the principle of the design of this tool is practically the same as the one employed in the adjustable hollow mills made by the Brown & Sharpe Mfg. Co. In these latter tools, however, there is no dove-tail slot, but the blade is simply bound tightly against the back of a square slot by means of the taper side of the binding bolt, which engages an angular groove in the inserted blade. The hollow mill shown by our correspondent is somewhat more expensive to make, but undoubtedly it permits a firmer grip on the blade, and holds it in position very rigidly.—EDITOR.]

SHERARDIZING OR DRY GALVANIZING.

In the November, 1904, December, 1905, and February, 1908, issues of MACHINERY articles were published descriptive of the dry galvanizing process, discovered and developed by Mr. Sherard Cowper-Coles, London, England. The United States rights for this process have been acquired by the United States Sherardizing Co., New Castle, Pa., and the Globe Machine & Stamping Co., Cleveland, O., has acquired the shop rights. It is to the latter concern that we are indebted for the following description of the process, prepared by Mr. J. Everett Thompson, formerly of the American Steel & Wire Co., and the Jones & Laughlin Steel Co. Mr. Thompson is making a special study of the new process.

The "sherardizing" process of dry galvanizing is applicable not only in all cases where hot or cold galvanizing can be used, but in numberless other cases where they cannot. Briefly, the process consists in packing the articles to be covered with the zinc coating into a closed drum, box or other suitable receptacle in contact with the ordinary zinc dust of commerce. The receptacle is then put into an oven and gradually heated to the required temperature of about 700 degrees F. for a period of four or five hours. The drum is then withdrawn and allowed to cool down to a temperature convenient for handling, when its contents are dumped upon a screen, which allows the zinc dust to fall freely into the chamber below, from which it can be drawn for use again.

The articles are found to be evenly coated with pure zinc, this constituting the entire process. The operation is so simple that the most ordinary class of unskilled labor can be employed without fear of securing poor results. Even the matter of gradually heating up and cooling off is automatically controlled by the fact that zinc dust is a poor conductor of heat. There can be no sudden increase of temperature, as is the case when an article is suddenly plunged into a molten bath of zinc, or the subsequent rapid cooling. Articles do not warp out of shape and even springs are found to retain their temper.

The great superiority of the sherardizing process consists in the fact that in addition to a surface coating of zinc, an infinitesimal quantity of zinc is alloyed into the iron or steel itself and forms a rust-proofing that resists corrosion. This is a very important advantage over the hot galvanizing process. With the latter, in case of a pin-hole, scratch or other abrasion of the coating, a rusting action is set up upon exposure to the elements which in time causes the galvanized coating to peel off. In the case of the sherardizing process, a pin-hole would probably penetrate only to the alloy coating, and no rusting action would take place, but even if the abrasion penetrated through the alloy there could be no possibility of rusting between the zinc coating and the steel.

In many cases, the articles need no special cleaning before being sherardized, but when they do, they are cleaned as is done in ordinary galvanizing. Articles coated with grease or oil take as good, if not better, coating of zinc than those which are free from it.

The extreme evenness of the zinc coating, no matter how thickly it may be applied, preserves sharpness of outline. Screw threads, stamped letters, graduated lines on steel scales are preserved sharp in outline, and if a slight clearance has been given a sherardized nut, it will run onto a sherardized screw as easily and smoothly as if there were no coating; thus no recutting is required. The coating is so smooth and even on parts of fine machinery that they can be assembled after being subjected to the process without requiring filing or fitting.

Numerous other advantages could be mentioned. Articles coated by the process when buffed may be substituted for brass or nickel plated goods; they will retain their color and brightness and can be cleaned more readily than nickel. Since the coating is in the surface and not on it, it does not peel off as the plating is prone to do. It is claimed that sherardized plumbers' fittings are unequaled for finish and durability. Sherardized marine fittings rank next to solid copper and brass in ability to withstand corrosion. A sherardized steel propeller shaft is stronger and will withstand corrosion as well as one made of costly phosphor bronze. Chains treated have remained in sea water continually for nine months without showing any evidence of corrosion.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

HOW ARE HACK-SAW BLADES HARDENED?

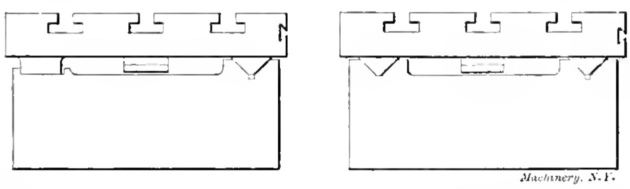
H. G.—How are hack-saw blades hardened in large quantities? Working them one by one as I do now takes too long.

A.—We are unable to give you the desired information. The manufacture of hack-saw blades has been kept pretty well under cover, but inasmuch as there is a number of manufacturers now engaged in making hack-saw blades, it cannot be regarded strictly as a trade secret. We would be pleased to receive a good contribution on the subject from one of our readers.

BEARINGS FOR PLANER PLATENS.

H. U.—What are the advantages or disadvantages in large planers of 8-foot size and larger, having the platen made with two vees, as compared with platens having one vee and one flat way? Which, in general, is considered the preferable construction?

A.—Small planers are built with two vees, not for the reason that two vees are necessarily required for guiding the platen, but largely, we believe, because the weight of a small platen might not be sufficient to hold it down into the vee way when



planing on the extreme edge of a piece located over the flat way. The side and vertical pressures of the tool might be sufficient to lift the opposite side of the platen slightly and push it over, thus causing defective work, whereas if a vee is under the side of the platen where the tool is working, the side pressure effect would be overcome by the vertical pressure, tending to hold the platen in place. On large planers this danger disappears because of the great weight of the platen relative to the pressure of cut and weight of work. The fact that a platen with one vee way and one flat way is easier fitted, and that the combination wears better, naturally causes it to be regarded by many competent designers as the preferable construction for large planers where it can be safely used. We would like the opinions of our readers on the subject.

A PROBLEM IN TRIGONOMETRY.

S. S. Y.—In the accompanying sketch (see Fig. 1) is shown the cross section of a trolley wire, the dimensions and angles being given as shown. I would like to know how to find the dimensions indicated by x and y.

A.—Referring to Fig. 2, we will first solve a problem of this kind having a general application, and will then apply the

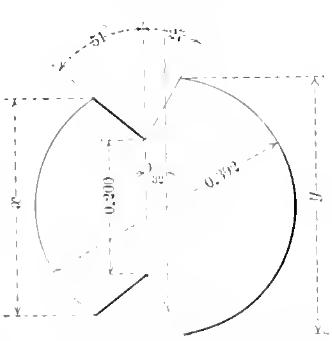


Fig. 1.

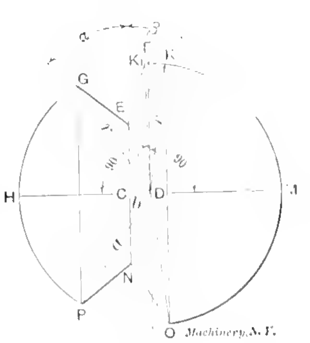


Fig. 2.

formulas we find to the specific case in question. It will be found upon examination, that it is not possible to give a simple general formula, but that it is much easier to solve this problem by taking a step at a time, and finding various dimensions and angles, as we go along. Referring to Fig. 2, it is apparent that to find the distances GP and KO, which are the required distances x and y in Fig. 1, we must find the angles GDH and KDM. When these angles are found, the distances GP and KO are simply the chords corresponding to the angles GDP and KDO, of which the angles GDH and KDM are one-half, respectively. Any handbook will give us the formula for finding the chord when the center angle is given, so that our problem resolves itself into finding this angle.

Let a = the given length EN,

b = the given distance CD, and

r = the radius of the wire = one-half the given diameter.

We have then

$$\tan CED = \frac{b}{\frac{1}{2}a}$$

From this we can find the angle CED, which we will now consider as known. Angle $EDF = CED$, and is therefore also known. Further,

$$ED = \sqrt{\left(\frac{a}{2}\right)^2 + b^2}$$

and angle

$$GED = (180^\circ - \alpha) + CED$$

α, being one of our given angles.

We have now the triangle GED, in which we know two sides ED and GD and the angle GED. The side $GD = r$. We then have

$$\sin EGD = \frac{ED \sin GED}{r}$$

and when we have found the value of angle EGD from this formula, we can find angle GDE from

$$GDE = 180^\circ - (GED + EGD).$$

Furthermore, $GDE + EDF = GDF$, and $GDH = 90^\circ - GDF$. Knowing the angle GDH, we have

$$x = 2r \sin GDH.$$

Applying the same reasoning on the other side of line ED, in order to find the angle KDM, we have:

$$KED = 180^\circ - (\beta + CED)$$

$$\sin EKD = \frac{ED \sin KED}{r}$$

$$EDK = 180^\circ - (EKD + KED)$$

$$FDK = EDK - EDF$$

$$KDM = 90^\circ - FDK$$

$$y = 2r \sin KDM.$$

However, it may happen that the point K does not fall on the right-hand side of the line DF, as shown, but may fall as K_1. In principle, this makes no difference. Only, in calculating the length of the line KO, we use the angle K_1DH instead of the angle KDM. Our numerical calculations will always indicate on which side of the line FD the point K falls, by making angle FDK negative, if K falls as K_1, so that there is no possibility of mistake.

If we apply the formulas, as given above, directly to the case in Fig. 1, our calculations will be as follows:

$$\tan CED = \frac{0.03125}{0.1} = 0.3125;\quad CED = 17^\circ 21' = EDF.$$

$$ED = \sqrt{0.1^2 + 0.03125^2} = 0.1048.$$

$$GED = (180^\circ - 51^\circ) + 17^\circ 21' = 146^\circ 21'.$$

$$\sin EGD = \frac{0.1048 \sin 146^\circ 21'}{0.196} = 0.29629.$$

$$EGD = 17^\circ 14'.$$

$$GDE = 180^\circ - (146^\circ 21' + 17^\circ 14') = 16^\circ 25'.$$

$$16^\circ 25' + 17^\circ 21' = 33^\circ 46' = GDF;\quad 90^\circ - 33^\circ 46' = 56^\circ 14' = GHD.$$

$$x = 0.392 \sin 56^\circ 14' = 0.3259.$$

To find y, we have

$$KED = 180 - (27 + 17^\circ 21') = 135^\circ 39'.$$

$$\sin EKD = \frac{0.1048 \sin 135^\circ 39'}{0.196} = 0.37378.$$

$$EKD = 21^\circ 57'.$$

$$EDK = 180^\circ - (135^\circ 39' + 21^\circ 57') = 22^\circ 24'.$$

$$22^\circ 24' - 17^\circ 21' = 5^\circ 3' = FDK;\quad 90^\circ - 5^\circ 3' = 84^\circ 57' = KDM.$$

$$y = 0.392 \sin 84^\circ 57' = 0.3905.$$

The problem, while requiring some time for working out, is very simple, involving as it does only the first principles of trigonometry.

MODERN GERMAN MILLING MACHINES.

OSKAR KYLIN.*

The accompanying half-tone engravings, Figs. 1 and 2, show two milling machines built by the Wanderer Fahrradwerke, Schoenau bei Chemnitz, Germany. The machines shown represent the highest development of this firm's milling machines, being the last ones of the company's line of machine tools that have been placed on the market. The Wanderer Fahrradwerke originally engaged only in the bicycle business, but, when the demand for accurately made machine tools increased in Germany during the last decade, the company added a department for machine tool manufacture.

Fig. 1 shows what is designated as the Wanderer No. 3 vertical milling machine. An inspection of the engraving will easily convince the careful observer that proper attention has been paid to the matter of giving the machine the rigidity and stiffness required for accurate work of the heavy character for which the machine is intended. It is also in evidence that nothing has been left undone in the way of providing easily adjustable in suitable slots. Twelve different feeds are obtainable, the feed changing device consisting of a gear box placed on the column of the machine as shown. The mechanism is operated by small hand-wheels, the machine being provided with proper scales, giving the table feed per revolution of spindle, for different settings of the hand-wheels. The amount of variation obtainable of the feed per revolution of spindle varies between the limits 0.036 and 7.2 millimeters (0.0014 to 0.29 inch). In order to prevent accidental motion of the table during working, all the hubs of the controlling hand-wheels are provided with clutch devices which enable them to be disengaged as soon as the different adjustments have been made. Suitable covers have been provided over all gearing, and proper care has been taken to prevent the chips from coming into the oiling devices and other vital parts of the machine. The speed change mechanism is placed in an oil and dust-proof cover.

The total horizontal working surface of the machine is 44 × 12 inches, the longitudinal feed of the table is 44 inches, and the cross-feed 12½ inches. The vertical motion of the

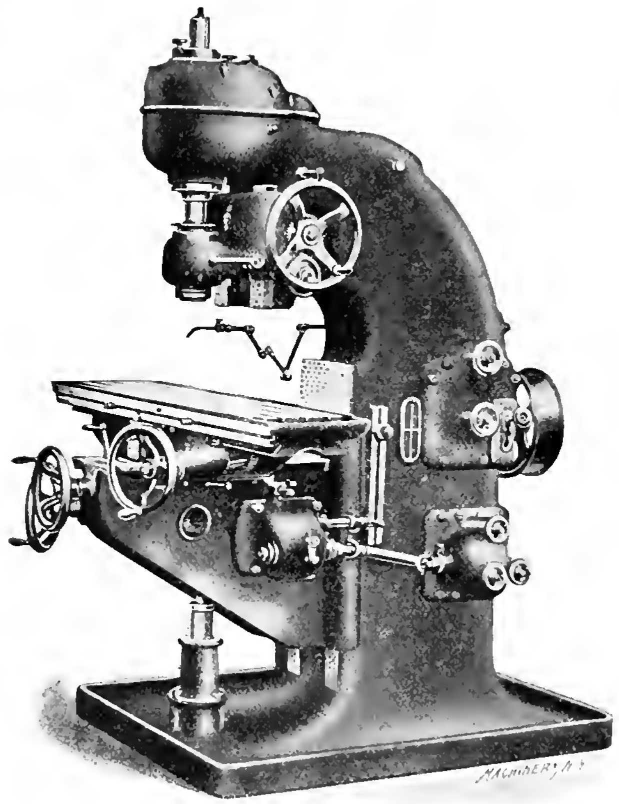


Fig. 1. Wanderer Fahrradwerke No. 3 Vertical Milling Machine.

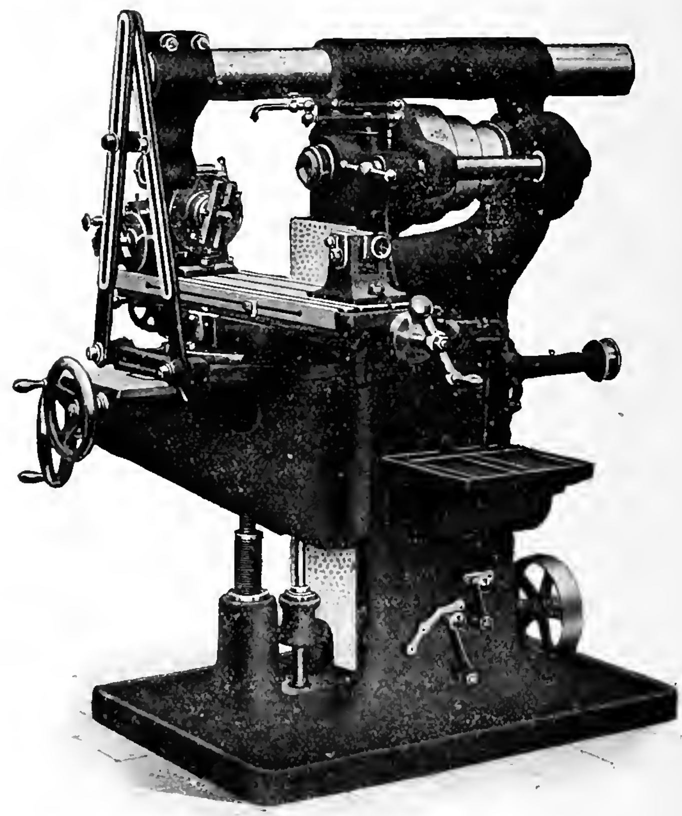


Fig. 2. Universal Milling Machine built by the Wanderer Fahrradwerke.

for easy means of adjustment and handiness of operation, the machine possessing practically the same features as the last model of the Brown & Sharpe Company's vertical milling machine.

The machine is driven from a constant-speed counter-shaft through a single pulley drive, from which all motions of the machine are obtained. By means of a gear box, 16 different speeds are obtainable for the spindle of the machine, varying from 17 to 352 revolutions per minute. The vertical adjustment of the spindle is operated by a hand-wheel provided with a dial graduated to indicate motions of the spindle of 1/20 millimeter (0.002 inch). The table of the milling machine is provided with automatic feed in three directions—vertical, longitudinal, and cross-feed. The longitudinal feed motion is driven by a spiral gear, engaging with a rack on the under side of the table. The mechanisms for engaging and disengaging all the automatic feeds are located on the side of the knee, and may be conveniently reached by the operator, the engaging and disengaging being accomplished by the turning of the respective cranks provided. All the different table feeds can be stopped automatically by dogs provided, spindle is 4 inches, and the total weight of the machine is 4,200 pounds.

In the half-tone, Fig. 2, the universal milling machine built by the Wanderer Fahrradwerke is illustrated. This machine is known as the Wanderer No. 2 universal milling machine. It is apparent from an inspection of the illustration that, in this machine also, proper attention has been paid to the question of the stiffness and rigidity required in order to turn out accurate work under severe working conditions. This machine is driven by a three-step cone pulley, provided with back gears, the three steps of the pulley being 6, 8, and 10 inches in diameter, respectively.

The automatic feed for the work table provides for 16 changes, varying from 0.1 to 5 millimeters (0.004 to 0.20 inch) per revolution of spindle. The gear box for the feed changes is located inside of the column, and is operated by levers, plainly shown in the illustration, the motion for the gear box mechanism being obtained through a belt-driven pulley.

The total table surface is 34 × 8 inches; the longitudinal motion of the table, 20½ inches; the cross-feed, 10 inches; and the vertical adjustment 17½ inches. The weight of this machine is 2,200 pounds.

* Foreign Traveling Representative of MACHINERY.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

KEARNEY & TRECKER UNIVERSAL MILLING MACHINE.

The accompanying illustrations show a new improved milling machine, brought out by the Kearney & Trecker Co., Milwaukee, Wis., and known as No. 3 B Milwaukee universal milling machine. Several interesting features have been introduced in this design, which are not generally found in machines of this type, and while following the general style of previous construction, the design is original and highly interesting in many respects.

Figs. 1 and 2 show two general views of the machine, one taken from the front and one from the side. Fig. 3 shows a rear view of the machine, and gives a clear idea of the manner in which the feed box and pulley bracket are attached, as well as of the arrangement of the levers for the speed and feed changing device. As seen from these illustrations, the tool is a constant drive geared machine, of the advantages of which the firm manufacturing these machines is fully convinced. Tests undertaken have caused the firm to abandon the cone pulley driven milling machines entirely.

Spindle Drive and Speed Changing Device.

The driving pulley is mounted on a shaft carrying on its inner end a pinion which engages with a larger gear, whereby a speed reduction of about $3\frac{1}{2}$ to 1 is accomplished, the pulley itself running at 350 R. P. M. This larger gear runs idle on its shaft and is free to move endwise thereon. On one side of the gear is placed a hardened steel clutch, and on the same shaft is also another gear of the same size, also carrying a clutch. This last gear, in turn, meshes with a gear directly above it on one of the shafts in the gear box, which, in turn, drives the feed and also meshes with pinion *V*, shown in the line engraving, Fig. 4.

The first large gear mentioned, the one which engages with the pinion on the pulley shaft, is moved by the starting lever seen extending upward directly at the right of the head in Fig. 3, until the clutches referred to become engaged, thus starting and stopping the machine without the use of friction clutches. This is permissible by reason of the fact that the clutch referred to always revolves at a constant speed, and this speed is low enough not to produce any noticeable shock, regardless of the speed at which the milling machine spindle itself may be running. The pinion *V*, in Fig. 4, drives the shaft *B*, to which is keyed pinion *W*, which, in turn, drives the idle gear *D*. This idler is carried by the swinging bracket *X*, which has gear teeth cut on its outside at *A*. These gear teeth mesh with a long-faced pinion controlled by the upper index lever shown to the right of the gear box in Fig. 3. The line engraving, Fig. 4, in order to show the construction, shows the segment *X* dropped down further than it actually would come, because in reality it swings in such a way that the pinion *D* engages with the various steps on the cone gear *E*. The endwise location of the swinging bracket *X* is controlled by the handle attached to the spindle speed dial, shown in Fig. 5. This handle operates the lower gear and rack shown in the same illustration, a projecting extension from the rack engaging with the slot *C* in the bracket *X*. The spindle speed plate in Fig. 5 shows 18 speeds, varying by increments of approximately 20 per cent from 13 to 320 R. P. M.

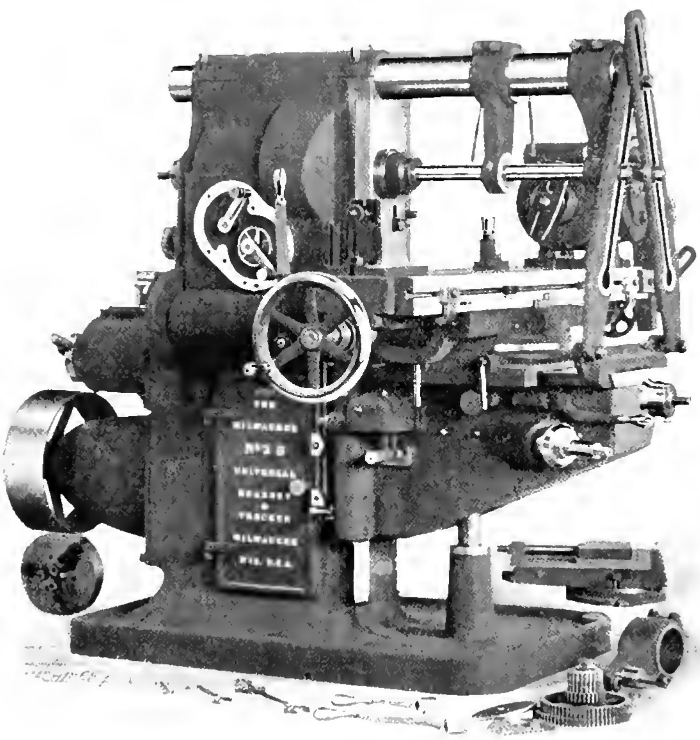


Fig 1. Front View of Kearney & Trecker No. 3B Universal Milling Machine.

Attached to and revolving with the cone *E* in Fig. 4 is the pinion *O*, which engages the gear *N*. This latter gear turns idle on the spindle of the machine and carries a pin *M*. The sleeve gear *F* on the spindle has two gears *I* and *K*, which engage alternately with gears *J* and *L* on the cone *E*, this sleeve being keyed to the spindle *G*. The gear *I*, when moved to the right, thereby bringing *K* out of engagement with *L*, engages the gear *N* through the pin *M*. It will be easily seen that by this arrangement three speeds are obtained directly at the spindle, which, multiplied by the six speeds obtained by the cone *E* and idler *D*, gives 18 speeds in all.

The speed plate in Fig. 5 has three concentric rows of speeds, the inner row being the slowest and the outer the fastest speeds. The inner one of these sets of speeds is obtained when the lever at the left in Fig. 5 is at the position shown in Fig. 1. This lever operates the upper gear and rack in the view to the right in Fig. 5, and a projection on the rack engages with the groove *H* on sleeve *F*, Fig. 4, so that this sleeve can be set easily to any one of the three positions which the lever can occupy. The hand-wheel *U*, in Fig. 4, serves the purpose of turning the spindle by hand, when necessary, or to slightly move the gears, when this is required, in order to bring them into engagement. It will be noticed that the spindle runs in taper bearings, the wear being taken up by the sliding of the cone-shaped bearing *R*, which is accomplished by means of a collar *S*, threaded on the spindle. When the collar has been properly adjusted, it is locked in position by the screw *T*.

Lubrication Arrangement.

Connected with the large gear, driven by the pulley shaft pinion previously mentioned, is a pump of simple construction, consisting of two spur gears running together in a suitable case. This pump raises the oil from the reservoir, shown at the right-hand side at the bottom of the column of the machine in Fig. 2. The oil is raised to the top of the machine above the gears on spindle *G*. Here is a perforated pipe extending from end to end of the frame and delivering oil into the pockets *P* and *Q*, and through the numerous openings in the pipe to the gears between the bearings. The oil is thrown by the gears from one to the other, and falls downward by gravity, the shafts being located approximately in a vertical plane. It also works its way downward by reason of overflow from the pockets *P* and *Q*, cascading into the various pockets and bearings in continuous streams, flowing over the mechanism without interruption. Provision is also made so that a portion of this falling oil finds its way into the feed box at the back end of the machine, lubricating all the shafts and gears contained therein. It also finds its way in a continuous stream through the pulley bracket to the bearing next

to the pulley. The oil is returned through the bottom of the pulley bracket, most clearly shown in Figs. 1 and 2, to the reservoir which extends from the one side of the machine to the other. From this it is again pumped to the discharge pipe above the spindle to continue its circuitous route.

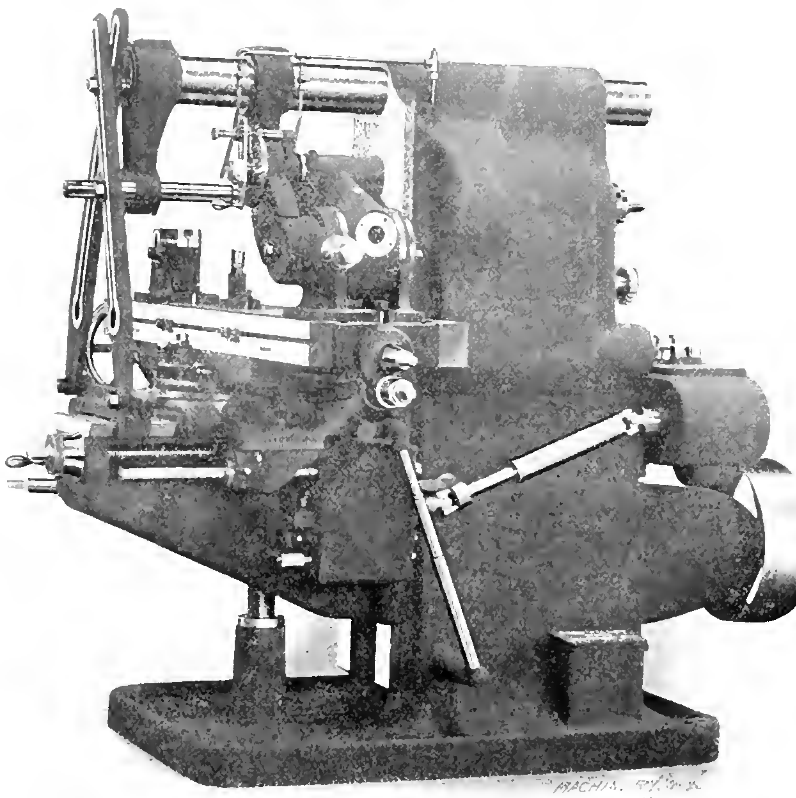


Fig. 2. Side View of Milwaukee Universal Milling Machine.

There is another pump for the oil used for lubricating the cutters, this pump being located in the closet in the inside of the machine frame, behind the door shown in Fig. 1. This pump runs only when the spindle runs, while the pump for lubricating the gears and bearings runs continuously, so that the pulley shaft is flooded with oil, regardless of whether the machine is running or not. The opening covered by the front door, on which the name of the machine and the makers is cast, is not as large as the door would indicate, as there is a wall back of this door, extending from the bottom to about the height of the door knob for the purpose of forming a reservoir for the lubricant used for cooling and lubricating the milling cutters. The pump for this lubrication has a relief and pressure regulating valve, so that the pressure of oil can be regulated to any desired amount. From this pump a pipe extends upward in the interior of the machine, emerging near the top of the frame, as shown in Fig. 2. To the top end of this pipe is attached a swinging connection, and from this a horizontal pipe connection, branching out and connecting with two pieces of flexible oil tubing, carries the oil to the cutters. This arrangement is the standard equipment, which, of course can readily be varied to suit any special case, as many of these flexible tubes being used as found necessary.

One of the great troubles in connection with flooding the cutters and the table with oil has hitherto been the trouble in connection with returning it to the reservoir, the means provided never being adequate. Referring to Fig. 6, which shows part of the table and the swivel carriage of the machine, it will be noted that an oil pocket is provided at the end of the table, there being another pocket at the other end. These pockets are partitioned half way down by the screen shown in the illustration. Connected with the pockets are channels along the sides of the table, which are also divided half way down into two sections by a strip of steel, shown extending up from the groove at the end of the table. The oil falling on the table runs into the T-slots and into the grooves along the edges of the table, which carry the oil to the pockets at one or both ends, where it is strained by the screen mentioned, and then flows to the center of the table through the same grooves along the edges, but under the strip of steel referred to. From the center of the table the oil escapes through a hole into a telescopic slide shown at the extreme top of the swivel carriage in Fig. 6. The parts are so proportioned that the hole in the table will never run beyond the swivel carriage. An opening in the side of the top slide mentioned connects with the long opening in the swivel carriage. This opening terminates in a hole in the bottom of the swivel carriage, which registers with a circular groove in the saddle, and this circular groove, in turn, connects with the swivel joint of the telescopic oil tube, shown at the side of the knee and column in Fig. 2, the oil flowing through this tube to the reservoir, to be again pumped to the cutters. The strip of steel shown lying across the table in Fig. 6 is used to replace the screen when milling cast iron, in order to prevent the dust and chips from this material from finding their way into the channels leading downward to the reservoir.

Feed Mechanism.

The feed change mechanism is contained in the change gear box at the rear of the machine, and the feed changes are effected through gearing quite similar to that shown by the line engraving, Fig. 4, for the spindle drive, these gears also running in oil, as before mentioned. The index plate, giving the amount of feed, shows this in the rates of feed in inches per minute. Twelve feed changes are obtainable, varying from ½ inch to 16 inches per minute, or from about 0.0015 inch per turn of spindle for small cutters, to a little over one inch per turn for finishing cuts with large cutters. From the feed box the power is transmitted directly to the knee, through the universal joint telescopic shaft, shown in Fig. 2. A spur gear reverse is provided at the side of the knee, operated by the push handle, shown in Fig. 2, near the lower edge of the gear box on the side of the knee. This handle slides a clutch between two spur gears running in opposite directions. The feed

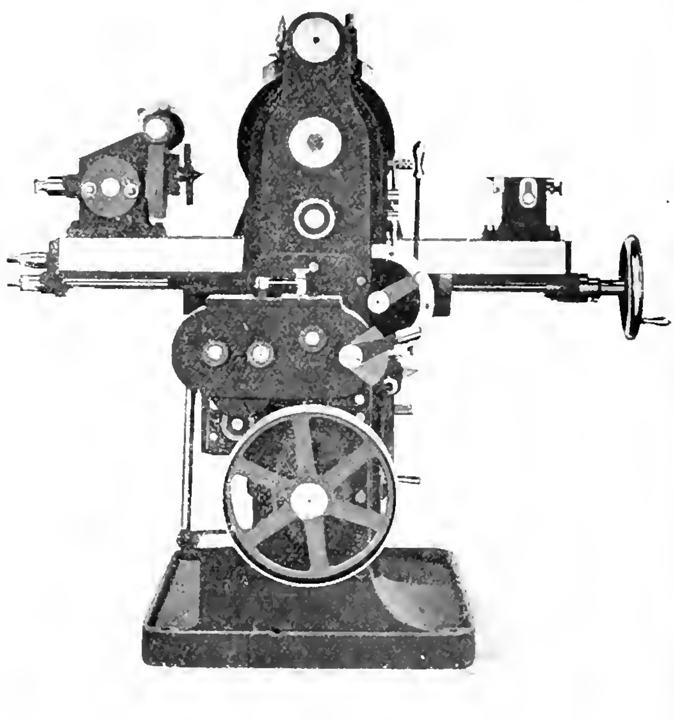


Fig. 3. Rear View of the Milling Machine.

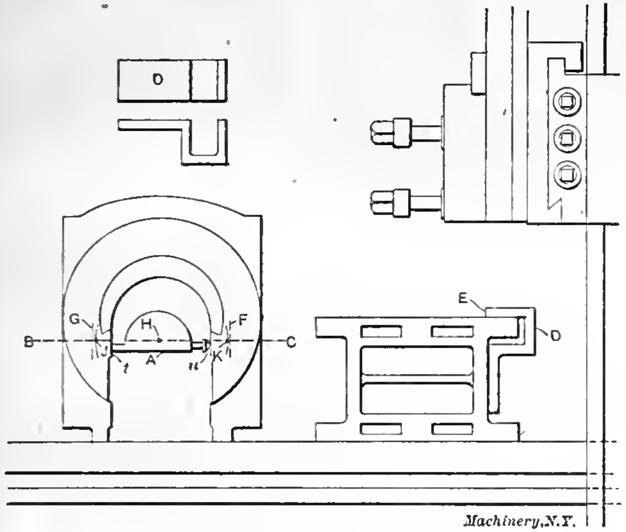
operating handles are shown in Fig. 1. The machine is provided with longitudinal, vertical, and cross feed, for the table, and means are provided to prevent the accidental engagement of more than one of these feeds at a time, and also to make it clear to the operator which feed he is about to use,

Supplement to MACHINERY, August, 1908.

Operations for the Article in this number entitled "Machine Shop Practice—Re-planing a Locomotive Driving-Box."

SHOP OPERATION SHEET NO. 70.

Arthur J. Humphrey. MACHINERY, August, 1908.



To Lay Out a Driving-box for Re-planing the Shoe and Wedge Faces.

1. Place the driving-box on the bed of the planer, as shown, with the inside face toward the operator.

2. Fasten a center-piece A in place, setting it so that it will be flush with the face of the box. With a surface gage draw the line B-C across the center-piece and the flanges of the box. If the crown brass is new, draw this line just below the points of the brass, as shown, but if the brass is worn, the line should be about the same height as the center of the bore of the brass.

NOTE—When the brass is old and is to be re-bored, the line B-C is drawn across the center of the bore so that the center H may be located with reference to the brass, in order that a minimum amount of metal may be removed when re-boring.

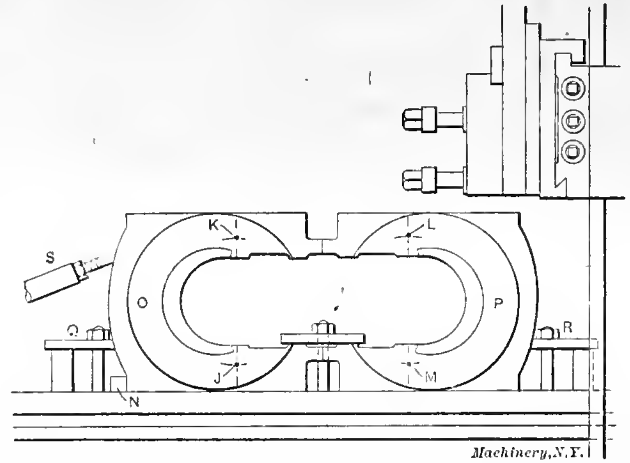
3. Hold the box gage D firmly against the shoe or wedge bearing surface of the driving box, as shown, and using the edge E of the box gage as a guide, draw the line F on the outside of the flange. This line, which is in the same plane as the shoe or wedge bearing surface, intersects the line B-C. Repeat this operation on the opposite side of the box, drawing the line G which also intersects the line B-C.

4. With a pair of hermaphrodite calipers locate a center H midway between the points t and u. With a pair of dividers see if the distance from the lines F and G to the center H are equal. If not, set the dividers 1/16 inch less than the smallest distance, or enough less to allow for planing, and with H as a center, scribe arcs intersecting the line B-C, thus locating the points J and K.

5. Mark the points J and K lightly with a prick-punch, and lay out the other box in the same manner, locating the corresponding points.

SHOP OPERATION SHEET NO. 71.

Arthur J. Humphrey. MACHINERY, August, 1908.



To Set Up a Pair of Driving-boxes for Re-planing the Shoe and Wedge Faces.

NOTE—The driving-boxes are supposed to have been laid out as previously described, and the points J, K, L, and M, located on the outside of the flanges, these points being in the same plane that the shoe or wedge bearing surfaces of the boxes are to be, when planed.

1. Place the boxes on the planer table, with their bottoms together and with a bolt inserted between them, as shown in the illustration.

2. Insert stop plugs N, which are for taking the thrust of the cut, in the table, and place the driving box O against these plugs, and the box P against O.

3. Now place the clamps Q and R in position, with their ends resting in the oil cavities in the tops of the boxes.

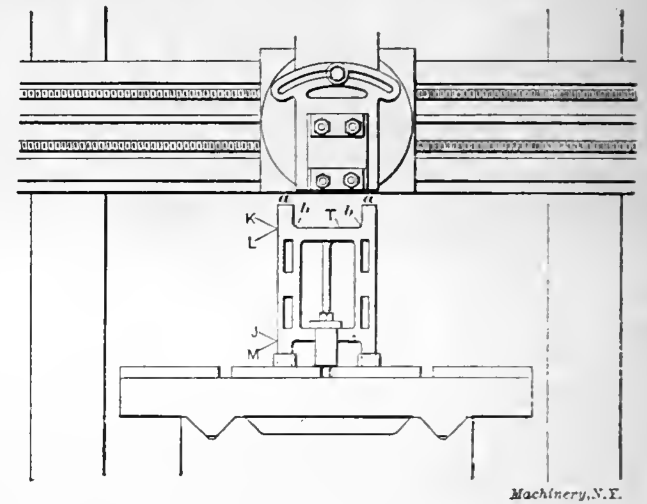
4. With the surface gage test the height of the prick-punch marks K and L, and adjust the box, by placing tin or brass liners beneath the flanges, until these marks are the same height from the table. Using a square, test the face of each driving box, and see if the faces are square with the planer table. If not, they should be set square by again placing liners beneath the box flanges.

5. Place the surface gage on the planer table, with the rear pins of the gage lowered and held firmly against the edge of the table or T-slot, and test the faces of both boxes, adjusting them until they are parallel with the edge of the table.

6. Fasten the boxes securely to the table, by tightening the clamps, and then, with surface gage and square, again test all points as previously described. If the boxes are not properly set, again loosen the bolts and adjust the liners, and continue to make adjustments until the boxes are set properly. Fix a brace S against one box, as shown, to take thrust of cut.

SHOP OPERATION SHEET NO. 72.

Arthur J. Humphrey. MACHINERY, August, 1908.



To Re-plane the Shoe and Wedge Faces

NOTE—It is assumed that the points J, M, K and L, to which the faces of the boxes are to be planed, have been located, and that the boxes have been set up as previously described.

1. Clamp a roughing tool in the tool-post of the planer, and take a roughing cut over the flanges of both boxes at a, removing enough metal to true them. Take a roughing cut over the shoe, or wedge bearing surface T, setting the point of the tool 1/32 inch above the prick-punch marks K and L. When taking the roughing cut, be sure to leave enough stock in the corners b for the fillets.

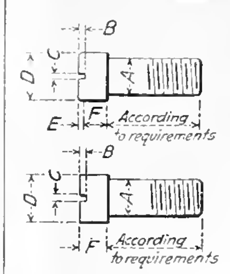
2. Replace the roughing tool with a broad finishing tool, rounded at both corners to the radius of the fillet desired at corners b. Set the cutting edge of the finishing tool the same height as the prick-punch marks K and L, and take a finishing cut over the shoe, or wedge bearing surface T, using a coarse feed. With the rounded corners of the tool finish the fillets at b. With the same tool take finishing cuts over the flanges.

3. Remove the clamps and turn the boxes over, setting them as described in the preceding operation sheet by the points J and M, and plane the faces on the opposite sides until they coincide with these marks.

NOTE—When taking the finishing cuts, the cutting edge of the tool may be set with the points K, L, or J, M, by setting the pointer of the surface gage with the prick-punch marks, and then raising or lowering the tool to correspond with the height of the pointer, or, after the cut is taken over the flanges, the depth of the cut may be determined by the use of a depth gage set to these points. After the finishing cuts are taken, the work may be proved by means of the box gage used in connection with Shop Operation Sheet No. 70.

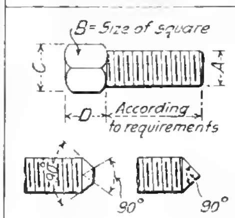
I, II, III.—DIMENSIONS OF FILLISTER HEAD, STANDARD SQUARE HEAD, AND HEADLESS SCREWS.

Table I.– Fillister Head Screws.



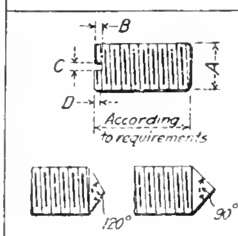
A	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/8	1 1/4
B	0.02	0.02	1/32	1/32	3/64	1/16	5/64	5/64	7/64	7/64	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4	9/32	5/16
C	.02	.02	.025	.025	.039	.039	.058	.071	.086	.099	.112	.133	.133	.133	.133	.133	.133	.165	.165	.165	.165
D	1/8	5/32	11/64	7/32	1/4	5/16	11/32	7/16	1/2	9/16	11/16	3/4	7/8	15/16	1 1/16	1 1/8	1 3/16	1 1/4	1 3/8	1 1/2	1 5/8
E	1/64	1/64	1/32	1/32	1/32	1/32	1/32	3/64	3/64	3/64	3/64	3/64	1/16	1/16	1/16	1/16	1/16	1/16	1/16	1/16	1/16
F	1/16	1/16	3/32	3/32	1/8	5/32	5/32	3/16	1/4	1/4	5/16	3/8	7/16	7/16	1/2	1/2	9/16	5/8	5/8	3/4	13/16
No. of threads per inch	64	50	40	36	32	28	20	18	16	14	13	12	11	11	10	10	9	9	8	7	7

Table II.– Square Head Screws.



A	3/16	1/4		5/16			3/8			7/16			1/2			9/16			5/8			3/4		
B	3/16	1/4	5/16	1/4	5/16	3/8	5/16	3/8	7/16	3/8	7/16	1/2	7/16	1/2	9/16	1/2	9/16	5/8	9/16	5/8	3/4	5/8	3/4	7/8
C	0.26	0.35	0.44	0.35	0.44	0.53	0.44	0.53	0.62	0.53	0.62	0.71	0.62	0.71	0.79	0.71	0.79	0.88	0.79	0.88	1.06	0.88	1.06	1.24
D	1/4	5/16	3/8	5/16	3/8	7/16	3/8	7/16	1/2	7/16	1/2	9/16	1/2	9/16	5/8	9/16	5/8	11/16	5/8	11/16	13/16	11/16	13/16	15/16
No. of threads per inch	32	20		18			16			14			13			12			11			10		

Table III.– Headless Set-Screws.

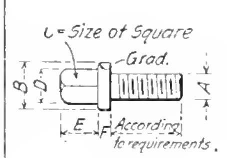


A	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4
B	0.02	1/32	3/64	1/16	5/64	5/64	7/64	7/64	1/8	1/8	9/64
C	0.02	0.025	0.039	0.039	0.058	0.071	0.086	0.099	0.112	0.112	0.133
D	1/64	1/32	1/32	1/32	1/32	1/32	1/32	1/32	3/64	3/64	3/64
No. of threads per inch	40	32	20	18	16	14	13	12	11	11	10

Contributed by Erik Oberg.

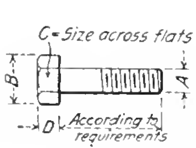
IV, V.—DIMENSIONS OF COLLAR-HEAD, AND STANDARD HEXAGON HEAD SCREWS.

Table IV.– Collar-head Screws.



A	3/16	1/4		5/16			3/8			7/16			1/2			9/16			5/8			3/4		
B	3/8	1/2	9/16	9/16	9/16	5/8	9/16	11/16	3/4	11/16	3/4	7/8	13/16	7/8	1	15/16	1	1 1/16	1	1 1/16	1 1/4	1 3/16	1 1/4	1 7/16
C	3/16	1/4	5/16	1/4	5/16	3/8	5/16	3/8	7/16	3/8	7/16	1/2	7/16	1/2	9/16	1/2	9/16	5/8	9/16	5/8	3/4	5/8	3/4	7/8
D	0.26	0.35	0.44	0.35	0.44	0.53	0.44	0.53	0.62	0.53	0.62	0.71	0.62	0.71	0.79	0.71	0.79	0.88	0.79	0.88	1.06	0.88	1.06	1.24
E	1/4	5/16	3/8	5/16	3/8	7/16	3/8	7/16	1/2	7/16	1/2	9/16	1/2	9/16	5/8	9/16	5/8	11/16	5/8	11/16	13/16	11/16	13/16	15/16
F	3/32	1/8	1/8	1/8	1/8	5/32	1/8	5/32	5/32	5/32	5/32	3/16	5/32	3/16	3/16	3/16	3/16	7/32	3/16	7/32	1/4	7/32	1/4	9/32
G	1/32	3/64	3/64	3/64	3/64	3/64	3/64	3/64	1/16	1/16	1/16	3/32	1/16	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32
No. of threads per inch	32	20		18			16			14			13			12			11			10		

Table V.– Hexagon Head Screws.



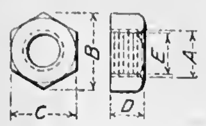
A	7/8		1			1 1/8			1 1/4			1 3/8			1 1/2			1 5/8			1 3/4		
B	1 7/16	1 9/32	1 9/32	1 13/16	2 1/64	1 13/16	2 1/64	2 15/64	2 1/64	2 15/64	2 29/64	2 15/64	2 29/64	2 43/64	2 29/64	2 43/64	2 57/64	2 43/64	2 57/64	3 7/64	2 57/64	3 7/64	3 5/16
C	1 1/4	1 3/8	1 3/8	1 9/16	1 3/4	1 9/16	1 3/4	1 15/16	1 3/4	1 15/16	2 1/8	1 15/16	2 1/8	2 5/16	2 1/8	2 5/16	2 1/2	2 5/16	2 1/2	2 11/16	2 1/2	2 11/16	2 7/8
D	9/16	5/8	9/16	5/8	11/16	5/8	11/16	3/4	11/16	3/4	13/16	3/4	13/16	7/8	13/16	7/8	15/16	7/8	15/16	1	15/16	1	1 1/16
No. of threads per inch	9		8			7			7			6			6			5 1/2			5		

Contributed by Erik Oberg.

VI, VII, VIII.—DIMENSIONS OF STANDARD, AND SPECIAL HEXAGON NUTS.

Table VI.– Standard Hexagon Nuts.

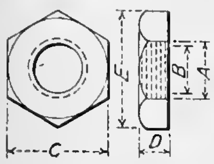
A = Size of tap
E = Size of plain hole



A	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	2	2 1/2	3
B	1/2	37/64	23/32	7/8	1 1/64	1 1/64	1 15/64	1 15/64	1 7/16	1 19/32	1 3/16	2 1/64	2 15/64	2 29/64	2 43/64	2 57/64	3 7/64	3 17/32	4 13/32	5 1/8
C	7/16	1/2	5/8	3/4	7/8	7/8	1 1/16	1 1/16	1 1/4	1 3/8	1 9/16	1 3/4	1 15/16	2 1/8	2 5/16	2 1/2	2 11/16	3 1/16	3 13/16	4 7/16
D	3/16	1/4	1/4	5/16	3/8	7/16	1/2, 5/8	1/2, 5/8	1/2, 3/4	9/16, 7/8	5/8, 1	11/16, 1 1/8	3/4, 1 1/4	13/16, 1 3/8	7/8, 1 1/2	15/16, 1 5/8	1, 1 3/4	1 1/8, 2	1 3/8, 2 1/2	1 5/8, 3
E	3/16	1/4	19/64	23/64	13/32	15/32	33/64	37/64	5/8	47/64	27/32	61/64	1 5/64	1 11/64	1 19/64	1 25/64	1 1/2	1 23/32	2 3/16	2 41/64
No. of threads per inch	20	18	16	14	13	12	11	11	10	9	8	7	7	6	6	5 1/2	5	4 1/2	4	3 1/2

Table VII.– Hexagon Nuts with Special Fine Threads.

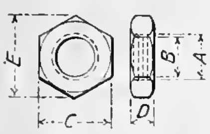
A = Size of tap
B = Size of plain hole



A	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 3/8	1 7/8	1 1/2	1 9/16	1 5/8	1 3/4	1 7/8	2
B	35/64	39/64	43/64	47/64	51/64	55/64	59/64	63/64	1 3/64	1 7/64	1 11/64	1 19/64	1 23/64	1 27/64	1 31/64	1 35/64	1 43/64	1 51/64	1 59/64
C	1 1/16			1 1/4		1 7/16			1 3/4			2 1/8			2 5/16			2 11/16	
D	5/16			5/16		5/16			5/16			3/8			1/2			5/8	
E	1 15/64			1 7/16		1 21/32			2 1/64			2 29/64			2 43/64			3 7/64	
No. of threads per inch	16			16		16			16			16			16			16	

Table VIII.– Hexagon Check Nuts.

A = Size of tap
B = Size of plain hole

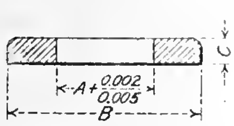


A	3/16	1/4	1/4	5/16	5/16	3/8	3/8	7/16	7/16	1/2	9/16	9/16	5/8	11/16	11/16	3/4	7/8	3/4	7/8	1
B	9/64	3/16	3/16	1/4	1/4	19/64	19/64	23/64	23/64	13/32	15/32	15/32	33/64	37/64	37/64	5/8	47/64	5/8	47/64	27/32
C	7/16		1/2		5/8		3/4		7/8			1 1/16			1 1/4			1 3/8		
D	5/32		7/32		1/4		1/4		5/16			5/16			3/8			3/8		
E	1/2		37/64		23/32		7/8		1 1/64			1 15/64			1 7/16			1 19/32		
No. of threads per inch	32	20	20	18	18	16	16	14	14	13	12	12	11	11	11	10	9	10	9	8

Contributed by Erik Oberg.

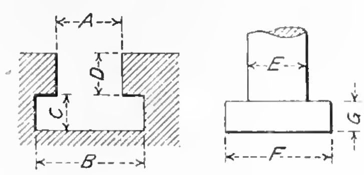
IX, X, XI.—DIMENSIONS OF WASHERS, T-BOLT HEADS, AND T-NUTS.

Table IX.– Washers.



A	B	C
1/4	5/8	3/32
5/16	3/4	7/64
3/8	7/8	1/8
7/16	1	9/64
1/2	1 1/8	5/32
9/16	1 1/4	11/64
5/8	1 3/8	3/16
11/16	1 1/2	13/64
3/4	1 5/8	7/32
7/8	1 7/8	1/4
1	2	1/4
1 1/8	2 1/4	9/32
1 1/4	2 1/2	5/16
1 3/8	2 3/4	11/32
1 1/2	3	3/8
1 5/8	3 1/4	13/32
1 3/4	3 1/2	7/16
1 7/8	3 3/4	15/32
2	4	1/2

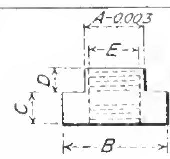
Table X.– T-Bolt Heads.



Slot.				Bolt-Head.		
A	B	C	D*	E	F	G
1/4	1/2	5/32	3/16	3/16	7/16	1/8
5/16	5/8	5/32	3/16	1/4	9/16	1/8
3/8	11/16	7/32	1/4	5/16	5/8	3/16
7/16	13/16	7/32	9/32	3/8	3/4	3/16
1/2	15/16	9/32	5/16	7/16	7/8	1/4
5/8	1 3/16	13/32	3/8	9/16	1 1/8	11/32
3/4	1 5/16	17/32	1/2	11/16	1 1/4	15/32
7/8	1 5/8	11/16	9/16	3/4	1 1/2	9/16
1	1 7/8	13/16	5/8	7/8	1 3/4	11/16

* Minimum distance permissible.
Maximum distance of D equals
A + 1/16 for sizes of bolt up to 5/8,
1 for 11/16 size of bolt,
1 1/16 for 3/4 size of bolt,
1 3/16 for 7/8 size of bolt.

Table XI.– T-Nuts.



A	B	C	D	E
3/16	7/16	1/8	3/32	1/8
1/4	9/16	1/8	1/8	1/8, 3/16
5/16	5/8	3/16	1/8	3/16, 1/4
3/8	3/4	3/16	5/32	1/4, 5/16
7/16	7/8	1/4	3/16	5/16, 3/8
9/16	1 1/8	11/32	3/16	7/16, 1/2
11/16	1 1/4	15/32	1/4	9/16, 5/8
3/4	1 1/2	9/16	5/16	5/8, 3/4
7/8	1 3/4	11/16	5/16	3/4, 7/8

Contributed by Erik Oberg.

without experiment. For each of the three feeds, there is a hole drilled in the side of the knee, below which is stamped the feed that will be engaged if the plunger shown on the side of the knee, in Fig. 1, below and somewhat to the right of the hand-wheel, is engaged in either of the three holes. The lever on which this plunger is mounted is connected in such a manner with the remainder of the mechanism that either of the two feeds for which the plunger is not set, becomes inoperative, until the plunger is changed to another hole. Adjustable trip blocks are provided to trip the feed at any desired point, and fixed trips are provided at the end of the stroke of all the feeds.

General Features of Design.

Ball bearing thrust collars are provided for all feed-screws. A second ball bearing on the cross feed screw, inside of the knee, takes the thrust in the opposite direction. The handles shown on the side of the saddle, in Fig. 1, pointing downward,

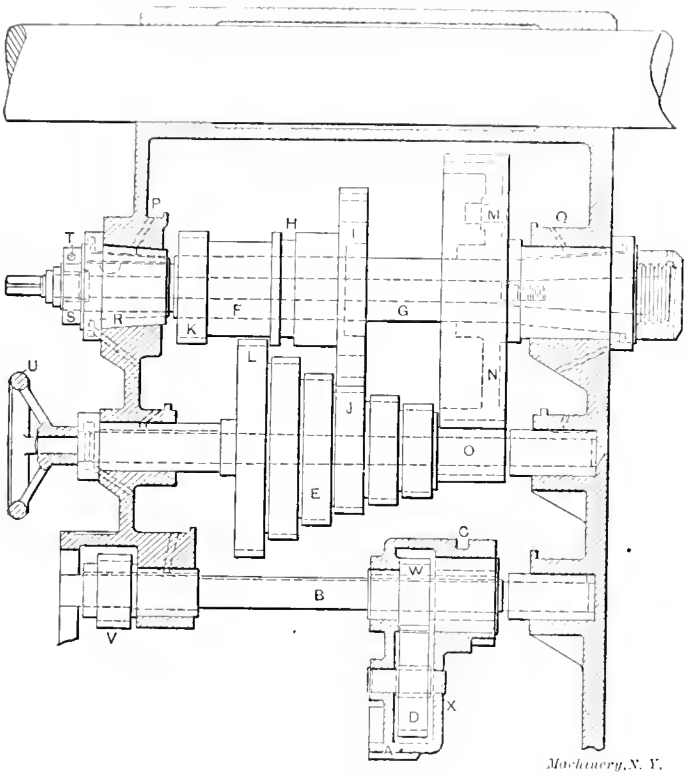


Fig. 4. Section through Speed Gear Box.

are used for clamping the saddle to the knee. To prevent the knee from becoming distorted, on account of this clamping, or from distortion produced by strains from the action of the cutters on the work, it is cast without a hole through the top, this construction being a continuation of the Kearney & Trecker Company's practice, having been inaugurated in the first cone pulley machine built by the company, and regarded as a very important feature in this type of machine. It not only renders the machine more rigid, and less liable to distortion under strain, but also permits greater cross range and

Fig. 5. Speed Change Lever Mechanism.

wider tables on universal machines. This machine has a table 14 inches wide, with a cross range of 12 inches, and is capable of being swiveled to an angle of 52 degrees, utilizing the full table travel. It can also be swiveled through an angle of 360 degrees, the table feed remaining operative at any angle.

The arm braces are so constructed that they can be removed from the machine without taking off any nuts. They are very simple in construction, and their efficiency is much enhanced by the bolt at the top which ties the two braces together.

Dividing Head.

The universal dividing head claims some attention. This is shown in Fig. 7. It will be seen from this engraving that the worm-wheel is on the front end of the spindle, which

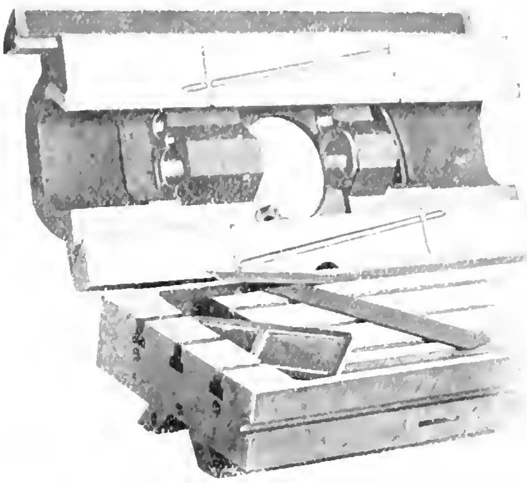


Fig. 6. Oil Return Arrangement in Table and Swivel Carriage.

makes it possible to make it very much larger in diameter than if it were placed in the interior of the head, where it could be no larger than the opening through which the spindle is introduced, or at most, no larger than the distance between the housings. A large diameter worm-wheel is clearly conducive to accuracy, other things being equal, and the placing of the index plate with the index lever directly on the worm shaft eliminates the inaccuracy that may arise on account of indexing through gearing, which is necessary when the index plate is placed on a secondary shaft. In order to prevent the spindle from becoming exceedingly high when turned to a vertical position, the center line of the spindle is considerably above the axis of the center block, so that the end of the spindle, when it swings in an arc around this axis, reaches the highest position before it stands in a vertical direction, and commences to move downward before reaching the vertical position. On account of the worm-wheel being large in diameter, larger work may be carried out on this machine than could otherwise be considered, and for this reason the driving mechanism and the change gears connecting the worm shaft with the table feed-screw must of necessity be strong enough for heavy work, and the method of carrying the change gears must be sufficiently rigid to withstand heavy duty. The swinging bracket in connection with the semi-circular bracket clamped to the end of the table, as shown in Fig. 7, fills these requirements. In order to facilitate the setting of the universal head to any angle, in relation to the spindle of the machine, and make it fully universal, it is arranged to interchange with the circular base on the milling machine vise.

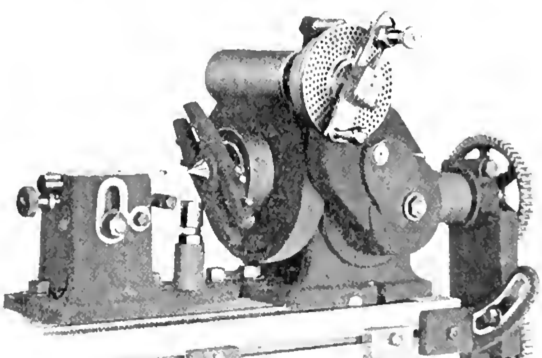


Fig. 7. Dividing Head.

The longitudinal table feed of the machine is 36 inches, the cross feed, as already mentioned, is 12 inches, and the vertical feed 19 inches. The driving pulley is 16 inches in diameter for a 5-inch belt, and runs at 350 R. P. M.

NEWTON CYLINDER AND VALVE CHAMBER BORING MACHINE.

The accompanying half-tone illustration, Fig. 1, shows a new machine brought out by the Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine is especially designed for the boring of the cylinder and piston valve chamber of simple and compound engines, at one setting. The machine shown in the illustration was built specially for a locomotive building company, where one machine was used for the valve chamber and another for the cylinders, and in this the vertical bearing is keyed to the spindle and revolves with it. Both of these sleeves are lapped in the hole for the spindle, so as to insure proper bearing, and are ground on the outside and fitted in brass bushings, a cap bearing being provided for compensation for wear.

To each of the sleeves is fitted a facing arm, as plainly shown in the illustration, Fig. 1. This arm can be engaged or disengaged without stopping the spindle motion. The arm is provided with a tool slide, having adjustment out and in for setting the proper depth of cut, while, at the same time, it has a feed in either direction on the arm by means of a small star wheel and screw. The spindle is fed forward by a carriage or trolley operated by a screw and nut, and has a continuous motion of 11 feet 8 inches, so that it can be entirely withdrawn, when removing the cylinders from the table of the machine, at one single traverse motion. The foot-

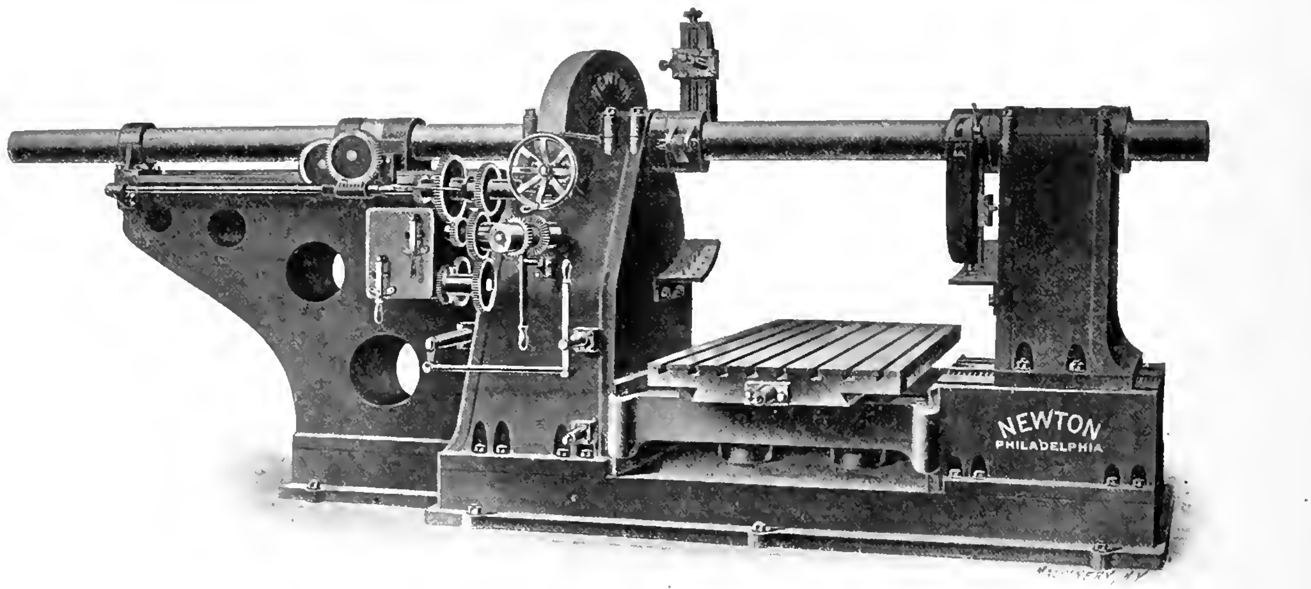


Fig. 1. Newton Cylinder and Valve Chamber Boring Machine.

travel of the table is only 8 inches. The regular type of machine, however, is provided with longer ways for the knee which carries the work table, so that in this case the work table has a vertical movement of 36 inches, the maximum distance between the spindle and the table being 51 inches, and the minimum 15 inches. When this machine is used, work such as shown in the line engraving, Fig. 2, can be carried out to advantage. The adjustment on the machine being vertical, longitudinal, and transverse, a cylinder, after it has been planed, can be placed on parallel strips on the table, and the high pressure and low pressure cylinders and the valve chambers bored without resetting, which insures perfect alignment of the cylinders, the proper centers being maintained by the use of gages.

Six changes of feed in either direction are supplied to the spindle through the gear box, the feeds amounting to 0.062, 0.100, 0.166, 0.333, 0.667 and 1 inch per revolution of spindle. The feed is engaged by the lever above the feed box, which when moved to the left engages the feed, and when moved to the right engages the quick traverse, both of these movements being reversed by the lever directly under the hand-wheel in the front of the machine. The quick power motion in either direction is at the rate of 10 feet per minute.

The spindle has a speed range of from 4 to 15 R.P.M., and is operated either by a four-step cone or by a 20 H.P. 3 to 1 variable speed motor, the drive being connected with the spindle through a clutch, so that the spindle can be started and stopped without stopping the motor or counter-shaft. A fly-wheel is attached to the motor to overcome the shock of the engaging and disengaging of the clutch. The spindle is 7 inches in diameter, and provided with two splines for driving, and is ground and fitted into two sleeves, one in each bearing. The sleeve in the head bearing is used for driving the spindle through a worm and worm-gear connection. The worm-wheel is made of bronze, and the worm of steel, the mechanism being encased and running in oil. The sleeve at the foot-stock bearing is adjustable by means of a rack and pinion, giving a minimum distance between the facing arms of 45 inches, and a maximum distance of 60 inches. The cross adjusting table is fitted with steel plates on the top, which give a steel web to the T-slots, and prevent the edges from breaking out, and at the same time the alignment of the top of the table is maintained. The table has both hand and power adjustment, and is adjustable longitudinally on the

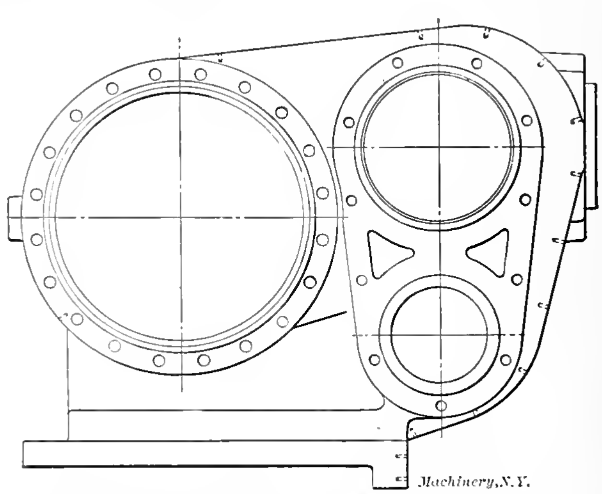


Fig. 2. Example of Work Bored in Machine at One Setting.

knee in order to permit bringing different lengths of cylinders centrally between the facing arms. The knee is raised and lowered by power, the vertical adjustment, however, having a fine hand adjustment as well. The hand adjustment for the table, vertically, is accomplished by a ratchet through a shaft visible in the illustration, Fig. 1, directly to the left of the knee. The knee is accurately fitted between ways on the front and back part of the bed, and is supported by four

screws, 6 inches in diameter, which are also used for the vertical adjustment.

It is possible on this machine to bore a simple cylinder and valve chamber in five hours, and an auxiliary table can be furnished for boring inclined cylinders. This table can be swiveled to an angle of 20 degrees so that inclined cylinders may be bored without requiring additional setting.

SINGLE PULLEY GEARED-DRIVE ROCKFORD SHAPER.

The accompanying half-tones, Figs. 1 and 2, and the line engraving, Fig. 3, illustrates a shaper equipped with a new positive speed changing device, which has been placed on the market by the Rockford Machine Tool Co., Rockford, Ill. In

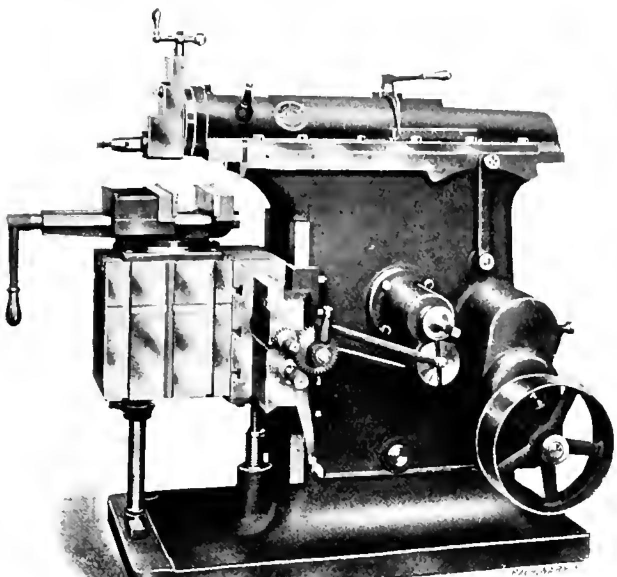


Fig. 1. Belt-driven Geared-drive Rockford Shaper.

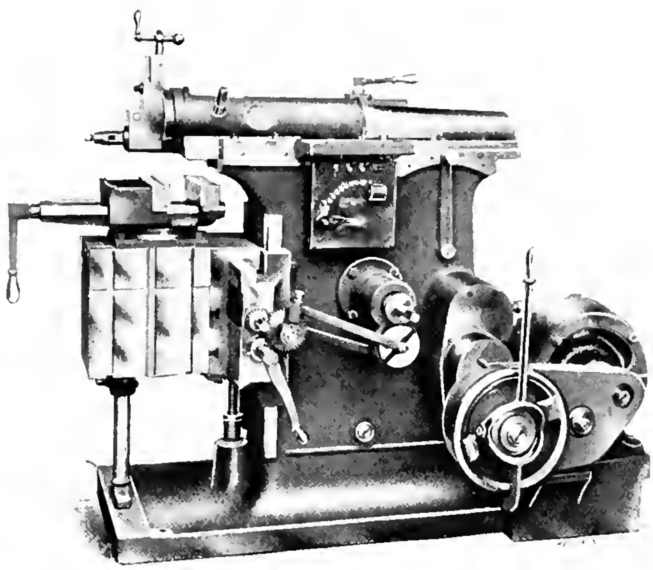


Fig. 2. Motor-driven Geared-drive Rockford Shaper.

Fig. 1 is shown a machine equipped with a single pulley, belt-driven from the counter-shaft. In Fig. 2 is shown a motor-driven machine, direct-connected by gearing to a Northern constant speed motor. This design is provided with a friction clutch for stopping and starting the machine without stopping or starting the motor, a long lever on the side of the machine at the outside end of the gear box operating this friction clutch. In the line engraving, Fig. 3, is shown an arrangement where the machine is belt-driven, but equipped with a friction clutch of the same type as that on the motor-driven machine, so that the driving pulley may be driven by belt directly from the line shaft, no counter-shaft being necessary. The line engraving, Fig. 3, also showing a section through the driving mechanism and an end view of same, gives a comprehensive idea of the design of the gear box and shifting mechanism, the simplicity and carefully thought out design of which is plainly in evidence.

The machine has eight speed changes for the ram, arranged in geometrical progression from 12 to 90 cutting strokes per minute. Referring to Fig. 3, the lower shaft *F* carries the friction pulley and clutch and two driving gears, either one of which may be locked to the shaft by means of a spring key. The gear not locked by the key will run loose on the shaft, driven by its mate on the second shaft *G*. The position of the spring key is changed by operating the lever *H* on the back side of the gear box frame. This lever is connected to a fork *E*, which, in turn, engages sleeve *J* on shaft *F*, by means of which the spring key is moved, so as to engage with either of the two driving gears. A sleeve carrying four gears, any one of which may be engaged with its corresponding gear on the upper shaft *K*, is keyed to the second shaft *G*. The shifting of this sleeve is effected by the shifting lever *D* on the side of the shaper, which connects with the sleeve through the forged levers and links *A*, *B*, and *C*. The lever or arm *A* immediately effects the motion of the sleeve and gears on the shaft *G*. The arm is carried in a bearing at its lower end, as shown in Fig. 3, and is provided with a steel pin at the upper end, which operates between two flanges on the sleeve.

It will be noticed that this arrangement is very simple, and places the two shifting levers within easy reach of the operator. An important feature of the design is that it is impossible to get any two combinations of gears in mesh at the same time. A speed plate is provided, showing the proper location of the two levers for the correct speed required. It will be noted, in particular, that the gear-driving device is very compact, and that the parts are easily accessible. The machine itself is of the regular Rockford design.

Conforming to their usual practice of not placing any new device on the market before it has been thoroughly tested in their own shops, the builders have been constantly using a 16-inch shaper equipped with this gear-driving device for a period of eighteen months, and is operation has been very satisfactory. The floor space required is less than that of a cone-driven machine.

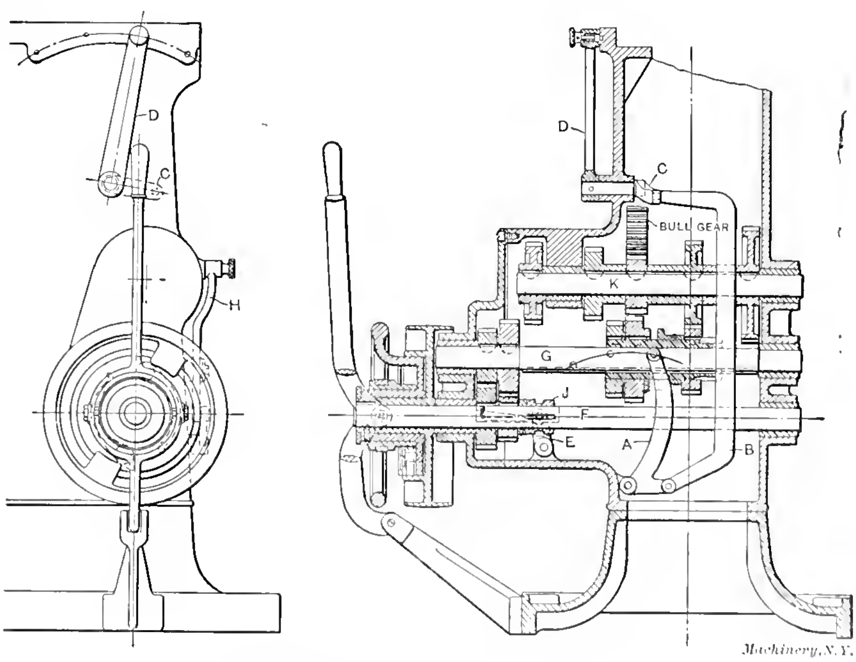
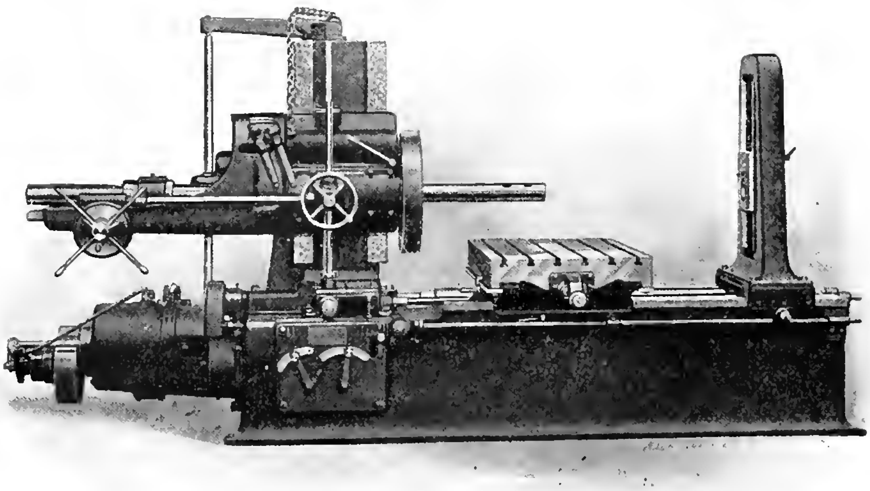


Fig. 3. Section through End View of Gear Box.

LUCAS HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

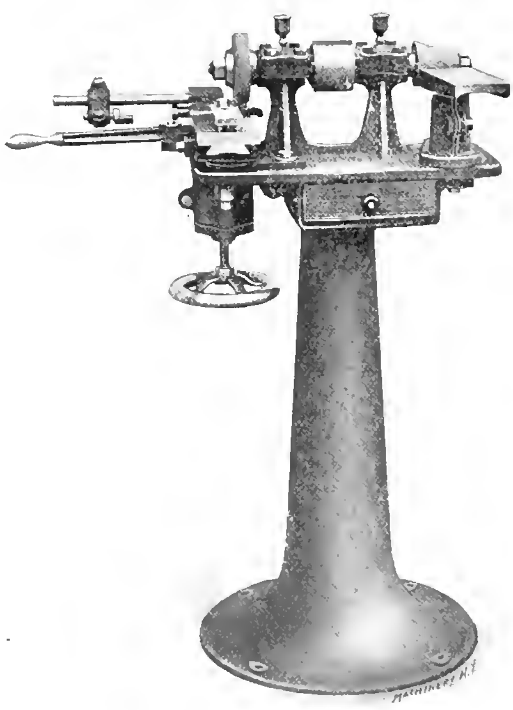
In the July issue of MACHINERY a description and illustration appeared of a No. 3 precision horizontal boring, drilling and milling machine, built by the Lucas Machine Tool Co., Cleveland, Ohio. The machine shown in the illustration was a cone-driven machine, whereas the description referred particularly to the same type of single pulley gear-driven machine. The latter type of machine which should have been shown instead of the cone-driven one, is reproduced herewith. The description of the mechanism of this machine will be found by referring to the July issue.



Lucas No. 3 Gear-driven, Precision, Horizontal Boring, Drilling, and Milling Machine.

BIGNALL & KEELER DIE-CHASER GRINDING MACHINE.

In order that a die may cut a clean and perfect thread, it is of great importance that the die chasers are provided with proper rake and clearance; if not, the threads cut are liable to be torn or stripped. It is equally important that a die chaser be kept sharp, as it is, for instance, that a lathe tool or a milling cutter be kept properly sharpened. As a rule, however, in most shops but little attention is given to the proper grinding of die chasers, and ordinarily no two chasers in the same die are ground alike. This mainly depends upon the fact that in the average shop there is no machine specially intended for doing this class of work.



Bignall & Keeler Die-chaser Grinding Machine.

Recognizing that there is a demand for a machine which will properly carry out the work mentioned, the Bignall & Keeler Mfg. Co., Edwardsville, Ill., has placed on the market the die-chaser grinding machine illustrated in the accompanying half-tone. It has been the aim of the makers to produce a simple and convenient tool which could be easily and rapidly operated, and which would require no particular skill of the operator of the machine. As seen from the illustration, the machine is provided with a special formed wheel on one end of the spindle. The die-chaser is clamped on the slide beneath the wheel, and is moved back and forth with a lever, the slide at the same time being gradually raised up closer towards the wheel by means of the hand-wheel shown. A gage on the slide, against which the die-chaser is placed, is adjustable at any angle with the wheel, in order to make it possible to grind straight thread die-chasers, as well as chasers for regular taper pipe dies. The shape of the wheel gives the die the correct angle of rake. A templet is furnished with the machine which will assist in dressing the wheel to the correct shape; a wheel dresser is also furnished. The cone-shaped wheel shown at the other end of the spindle is intended for grinding the lead or chamfer of the die-chasers. The specially shaped wheel at the left-hand end can easily be removed, and a straight face wheel used in its place, when it is required to grind tools other than die-chasers. The machine requires a floor space of 20 x 30 inches and weighs 425 pounds.

TRIPLEX BUFFING WHEEL.

A remarkable improvement in buffing and polishing wheels has been made by an invention of Mr. William A. Painter, of Pittsburg, Pa. This buffing wheel, known as the "triplex buff," is shown in the half-tone, Fig. 1, the construction also being indicated in the line engraving, Fig. 2. The buffing wheel is manufactured by the Zucker & Levett & Loeb Co., of 516-524 W. 25th St., New York City. The buffing wheel is made of the same grade of muslin as ordinarily employed for buffing wheels; but shows remarkable wearing qualities, the secret of the improved wearing qualities being in the manner in which the disks of muslin are folded and attached together. Instead of simply placing a number of disks side by side as in the ordinary buffing wheel, the Painter "triplex buff" is made in the following manner: A disk, as shown at *A* in Fig. 2 is folded along the dotted line, so as to appear as at *B*. It is then again folded along the dotted line, appearing as at *C*. A number of these folded sectors, the material of which is then four-ply, are arranged in a wheel as shown at *D*, each sector entering in between the folds in the next previous sector, for about 45 degrees of its full 90-degree angle. The prime object of this manner of making the wheel is to prevent the threads of the material at the edge of the wheel from pulling out, and fraying on the working edge. It is evident that in wheels consisting of plain circular disks, when fraying is started, it will continue all around the wheel, whereas in a wheel built up as described, there is no possibility for a continuous fraying all around the circumference of the wheel, on account of the fact that no one edge of the material continues for more than a quarter turn around the wheel.

There is another very important feature in connection with this method of making buffing wheels. When the wheel is worn down to, say, about half its original size, so that it can no longer be used to advantage, the stubs may be re-made into a wheel of the standard size, using two old wheels to make one new wheel. This is accomplished by fitting the

portions of the old wheel together in a manner as indicated at *E* in Fig. 2. In assembling a wheel of this form, two circular pieces of the diameter of the completed wheel are employed on the outside. One of these is spread out flat, and scrap pieces already folded in quarter sectors are arranged

Fig. 1. The Triplex Buffing Wheel.

radially as shown, and interwoven with one another in the same manner as described for the wheel at *D*. When a sufficient number are placed on one another to give the desired thickness, the second outside disk is placed over the folded disks and the folded disks are secured to the two outside ones by staples, the positions for which are indicated at *F*. The re-made buffing wheel is fully equal to the original buffing wheel in its wearing qualities.

The triplex buffing wheel wears at least twice as long as the ordinary wheel, and in some cases it is stated that the wear has been four times that of the regular buffing wheel.

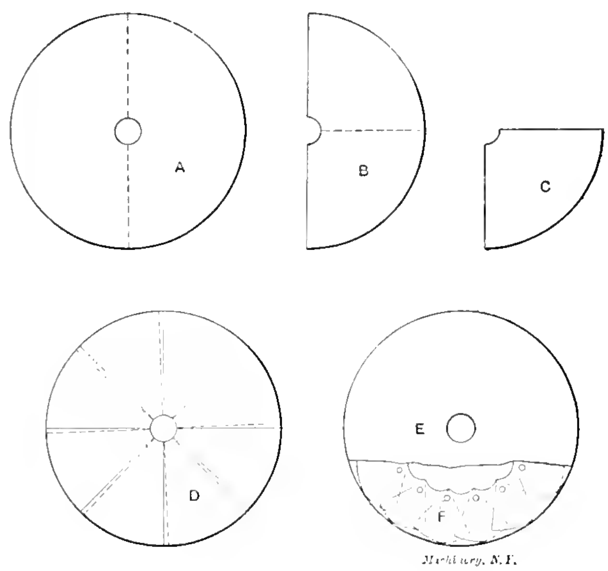


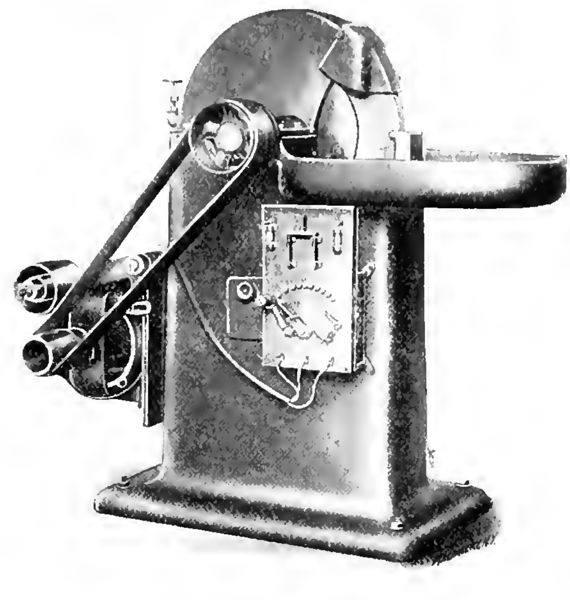
Fig. 2. Illustrations showing the Construction of the Triplex Buffing Wheel.

Another advantage of the wheel is that it saves rouge or other polishing composition to a considerable extent, the construction of the wheel tending to hold the composition in a better manner than does a regular circular disk. Wheels of this description have been in actual use for over a year, and thus do not constitute a mere experiment, but have actually proved their value.

RANSOM MOTOR-DRIVEN TOOL GRINDER.

The illustration herewith shows a motor-driven tool grinder brought out by the Ransom Mfg. Co., Oshkosh, Wis. One of the principal features of this machine is the application of the Ransom patent speed controller, which may be adapted to these machines when used with direct current. This device automatically speeds up the motor as the grinding wheel wears down, thus maintaining the same peripheral speed of the wheel. In general, this device consists of a field rheostat, the arm on which is connected by a link to the so-called water trap, or the piece of the guard at the front of the hood shown in the illustration, which is shoved down as the wheel wears. The connection is made in such a way that the proper amount of resistance is put into the field coils to give the proper speed for the various diameters of the wheel. Attaching the motor, as shown in the illustration, permits any size and type of motor, using any current, to be placed in position.

The water is contained in a large tank holding a month's supply. The tank can be taken out-of-doors for cleaning purposes. The pump is, in reality, a vertical blower in which there are no packed joints, so that the grit in the water does not affect it. A rubber hose is used to feed the water, as it is more easily cleaned than a gas pipe with its elbows and connections. The tool rest is perforated on the inside so that the water shoots through it on the wheel instead of spattering



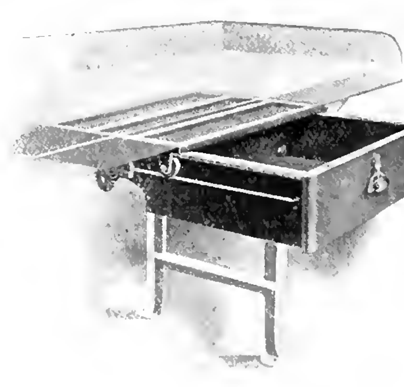
Ransom Motor-driven Tool Grinder.

all over from a nozzle above the tool, as is the case with most tool grinders. On account of this, there is no water on the upper part of the wheel except when running.

On this grinder the wheel is 20 inches in diameter by $1\frac{1}{2}$ inch wide. The floor space required by the base is 20 x 33 inches. The pulley is 6 inches in diameter by $4\frac{1}{4}$ inches wide, and the weight of the machine is 950 pounds.

NEW BRITAIN BENCH DRAWER.

A bench drawer for machine shop use has been placed on the market by the New Britain Machine Co., of New Britain, Conn. The accompanying illustration shows the appearance of the drawer, the principal features of which are the locking arrangement and the fact that the drawer is sold as a unit, and



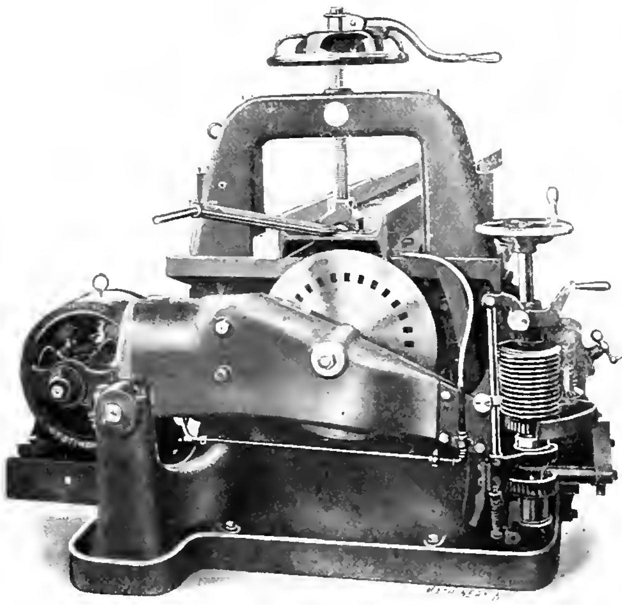
"New Britain" Work Bench Drawer.

can be applied by anybody who can insert a few screws, without any cutting of the work bench. There is no assembling to be done, and there is no damage or loss if it is ever desired to move the drawer. The locking arrangement, as mentioned, is a special feature; when locked, the drawer cannot

be entered or removed without breaking the lock. A smooth plate over the top of the drawer prevents any tampering with it from the rear. The dimensions are such that the drawer is long enough to hold, laid straight, the longest hammer or file a machinist is liable to use, and broad enough to contain the required variety of tools, without piling them on top of one another. Wood is used for the back, top and front, so that fine edge or precision tools may be laid in the drawer without damage. The drawer runs on anti-friction rollers on finished surfaces, giving a smooth movement, and at the same time clamping or wedging of the drawer is entirely prevented by a parallel motion, consisting of a cross shaft and pinions on racks. The inside dimensions are 22½ inches long, 15 inches front to back, and 5 inches deep. The weight, ready for shipment, is 75 pounds.

LEA MOTOR-DRIVEN COLD METAL SAW.

The cold-metal saw illustrated in the accompanying half-tone has been placed on the market by the Lea Equipment Co., 136 Liberty St., New York City, and has been specially de-



Lea Equipment Co.'s Motor-driven Cold Metal Saw.

signed for motor drive. This adaptation will make it particularly valuable for installation in such parts of the shop where it is difficult to locate a saw driven from a counter-shaft. There are, for instance, in the average machine shop, one or more saws required in the stock room or at some other equally inconvenient place for a belt-driven machine. In such a case, the use of a self-contained motor-driven machine will be particularly appreciated. The machine is fitted with a Westinghouse variable speed motor, having a speed range of from 1 1/3 to 1, with a speed controlling rheostat. It is only necessary to move the handle of the controller to obtain any desired speed. The size of machine shown in the illustration requires a 3½ H. P. motor, and is capable of cutting off round stock up to 8 inches in diameter. The motor is connected with the driving shaft of the saw by a Morse silent chain, direct-connected gearing having been eliminated because experiments have shown that a chain drive is more satisfactory. The variable speed of the motor permits adjustment of the cutting speed for different materials, in order to obtain the maximum efficiency of the saw. The most advantageous peripheral speed of the saw is 52 feet per minute with a very coarse feed for structural iron, machine steel, and similar materials. For annealed steel a lower speed of but 37 feet a minute gives greatest efficiency. The same speed is also used on chrome-nickel steel. The cutting-off machine itself is heavily and rigidly designed and embodies all the features required of an up-to-date tool of this description.

CONKLING REVERSING DEVICE.

The accompanying half-tones illustrate the application and construction of a new mechanical reversing device which has been designed by the Conkling Company, Chicago, Ill. The particular features of this device are that it is applicable to any

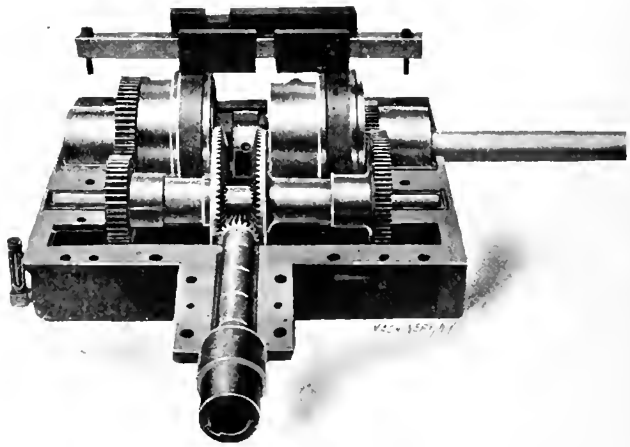


Fig. 1. Construction of Reversing Device—Upper Half of Cover removed.

machine requiring reversing, that it will reverse without shock, is self-adjusting, and automatically takes up the wear. The device is running in oil so that the wear, therefore, is reduced to a minimum.

In Fig. 2 the device is shown applied as a reversing mechanism to a planer. In this capacity the mechanism has been in operation in the Conklin Company's shop on a planer, used in connection with an individual motor drive. When applied as shown, the platen of planers ranging in size from 24 to 40 inches can be run on the return stroke at a speed of 200 feet per minute. Ordinarily the platens of these sizes of planers are not run on the return stroke at a higher speed than 75 feet, or at most 100 feet per minute.

Referring to Fig. 1, this illustration shows the construction of the reversing mechanism. The shaft extending at the right is coupled to the pinion shaft on the planer, while the other shaft extending toward the front of the device is connected to the driving motor. On this shaft is placed a bevel pinion

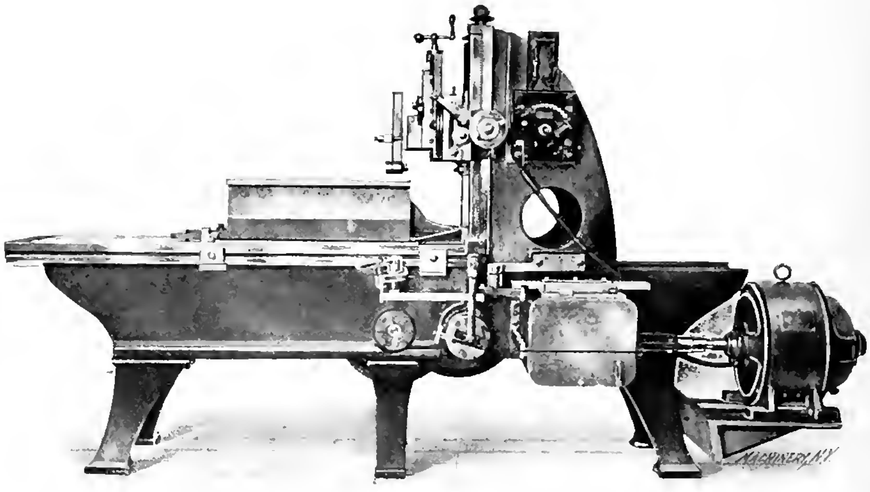


Fig. 2. Planer equipped with Conkling Reversing Device.

driving one bevel gear on each side, these gears, of course, running in opposite directions. The gear at the right runs the platen on the return stroke at high velocity, and the gear to the left drives the planer on the forward stroke. The manner in which the speed reduction is obtained is easily visible from this illustration, a large spur gear being placed to the right,

meshing with a smaller one on the planer driving shaft, while to the left a small spur gear on the same shaft as the bevel gears drives a large gear on the planer driving shaft. On this latter shaft are placed the clutches by means of which either of the spur gears on this shaft are connected with the shaft itself, the controlling yokes being shown in place in the illustration, together with the bar by means of which they are operated. To the extreme left in Fig. 1 is shown an oil gage glass which shows the depth of oil that should be kept in the gear case.

This device can be applied to any planer, whether new or in use, and in connection with individual motor drive it adds a valuable feature to the machine.

DUST EXHAUSTER FOR WALKER SURFACE GRINDER.

The accompanying half-tone and line engravings illustrate the arrangement and construction of a dust exhauster for surface grinding machines, recently brought out by the Walker Grinder Co., Worcester, Mass. The device consists principally of an ordinary exhaust fan, mounted over an iron receptacle partially filled with water, and exhausting downward into the tank. The hood over the grinding wheel is provided with a large mouthpiece on the rear side near the bottom, so arranged that it is in close proximity to the work and so that the natural course of the sparks from the grinding will be toward the suction pipe. The detailed construction is

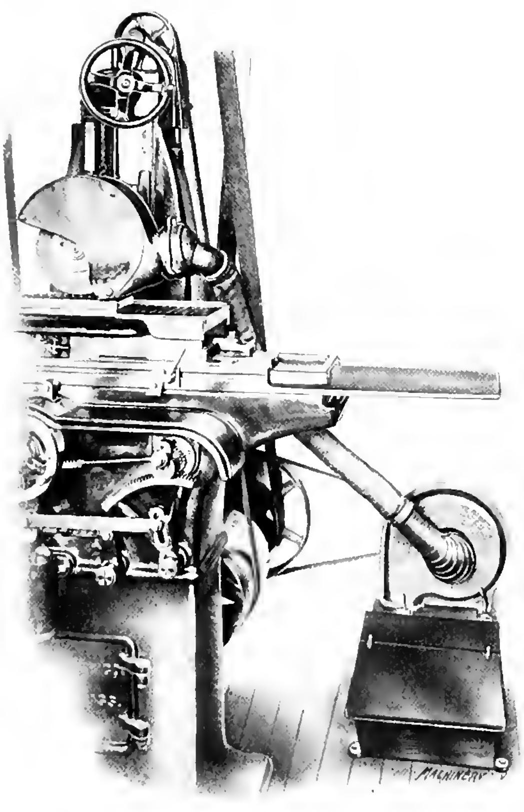


Fig 1. Arrangement of Walker Exhauster for Surface Grinder.

very plainly shown in Figs. 2 and 3. In Fig. 2, *A* is the grinder hood provided with a detachable side *B*, for the purpose of being able to easily remove and replace the grinding wheel when required. The mouthpiece of the hood is lined with a leather cone *E*, forming a seat for the ball joint exhaust connection *C*, which is held in place by the ring *D*, which is concaved on the inside opening so that it may be set to any desired angle, and clamped by means of screws *F*. The hood *A* is fastened to the grinder head and swivels around the axis of stud *G*, being clamped in position by a screw passing through the oblong slot *H*. This adjustment is introduced for the purpose of setting knife *K* of the device, so that it will just clear the top of the work, and also to provide for different diameters of wheels. The wheel shown in the half-tone Fig. 1 is about half worn out.

The fan, mounted on the water tank, as shown in Fig. 3, is driven from a 14-inch pulley on the drum counter-shaft, belonging to the surface grinder itself. If preferred, the fan can be belted to a counter-shaft in the ceiling, but as there is

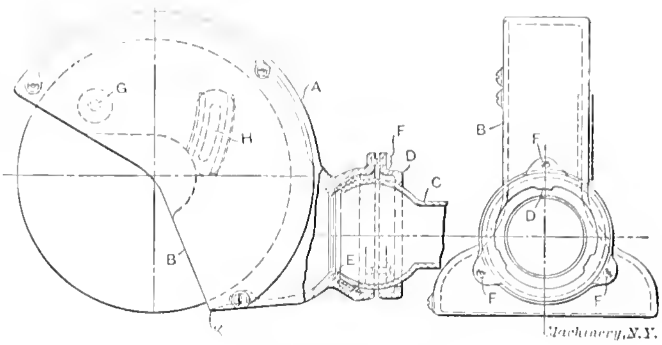


Fig. 2. Dust Exhauster Hood.

no objection to the arrangement shown, it is recommended on account of being very compact, and also because it has the merit of being self-contained. The tank is provided with a cover *M*, which can easily be raised at the front for the purpose of cleaning, and renewal of the water.

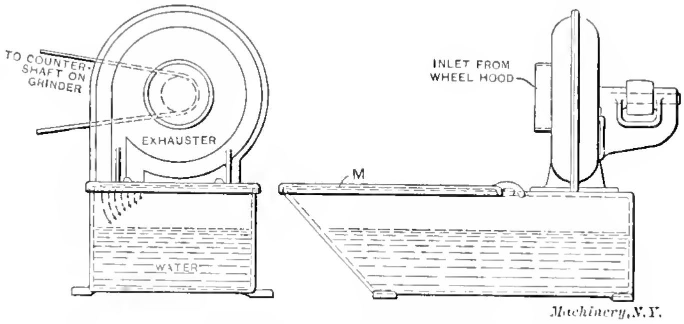
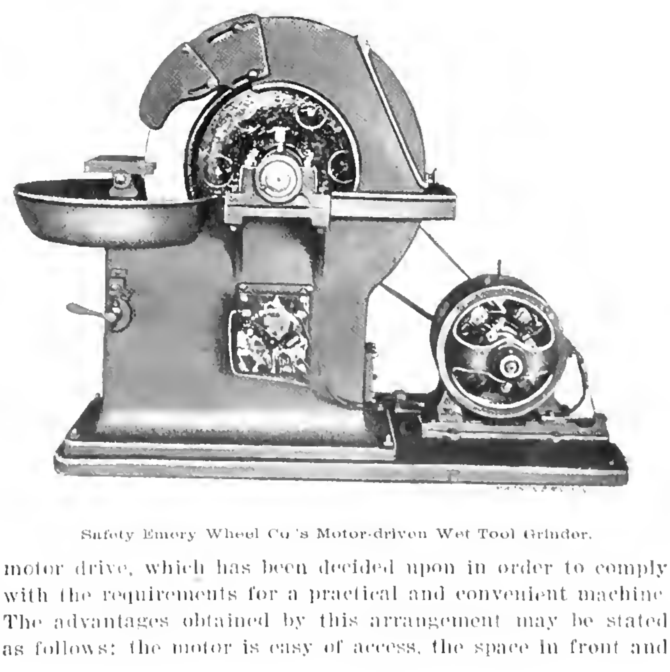


Fig. 3. Water Tank and Fan Exhauster.

The Walker Grinder Co. has had one of these devices in operation in its own shops for several months, and has found it highly desirable for a machine used for dry grinding. While it is not claimed that the device takes care, entirely, of the metal dust from the grinding, it does exhaust all the fine dust, so that the air is not contaminated, and the slight amount of metal dust remaining is of no consequence.

MOTOR-DRIVEN TOOL GRINDER.

The wet tool grinder illustrated herewith, arranged, as shown, for motor drive, has recently been placed on the market by the Safety Emery Wheel Co., of Springfield, Ohio. The main feature of the new machine is the arrangement of the



Safety Emery Wheel Co.'s Motor-driven Wet Tool Grinder.

motor drive, which has been decided upon in order to comply with the requirements for a practical and convenient machine. The advantages obtained by this arrangement may be stated as follows: the motor is easy of access, the space in front and

on the sides of the grinder is unobstructed; there is no difficulty in renewing the wheel; and the belt connection between the motor and the wheel prevents undue wheel shock from being transmitted to the motor, and, at the same time, the belt tension is easily adjusted by moving the motor slightly back and forth on its base-plate pads. Incidentally, the advantage of being able to use any standard motor is gained, the pulleys being proportioned accordingly. The machine and the motor, although independent of each other, as shown in the illustration, are both mounted on the same sub-base plate, so that the motor forms an integral part of the complete machine. The controller is placed very conveniently on the side of the machine, as shown. As regards the grinder itself, it possesses some valuable features not commonly found. Long tools, bars, etc., can be ground by opening a hinged door or cover in the back of the gear guard. The motor is properly covered to prevent any disastrous effects from the water which may spray over it from this grinding operation. Topheaviness is avoided by ample distribution of metal near the base.

SPUR GEAR HOBBING MACHINE.

A machine for hobbing spur gears, remarkable for its simplicity of design, has been brought out by the Moline Tool Co., Moline, Ill., and is illustrated in the half-tones, Figs. 1 and 2, Fig. 1 showing a general view of the machine, and Fig. 2 a view of the machine from above.

The machine is a marked departure from any previous designs of spur gear hobbing machines. A feature that at once demands the attention of the observer is that the hob spindle is set at a permanent angle to the travel of the gear blank and is not adjustable, which, as far as we know, is a feature wherein the tool differs from all other machines for hobbing gears. Thus the spiral angles of all the hobs are set the same, and the hobs are made of different diameters in order to allow for the different pitches. For the finer

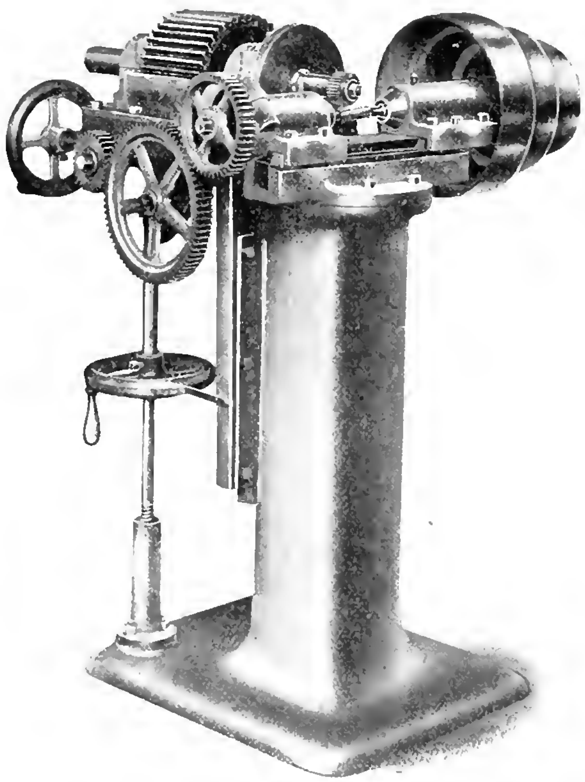


Fig. 1. Moline Tool Co.'s Automatic Spur Gear Hobbing Machine.

pitches, where the hob would become too small to be advantageously used, it is made with double thread. As is very plainly shown in Fig. 1, the hob spindle on which the driving pulley is mounted is connected by gearing to a shaft *A*, Fig. 2, at the rear of the machine, from which the rotary motion to the gear blank is transmitted. This motion, however, is not transmitted to a worm-wheel from the worm on shaft *A*, but instead of a worm-wheel a master spur wheel is used, which has sufficient width of face to traverse past the worm on the shaft *A*, Fig. 2, when the blank is fed forward. The worm shaft runs in an adjustable bearing, so that the worm can always be kept in proper mesh with the master wheel. The worm is cut at the same angle as are the hobs, so that the worm shaft and hob spindle are set parallel with each other, and are permanently in line. It is evident that this greatly adds to the simplicity of the design.

The master wheel *B*, Fig. 2, is mounted directly on the work-carrying spindle, and is mounted in bearings on a carriage or slide, which is fed automatically forth and back, so that when the master wheel traverses past the master worm, the blank to be cut is traversed past the cutting hob. On account of the parallelism between the hob and the worm-driving master gear *B*, the matter of gearing is very much simplified, and, in fact, is no more complicated than that of the gearing in an ordinary screw-cutting lathe.

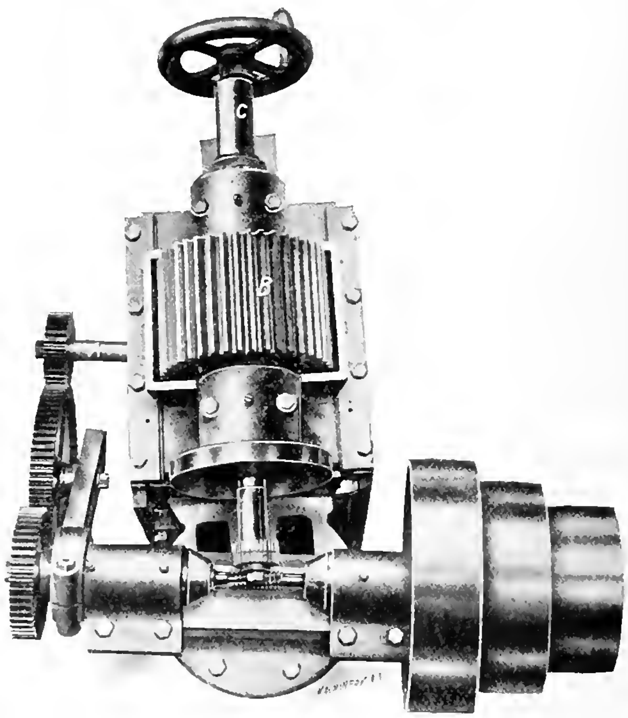


Fig. 2. Top View of the Spur Gear Hobbing Machine.

The feed of the carriage is directly from gears mounted on the rear end of the work spindle at *C*, Fig. 2, to gears on the feed-screw directly below. The end of the feed-screw is provided with a hand-wheel for feeding by hand. In the half-tones, the feed gear on the end of the work-carrying spindle and the feed-screw gear, are removed and are not visible. There is also a cover over the master gear *B*, which is removed in order to show this part.

The hob end of the column, under the hob and work, is open, so that all the chips fall directly into the opening, and are removed through a door at the bottom of the column on the back side of the machine, thereby avoiding scattering the chips around the floor. This machine is made in one size only, and has a capacity of cutting spur gears up to 12 inches in diameter, 5 diametral pitch, and 6-inch face.

GARDNER COMBINATION DISK GRINDER.

In the July, 1908, issue of MACHINERY a double disk grinder, built by the Gardner Machine Co., Beloit, Wis., was described and illustrated. The company has also brought out a combination disk grinder, consisting of the grinder as previously shown in MACHINERY, and fitted with a third wheel on the right-hand end, and with a rocker shaft fastened in the base of the machine on which any style of work table may be mounted. A style of table particularly convenient for manufacturing purposes, where rapid handling of duplicate pieces is required, termed the universal lever feed table, is particularly recommended. This table has a vertical and angular adjustment and is counter-balanced. The top surface of the table is provided with T-slots for bolting fixtures or holders

for the work. The table is operated by a hand lever, and is adjusted by a micrometer stop screw, graduated to 0.001 inch. When the right-hand end of the machine is used alone, the head carrying the double disks is uncoupled from the rest of the machine. When the machine is not used for double-face grinding at all, the movable head can be entirely removed, and a special table substituted for single-face grinding. The weight of this machine, which is termed No. 12 Combination Gardner's improved disk grinder, with all its accessories, crated for domestic shipment, is 2,200 pounds.

NORTON MOTOR-DRIVEN GRINDING MACHINE.

The accompanying two half-tones show a front and back view of a new grinding machine which has been brought out by the Norton Grinding Co., Worcester, Mass. This machine is known as a 20 and 32x168-inch self-contained electric drive grinding machine, the name being derived from the fact that the machine swings 20 inches, except in the gap plainly indicated in Fig. 1, where it will swing 32 inches. One of the principal features of the machine is this gap arrangement. In the grinder shown in the half-tones the gap is in the center of the table and is 44 inches long. The gap can, however, be made of any length and placed at any position on the table to suit the work for which the machine is especially intended.

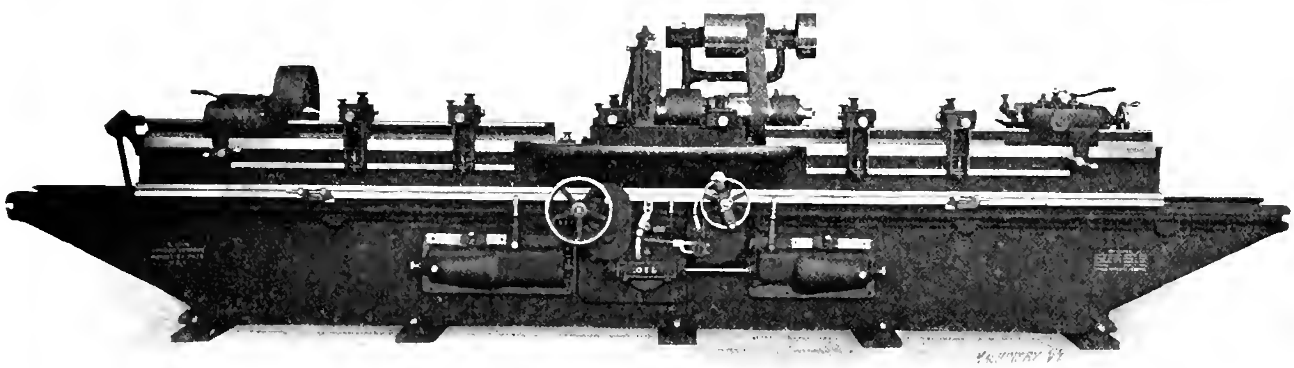


Fig. 1. Front View of Norton Self-contained Motor-driven Grinding Machine.

The rear view of the machine, Fig. 2, shows the manner of application of the electric motor. It will be seen that no extra floor space is required for the motor, as it stands within the rectangular outlines defined by the extremities of the base of the grinding machine itself. The motor should be of 20 horsepower for large and heavy work, but if the machine is regularly used for small work, a smaller motor could be applied, the makers stating that from 5 to 20 horse-power should be reckoned upon, according to the character of the work and the ambition of the operator in turning out the product. The details of the construction are practically the same as those of the regular sizes of the Norton grinding machines, and the same methods of construction as employed in the building of the regular types have been adhered to. The foot-stock is arranged for sensitive adjustment in order to secure straight work, and both the head and foot-stock are made extra heavy to insure durability as well as accuracy when heavy work is supported. The grinding wheel used with this machine is 24 inches in diameter by 4 inches face.

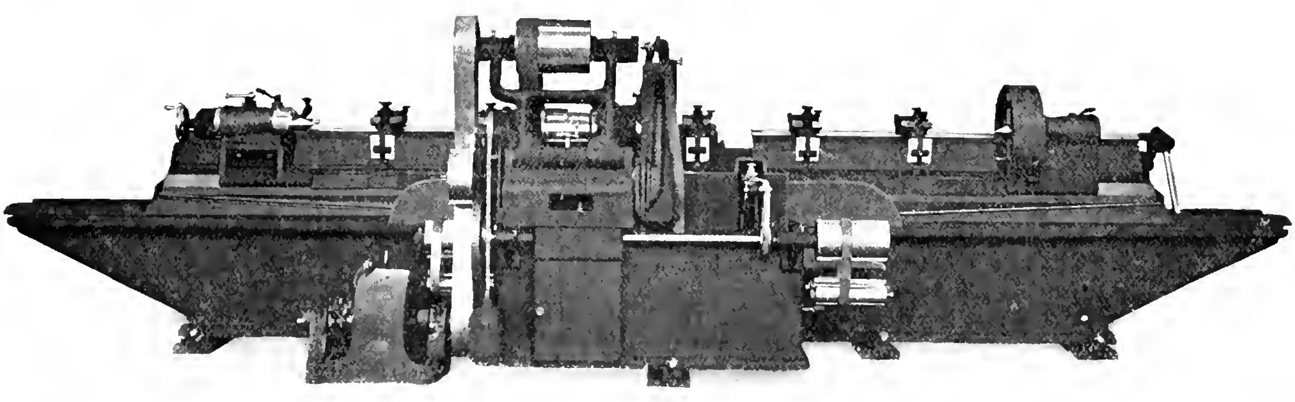


Fig. 2. Rear View of Grinding Machine, showing Arrangement of Motor and Drive.

The plates shown under the grinder bed in both Figs. 1 and 2 are intended to be carefully imbedded to straight-edge and level in the foundation of the machine. Wedges are used under the machine, resting on these plates; these wedges are adjusted with two nuts, one on either side of the projecting end of the wedge, the nuts being operated on threaded studs fixed in the base of the machine. Both the plates and the wedges are machined to insure broad permanent contact.

The machine shown in the half-tones was made especially for a German railway works, for grinding crank-pins, valve stems, truck axles and piston rods, the pistons having extension rods. Steady rests are shown mounted on a base, which is arranged to be moved along the front edge of the gap, to accommodate different thicknesses and different positions of pistons. These rests with their base can be removed to give a clear space over the entire gap. The total length of the machine is 22 feet and the total weight is 25,000 pounds.

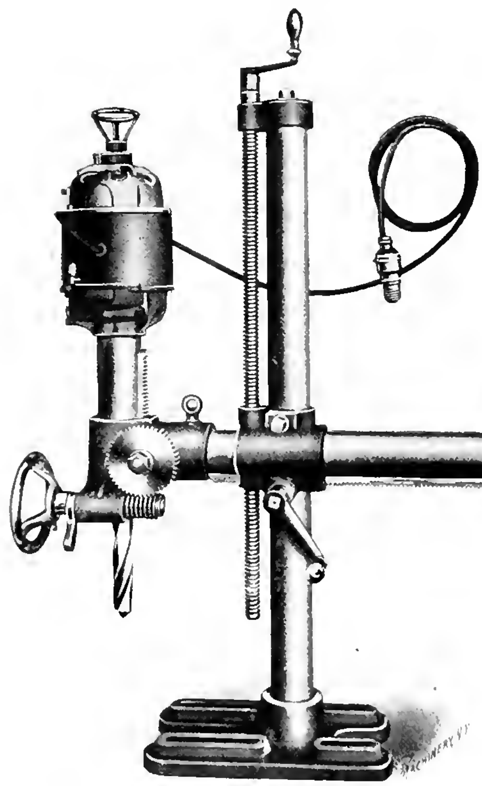
PORTABLE ELECTRIC RADIAL DRILL.

The accompanying half-tone illustrates a portable electric radial drill placed on the market by the United States Electrical Tool Co., Cincinnati, O. The general features of this machine are plainly indicated in the illustration. The drill is fitted with a rack and pinion for feeding the radial arm outward, and it can drill at a radius of 32 inches at any place in the horizontal plane and at any angle. The radial arm is provided with an index line and a corresponding line is made in its sleeve, so that the drill can be set in a perfectly vertical position in a very few seconds.

The drill can be fed downward 5 inches by means of the hand-wheel shown to the left in the illustration, which, through a worm and worm-wheel, connects with the usual rack and pinion feed arrangement. On the back side of the machine, not shown in the illustration, a crank is provided for quick return by hand. The vertical column and the horizontal arm are made of a hollow steel tubing, the column being fitted with a screw to raise and lower the arm. The drill spindle is fitted with thrust ball bearings. The motor is of the air-cooled type, and the current is taken directly from an ordinary incandes-

cent lamp socket, the motor being supplied either for direct or alternating current. The hand-wheel shown on the top of the electric drill motor, is used for knocking out the twist drills.

It will be noticed that the horizontal arm is fitted with an eye-bolt so placed that the device counterbalances at this point. This eye-bolt is used for carrying the drill about the shop



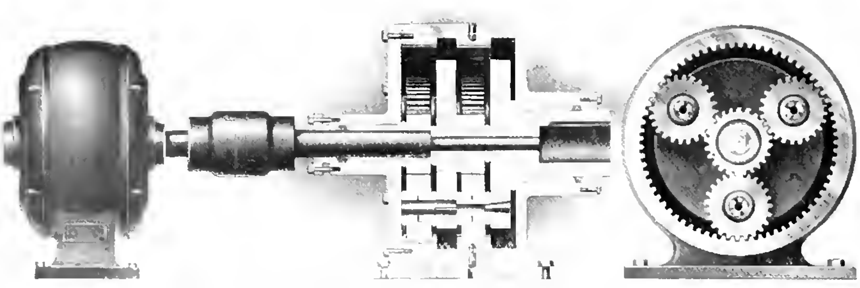
United States Electrical Tool Co.'s Portable Electric Radial Drill.

with a crane or hoist, or by placing a bar through the eye-bolt for two men to carry the drill, the weight of which is 160 pounds.

These drills are made in two sizes, one intended for drilling holes up to ⅞-inch in steel, and the other for drilling 1¼-inch holes in the same material, the drill spindle being fitted with a No. 2 Morse taper socket for the smaller size, and with a No. 3 socket for the larger size drill.

SPEED REDUCING GEAR.

The accompanying illustration shows a speed reducing gear intended particularly for reducing the speed from the motor driving shaft to any required speed of the driven shaft on the machine to which the motor is connected. As plainly shown in the illustration, the design is based on the principle of using planetary gears, two sets of which are used in order to bring down the speed reduction to the required ratio. The mechanism is entirely encased and oil-tight. The special advantage of this reducing gear is that the power is taken from



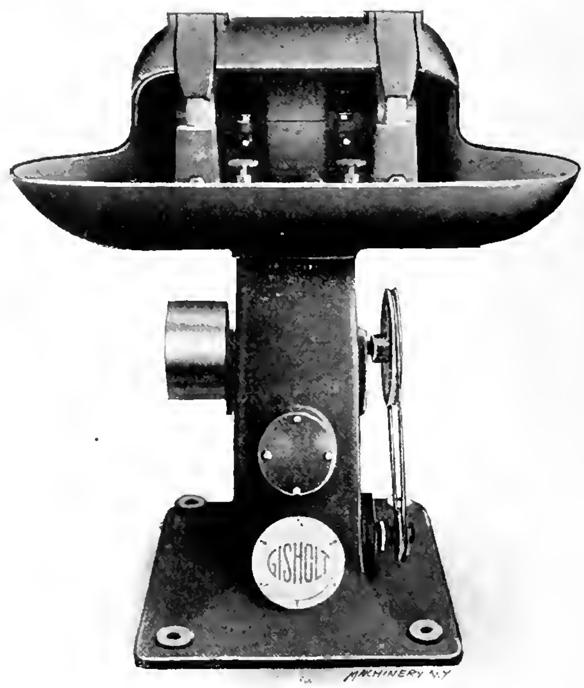
D. O. James Mfg. Co.'s Speed Reducing Gear.

three points, and all the moving parts run in the same direction, so that it gives a balanced drive that has a greater margin of safety than a drive with one or two planetary gears would have, and it requires practically no attention. The annular or internal gears are made of semi-steel, the idlers being made of steel, and bushed with hardened steel bushings. The bearings are bushed with phosphor-bronze. The device is made in a variety of sizes and speed reductions, for ⅛ to 50 H.P., and can be arranged either vertically or horizontally. A universal coupling is also made by the makers for connecting the motor to the reduction gear shaft, which obviates the necessity for perfect alignment between the motor and the device.

Several applications of the use of this speed-reducing gear could be mentioned. In one case, for instance, a 5 H.P. vertical motor driving a vertical shaft is provided with a speed-reducing gear having a reduction ratio of 73 to 1. In another case a 7½ H.P. motor with a reduction gearing of 4 to 1, is direct connected to a worm-gear elevator, this drive eliminating the objectionable belt drive. In another case, a 2 H.P. reduction gear is placed between the motor and an automatic gear-cutting machine, reducing the speed from 1,800 to 245 R.P.M. As a last example we may mention a 5 H.P. motor with reduction gear, direct connected to a line shaft, reducing the speed from 1,000 to 150 R.P.M. This device is manufactured by the D. O. James Mfg. Co., 351-353 W. Monroe St., Chicago, Ill.

GISHOLT DOUBLE EMERY GRINDER.

The double emery grinder illustrated herewith, represents one of the latest machines brought out by the Gisholt Machine



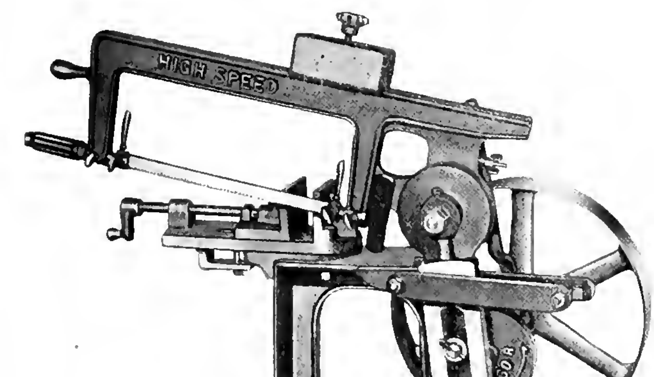
Gisholt Double Emery Grinder.

Co., Madison, Wis. This machine is supplied with two emery wheels, 1½-inch face and 14 inches diameter, mounted on a spindle running in adjustable self-oiling boxes. Any end play in the spindle may be easily taken up by adjusting two screws in the face of the spindle driving pulley. The machine is supplied either belt-driven or provided with motor drive. Several improvements have been embodied in the design of this grinder. The wheels and driving parts are enclosed as much as is possible by suitable guards. The method of water supply largely eliminates the splashing of the water, and materially assists in keeping the floor by the machine dry. A fan water pump and a large water reservoir are provided in order to insure an abundant supply of water. The water nozzle, instead of being at the usual position on the upper side of the work rest, is placed in the back or wheel side of the work rest; the water, therefore, instead of coming from the nozzle directly over the wheel and rest, follows the wheel nearly a

full revolution, and comes around in a fine spray, meeting the work at the point of contact with the emery wheel. The work is thus always in plain view. The machine has a large water pan of such dimensions that a piece of work up to 14 inches in length will come entirely within the pan when grinding, and therefore any drip from it will go directly into the pan, from which it drains into the tank, instead of splashing on the floor. It will be noticed from the engraving that the spindle pulley is well protected, so that the belt is kept entirely free from water and emery, thus materially increasing the life of the belt. The machine is very heavy for its size, and was originally designed by the Gisholt Machine Co. for its own use.

CHALLENGE HIGH-SPEED POWER HACK-SAW.

The power hack-saw illustrated in the accompanying halftone engraving is manufactured by the firm of C. J. Weinman & Co., Dayton, Ohio. It embodies several interesting features, and differs in some respects to a great extent from the ordinary type of power hack-saw. One of the special features of the machine is that a friction device is provided for raising the saw blade from the work on the return stroke, the same device forcing the blade into the metal during the cutting stroke. This on the one hand saves the saw teeth, and on the other, makes the saw cut faster. Another feature of interest is embodied in the design of the connecting arm; by having this slotted in the center, a quick return stroke is accomplished, while the forward stroke is slow. This arrangement adds about thirty per cent to the speed of the machine as compared with a machine of the old type, where the forward and return strokes are at the same velocity. Having done away with the regular type of connecting-rod, the builders have been able to present a machine that is much more compact than the ordinary power hack-saw, making it more rigid and at the same time taking up less space. The machine is provided with a swivel vise for cutting off stock at an angle, and with an adjustable stop for the length of the

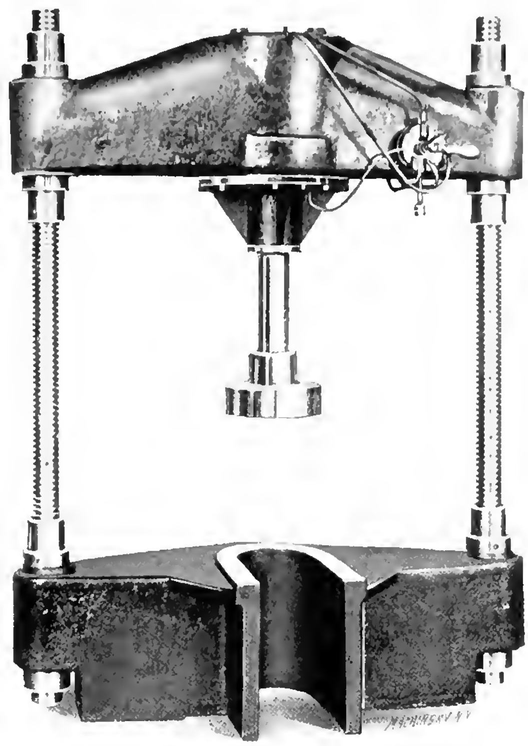


C. J. Weinman & Co.'s High-speed Power Hack-saw

stock to be cut off. The machine has adjustments to insure straightness of cut, and proper adjustment for wear. The most important dimensions are as follows: The capacity of the machine is $4\frac{1}{2}$ x 5-inch stock. The floor space occupied is 15 x 31 inches. The diameter of the driving pulley is 15 inches, the width $2\frac{1}{2}$ inches, and its speed 60 revolutions per minute. The length of saws used is 12 inches. The weight of the machine is 160 pounds.

SPRINGFIELD PNEUMATIC PRESS.

The accompanying illustration shows a pneumatic press designed and built by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O., for use in the company's own factory for making press fits, as an arbor press, etc. The tool, however, has proved to be so useful that it has been decided to place the device on the market. Besides its vari-



Pneumatic Press built by the Springfield Machine Tool Co.

ous uses in ordinary machine shops, this tool ought to find application in railroad shops, where a large number of bronze boxes are forced into locomotive parallel rods and for forcing crown brasses into locomotive driving boxes, and for many other purposes. The special feature of the press is that it is operated by compressed air. The device consists of two main frame castings and two heavy upright screws. The base casting is of massive proportions, in order to give adequate strength, and is wide enough to permit work 40 inches in diameter to be laid upon it. The opening in the base casting at its center, clearly shown in the illustration, extends back beyond the center of the device, and is for the purpose of permitting a portion of the work, such as a shaft, axle or arbor, to extend below the device a considerable distance.

The upper frame casting contains in its center the air cylinder, 12 inches in diameter, the piston having an 8-inch stroke. If required for special cases, the stroke can be made longer. The piston is fitted with three rings, which prevents air leakage. The lower end of the piston rod carries a heavy circular shoe, as shown in the engraving, the central portion of which is filled with babbitt, so that the work will not be bruised when the pressure is applied. The object of threading the two uprights is to permit adjusting the upper casting to whatever height is required by the work. By the use of the adjusting screws the press can be made to accommodate almost all classes of work.

The operation of the air for the piston is through a valve at the right-hand side of the upper frame casting, this valve controlling the air both above and below the piston. The valve is very simple in its operation. As it is moved from the left-hand position the piston is raised, while a further movement will shut off all the air; then by moving the handle still further in the same direction, the piston is lowered, which permits the full air pressure to be applied to the work. If the pressure thus obtained does not prove to be sufficient to give the desired results, a further movement of the controlling handle in the same direction throws into operation a small, quick-acting air pump, which is placed on

the top of the upper frame, but not shown in the accompanying engraving. This pump is capable of raising the pressure to 250 pounds, when the main line is supplied with air having 80 pounds pressure to the square inch. The air supplied through the valve is so regulated that the piston cannot move too rapidly in either direction. The press as shown, without the auxiliary pump, when supplied with air of 80 pounds pressure per square inch, is capable of exerting a total pressure of 8,800 pounds at the end of the piston rod, but when the pump is brought into action, it will exert a total pressure of 27,000 pounds.

TOLEDO DOUBLE-PITMAN GANG PRESS.

The demand for machines for performing punching operations rapidly and economically, as well as the activity of the manufacturers of this class of machines, is exemplified by the fact that hardly a month passes without our recording some progress in press design. In the half-tone, Fig. 1, and the line engraving, Fig. 2, a general view and the design of a double-pitman gang press, brought out by the Toledo Machine & Tool Co., Toledo, Ohio, is shown. This press is designed for operating a gang of six sets of dies for cutting out the tops or bottoms of tin cans, but the press can, of course, be used for various other classes of work of a similar nature. It is set in an inclined position in order to permit the sheet metal to feed through by gravity. The press has a capacity for producing 200,000 pieces of this character in ten hours, and its construction embodies several interesting features, which we shall refer to in detail.

When first placing the sheet in the press, the hand lever just visible on the left-hand side of the press in Fig. 1 is operated, after which the press is started in the regular manner by the foot treadle and runs continuously for the required number of

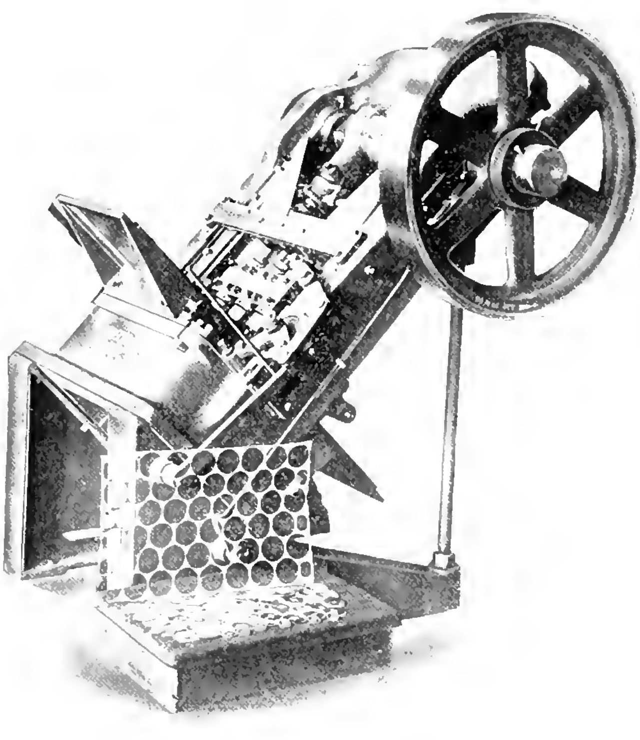


Fig. 1. Toledo Double Pitman Gang Press.

strokes to finish the sheet. At this point the press is automatically stopped by a cam movement of the disk at the right-hand side of the housing, which disengages the locking device for the foot treadle, and in this manner releases the driving clutch. The hand lever shown in Fig. 1 on the right-hand side of the press, enables the operator to instantly release the clutch mechanism, before the completion of the entire sheet, at any stroke required.

The relative position of the dies is shown in the line engraving, Fig. 2, which also shows in the sectional view the construction of the dies, and the independent means for control and adjustment of each die. The six dies are set in two rows in an alternate or staggered position in order to be able to use up the amount of stock to its fullest extent. How well this latter object is obtained is shown by the scrap left from the punching operation, which is shown in front of the base of the machine in Fig. 1. This illustration also shows how in a separate punching operation in another press the small amount of scrap left in three places at each end of the sheet is used up for rectangular can bottoms. This procedure, and the arrangement of the dies reduces the scrap to the smallest amount possible, yet leaving a web of the sheet between the holes to prevent clogging up or buckling of the sheet in the dies. This web, however, is a trifle less than 1/16 inch at its smallest width.

Referring to Fig. 1, it will be seen that the slide proper or main ram is very long, having bearings practically twice the

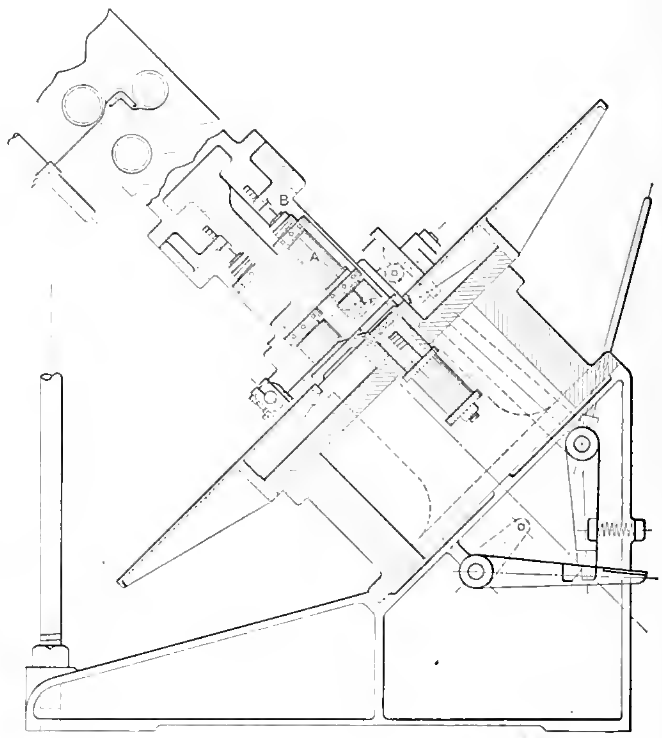


Fig. 2. Section through Press, showing Construction.

length of similar bearings in ordinary presses. Each of the upper dies fits in a recess or socket, the dies being securely clamped in position by means of a cap and four studs, as indicated. These punch holders or upper dies are provided with an adjustment obtained by a threaded shank *A*, Fig. 2, on which collars are fitted above and below the socket or cap, providing in this manner an easily accessible adjustment, in addition to the regular twin gear adjustment provided for the slide or ram proper. The cutting punches or upper dies are screwed to the ends of the shanks referred to, and can be removed for repairs or renewal without difficulty. The lower dies are each mounted separately in independent holders, which are in turn set in recesses in the main bolster or bed plate. In this manner positive and correct alignment of the upper and lower dies is obtained at all times.

An automatic positive knock-out to the upper dies is provided by means of a stem or bar *B*, running down through the threaded plunger or sleeve *A*, shown in Fig. 2, and connecting to the inner pad of the upper die. Directly above this rod or bar, and attached to the cross bar, running from right to left of the press, both in the front and rear of the machine, is the knock-out arm. This arm is fitted with a screw and jam nut, providing an independent adjustment for the knock-out to each set of dies.

The heavy bolster or bed plate is held in position by means of four large bolts. This plate has massive lugs or ears on the right- and left-hand side in front of each housing of the press, and the plate is securely held obviating the tendency to slide downward because of the inclined position.

It is not required to square the sheets to prepare them for this press, and one operation taking considerable time is thereby avoided. As already intimated, each die or set of dies in the group of six may be removed, replaced and adjusted independently of each other in the same manner as when

using similar dies in a single die press. This is one of the principal features of the machine, whereby it overcomes one of the greatest sources of inconvenience heretofore experienced in the use of gang presses.

American Steam Gage and Valve Mfg. Co., Boston, Mass. Vest pocket speed counter, registering accurately the number of revolutions in plain figures. The device is very small and convenient to carry.

Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa. Motor-driven cold saw, especially designed for small work. The table on which the work is clamped has vertical and horizontal adjustment, and the saw-carrying head can be swiveled around to any angle desired. Speed variation is effected by using a variable speed motor.

H. C. H. Walsh Co., 2448 W. Kinzie St., Chicago, Ill. Turret bench press carrying four sizes of punches or other tools for punching, bending, shearing, wire cutting, riveting, embossing, etc. The capacity of the machine for punching is a 5/16-inch hole through 1/4-inch stock. It will punch holes 1 1/4 inch from the edge of the stock. The device is built to be worked by hand, but may also be fitted so that it can be worked by power.

Hamilton Machine Tool Co., Hamilton, Ohio. Double back geared lathe, intended for unusually heavy work or for high speed. The machine is known as style A lathe, and this type is made in all regular sizes up to and including 28 inches swing. Larger lathes are furnished with double gears for doing extra heavy work. The double back-gears can be instantly connected or disconnected by a spring-locking device, and either set of back-gears can be thrown in and out very rapidly.

Williams Tool Co., Erie, Pa. Improvement in the company's No. 2 pipe threading and cutting-off machine, principally in the method of the drive. The speed changes are obtained mechanically from a single speed driving shaft which may be either belt or motor driven, the size of motor required being 2 H.P. The drive for the spindle is through gears under the head-stock in the bed of the machine, the changes in gear combinations being made by sliding gears. Six speed changes in all are obtainable.

Fay Machine Tool Co., Second and Glenwood Aves., Philadelphia, Pa. Cam-cutting machine designed especially for cutting cams for textile machinery. The cams usually cut are grooved face cams up to 20 inches in diameter. Cams of other descriptions can, of course, also be cut. The machine has a duplex head, the former or master cam being bolted to one face-plate, while the cam to be cut is held to the other and operated upon by the milling cutter, which latter is driven by a belt independent of the drive for the two face-plates of the machine.

Pratt & Whitney Co., Hartford, Conn. Double spindle spline milling machine intended for slotting work of any description clear through, or grooving work to any depth required. It is particularly adapted for milling the oblong openings in drill sockets, tool-posts, boring-bars, etc. The machine is provided with two cam-controlled spindles mounted one on each end of the machine, the table for feeding the work being between the cutters in the center. Each head may be operated independently when a single keyway or a shallow groove is to be cut

Ingersoll Milling Machine Co., Rockford, Ill. Special horizontal spindle milling machine of the planer type provided with a head carrying a vertical spindle and a spindle in an angular direction adapted especially for milling gas engine beds. The machine is of large dimensions, with a distance of 42 inches between the housings, the table being 10 feet long and the weight of the machine 30,000 pounds. While especially intended for gas engine beds, the design of the machine adapts it to any other milling which could conveniently be done on a machine of this size.

Eberhardt Brothers Machine Co., 66 Union St., Newark, N. J. Automatic worm-wheel hobbing machine designed for automatically hobbing large quantities of worm-wheels for manufacturing purposes. A cam feed is used, having been decided upon on account of the large quantities of each size gear to be cut, the cam being driven through change gears from the work spindle. The wheels are hobbed without being previously gashed. The machine feeds the head downward to the proper depth of cut, automatically, and proceeds with the hobbing process until finished. When the head returns to its original position, the machine stops.

* * *

MACHINERY SWINDLER ON PACIFIC COAST.

J. J. McCabe, 30 Church St., New York, manufacturer of the McCabe double-spindle lathe, has been informed that a man representing himself as Eddie Ward, and professing to be McCabe's western traveling agent, is at present making a tour of the Pacific Coast, ostensibly selling McCabe's double-spindle lathe. He introduces himself with cards printed in large letters "McCabe" and underneath in small letters "as sure as the hand of fate—New York office, 916 Brent St.; Chicago office, 8 So. Canal St." A few weeks ago Ward called on Mr. James Roake, Oregon City, Ore., and inquired if he was in the market for a double-spindle lathe. Mr. Roake was more interested in a shaper, and gave Ward an order for one which Ward claimed McCabe had taken in connection with other tools from a defunct shop at Suisan, Cal. The shaper was represented as an 18-inch machine in first-class condition, having been used but eighteen months, and fully equipped. It was claimed that the cost of the tool was $425.00 less 6 per cent. Ward "sold" the tool to Mr. Roake for $252.50 and Mr. Roake gave Ward a check for $39.60 to prepay the freight to Oregon City. Neither Ward nor the shaper has been heard from since.

Mr. McCabe informs us that he has no Mr. Eddie Ward in his employ and that the individual representing himself as his representative is an imposter. His Pacific Coast interests are cared for by Harron, Rickard & McCone, of San Francisco and Los Angeles, and by the Hahlidie Machinery Co., of Seattle and Spokane.

* * *

About three years ago B. J. Lambert, professor of structural engineering, State University of Iowa, designed a rather novel blue-print frame, a description of which was printed in the 1908 issue of the *Transit* as follows: The frame proper is of wood with a slightly curved top, over which is stretched a thin sheet of celluloid, fastened firmly at one end of the frame. By means of a cam action and adjusting screws at the other end, the celluloid sheet can be quickly tightened, or released and rolled back to insert tracings, films, and paper. The paper can be examined readily, without removal, by partly unrolling the celluloid cover. In this way the printing can be timed as desired. Rolled tracings, films, and papers are much more readily handled than in an ordinary glass frame. The frame is also very light in weight, gives perfect contact over all the surface, prints as readily as with glass, and is, in all respects, perfectly satisfactory.

* * *

The firm of Hans Renold, Ltd., Manchester, chain manufacturer, has issued an interesting pamphlet, giving accounts of a number of tests made at the works of the firm to ascertain the relative efficiencies of belts and chains for power transmission. The results show a decided advantage in favor of the chain when used for machine tools, both in respect to output and in regard to the finish of the work, the cutting action in machines with chain drive producing a smooth finish, as compared with the results obtained by belt drive. The difference in action is attributed to two causes, the irregular slipping of the belt on the smooth surface of the cone, and a vibrating movement arising out of this slipping, owing to the elongation and the contraction of the belt under the tension of the power transmitted. The tests have been extremely thorough, having extended over two years, and the records of tests taken over this period show, as is stated in the pamphlet, an increase of 23 1/2 per cent in favor of the chain-driven machine over a similar belt-driven one.

AN AMERICAN MECHANIC IN EUROPE—5.

A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

ASKLANDA, SWEDEN, July 3, 1908.

Since writing the letter published in the July issue, dated at Paris, France, I have been through England and visited a number of the well-known machine tool builders, and other large manufacturing concerns. It can be said that, generally speaking, the commercial situation in England does not differ to any extent worth mentioning from the conditions in Germany. The replies from dealers and manufacturers are in agreement that the trade at the present time is dull, but many of the largest and best informed dealers in London and elsewhere see signs of improvement in trade all along the line. In the machine tool works which the writer has visited, the situation differs materially, even to so great an extent that one concern in Halifax reported itself as still being forced to work overtime to fill the orders, while another concern stated that it was almost entirely out of orders. This concern is working short time, and with part of its normal working force, and even then is occupied principally with stock. These two cases represent the extremes between which the true state of affairs is to be found.

The general situation in the works which are principally building large heavy machine tools, is that they are still working full time and with full force, but having only a few recent orders on hand, and not being able to secure many new orders, they fear a reduction of time or force will be necessary in the near future. On the other hand, the works making the middle-sized or smaller machine tools, as a rule have reduced their output to below the average. Mr. Cooper, with Messrs. Buck & Hickman, London, stated that their sales of machine tools amounted to about ten per cent of that of a year ago, but, inasmuch as the small tool business kept up well, the total amount of business done was about sixty per cent of that for a year ago.

The New Patent Law.

The new English patent law, of which mention has been made in MACHINERY, is now in force. A few prominent people have kindly stated their opinions to me in regard to the consequence of this legislation. Judging from their statements, there is general satisfaction with the law and its probable effect on manufacturing industry. The opinion expressed is that the various branches of Great Britain's manufacturing will be benefited by the new law, that work will be obtained for a larger number of people because of the new lines of manufacturing established to conform to its requirements, and that the buyers or consumers will reap the benefit of a keener and more highly developed competition. At first glance, it appears that the new law would cause some damage to foreign patent holders or industries that export to England, but so far as the American machine tool industry is concerned, it is not believed that the law will cause material harm. The American manufacturer of a patented American machine tool has gained advantage over the English manufacturer of the same class of machines, as regards workmanship, methods of manufacturing, etc. With the same effort and enterprise in the future as in the past, he surely will be able to keep ahead of the game, and American-made machines should continue to be bought in preference to English makes.

The Franco-British Exhibition.

The machinery section of the Franco-British exhibition, which is now in progress at Shepherd's Bush, London, is not so large or so well represented as many other sections of the exposition. On the French side, the attention is mainly drawn to the line of wood-working machinery. Very few metal-working machines are to be seen, and these are of no great interest. On the English side the showing is comparatively large, and a number of interesting machine tools are to be seen, although nothing radically new is exhibited. Outside of the machine tool exhibit, the gas engine section consisting of two- and four-cycle engines, and the textile machinery sections are the principal sections of interest to the engineer and mechanic.

Wages in England.

In my previous letters a few figures have been given on the wages paid mechanics in the countries visited, and for the sake of comparison the figures of England may have some interest. Messrs. Alfred Herbert, Ltd., Coventry, states that the average pay in its works is 5 shillings ($1.50) a day for skilled labor, and this wage appears to be a fair average for other concerns. One Halifax concern reported that its pay for skilled labor varies from 32 to 42 shillings a week, which makes practically the same average.

Shop Notes from Machine Tool Building Works.

In my notes from Germany, it was remarked that the German machine tools, generally speaking, have the characteristics of being heavier and more solidly built than American machine tools. This is noticeable in a still greater degree in English machine tools, these being more heavily designed and more liberally dimensioned, even than German tools. The average Britisher likes a machine tool that looks very strong and rigid. This fact probably should be credited for the not unusual occurrence of finding machine tools in English works of great age, sometimes up to forty or fifty years, which are still doing work sufficient to warrant continuing them in service in this age of high-speed heavy duty machines. One feature that is sometimes found in English heavy duty lathes, which lends rigidity, is that of having the head-stock cast in one piece with the bed. This practice, however, is not followed to a large extent now, because of the greater manufacturing cost as compared with the separate head-stock construction.

One of the best known of all the English machine tool works is that of Messrs. Alfred Herbert, Ltd., Coventry. The growth of this establishment has been rapid and continuous. When it started twenty-one years ago it employed but twelve men, and now it employs not less than 1,500 throughout the works. The original plant is located in Coventry. Extensions required to accommodate the rapidly growing business, long ago covered the available space, and the company was forced to build an additional plant on a plot removed about two and one-half miles from the old works. The new plant is located at Edgwick where the foundry and pattern stores are already built. In laying out and equipping the new works, the company utilized its experience gathered throughout the years spent at the old plant, and in view of the past rapid growth, it has deemed it advisable to provide for large extensions in the future. The machine shop, in fact, has been designed so that it can be multiplied by four should trade conditions warrant such extensions. Provisions have also been made to extend the various auxiliary departments to a corresponding extent. (See MACHINERY, March, 1907.)

The chief machines manufactured in the new works are milling machines of both vertical and horizontal types, sensitive drills, cutter grinding machines and milling attachments. The old works are principally devoted to the manufacturing of turret lathes, automatic screw machines, and gear-cutting machines. The line of turret lathes comprises principally the hexagonal turret lathe for bar work, the combination turret lathe for chuck work, and the capstan lathe. The turret lathes are equipped with new roller back rests which have the advantage over the common back rest usually provided with turret lathes, of making heavier cuts and higher work speeds possible. With the heavy type of Herbert hexagon turret lathe a bar can be reduced from two inches diameter to one inch diameter at the rate of six inches per minute. It was interesting to note in these works to what large extent special jigs and fixtures are employed in order to reduce manufacturing cost. A feature of the manufacturing practice, of technical interest as well as indicative of the care that is taken to obtain good workmanship, is that all heavy castings such as lathe beds, milling machine columns, heavy slides and tool rests are stored for about six months after having been planed or milled. Then they are sent to the erecting department for assembling. The claim is made that the storing of the castings is necessary because they change shape slightly during the seasoning period. This change of shape is very slight, however, and does not necessitate re-machining when the parts are taken from the store-

room to the assembling department. Scraping is sufficient to correct the change of shape.

Generally speaking, the English machine tool builders do not specialize on one or a few machines, but build a multiplicity of types and sizes. Some concerns go so far in this direction as to build a complete line of machine tools from the smallest up to the largest sizes, but, of course, this complete line does not include any but the types that are most commonly found in average machine shops. Even in small and middle-sized shops where specialization is of, perhaps, greater importance than in the larger works, this condition holds true. A large establishment can afford to carry a larger number of sizes and types than the smaller works, and still employ the labor-saving devices and methods that are employed in specialized manufacture. There is safety in building several types of machines as compared with specialization on one, because at one time some one machine tool is in demand in the market, and at another time another machine tool will have a call, and so on. When a concern has only one type, it feels the fluctuations of the market more, while in the other case the fluctuations of the market for one type will, to a certain extent, be balanced by the fluctuations of the other types. This is probably the chief reason why English manufacturers do not specialize.

The small and middle-sized concerns seldom make any machines for stock, but as a rule build only to order. It seems to be a very common practice to build machines in batches of two, four, or six at a time, and only occasionally in such large batches as twelve. To fill out a batch, sometimes one or two machines are made extra for stock in case the order is not large enough.

An interesting middle-sized concern which the writer visited is H. W. Ward & Co., Birmingham. Some time ago this concern set out to supply a full line of machine tools, but it has dropped the manufacturing of a few types and sizes which it intended to build. The firm still makes a large variety of machines, engine lathes, turret lathes, milling machines, etc. A short time ago the concern took up the manufacture of a few types of grinding machines, and it has now placed on the market an internal grinding machine with a special feature. The machine is designed especially for the grinding of bushings and similar parts, and is equipped with two grinding wheels. The principal wheel for internal grinding is mounted according to the common practice, while the second one for grinding the ends of the part is mounted on a slide behind the internal grinding wheel spindle. The object, of course, is to be able to face the end of the bushing at the same setting at which the internal grinding is done.

One of the largest centers of machine tool manufacture in England is Halifax, and besides size, it offers many features of interest to the American visitor, one being that it is typically English. In explanation of this statement, we might say that the larger machine tool works on the Continent and in England cannot be said to be typically representative of the countries in which they are situated. The lay-out of the works and the methods employed are generally in accordance with the best internationally recognized practice. The practice that is typical of a country's work is to be found in the middle-sized and smaller shops. Generally speaking, this is so, but, of course, it does not always hold true. The machine tools made in Halifax are of the heavy English design to which reference already has been made. Regarding the quality and workmanship, the product varies from the good average machines which will satisfy all requirements of the ordinary up-to-date machine shops, down to the cheap grades of machines which are only good enough for the small repair shops, and whose principal recommendation is low price.

The manufacturers of the low class of machinery and tools are, one can say, without exception, small concerns with work laid out without system, equipped with old-type cheap-class tools, and evidently lacking all modern methods and devices. It seems impossible that these small old-fashioned works, in this age of highly developed labor-saving machines and methods, could still continue to do business enough to keep alive and pay interest on capital invested. About the only reason that the writer has been able to assign is that there is not enough competition in the cheap class of machinery. There is quite a large demand for cheap tools from small repair shops and small jobbing shops having a limited amount of capital, but this demand is neglected by the ordinary manufacturers. A concern employing modern methods and machinery goes in for the manufacture of high-class machinery and it does not care about the demand for the cheap machines. The consequence is the existing condition under which the buyer of cheap machinery has to pay a much higher price than should be the case were modern methods employed for manufacturing this class of tools.

J. Butler & Co., Halifax, is one of the middle-sized concerns making a good heavy class of machinery. This concern is engaged in the manufacture of nearly all kinds of machine tools from the small size up to the largest size, but is principally pushing its line of planers, shapers and slotting machines. Another concern in the same class, but somewhat smaller, is John Stirk & Sons, Ltd., Halifax. One of the few concerns that have started out to specialize to a large extent is Messrs. William Asquith, Ltd., Halifax. About eight years ago this concern devoted itself to building drills and boring mills. Its line of radial drills is very large, and contains types ranging from the smallest size for use of tool-makers, up to the largest size used by large ship-building concerns. The company usually builds the machines in lots of three throughout all departments, only occasionally making a larger number at a time.

Probably the oldest and at the same time the largest of the concerns in England, is that of W. G. Armstrong, Whitworth & Co. This concern owns several large plants for ordnance work, ship-building, engine building, machine tool manufacturing, etc. The chief work executed at its plant at Openshaw, Manchester, consists of ordnance work, armor-plates machine tools and small tools. The line of machine tools is large and the concern claims to build as complete a line as it is possible for any concern to build. Of special interest is its line of heavy machine tools for ordnance work, especially for planing and cutting off armor plates. Its heavy armor plate planer has not less than eight tools cutting at a time. To save the time ordinarily lost on the return stroke, the planer is built to cut both ways. The principle of the reversible tool-holder which is used on smaller planers here, could not be employed on this large planer on account of the great strength and rigidity required. Instead, the tool-holders are made to carry two tools, each of which is arranged so that one tool cuts in one direction while the other cuts with the table traversing in the opposite direction. The work remains stationary because of its heavy nature, while the two housings and cross-rails are traversed back and forth by heavy screws. (See MACHINERY, June, 1908, for photographs of pit planers used on armor-plate, etc.) The principle of using double tool-holders with two tools, one cutting one way and the other the other way, is applied to nearly all of the Armstrong armor-plate working machines and is a feature of much time saving.

It was of much interest to the writer to see planers fifty years old still in use in these works. These planers are of small size, built along common lines for small planers, that is, with reciprocating work table and fixed housings. A feature of interest is the reversible tool-holders which enable the planer tool to cut both ways. There is no quick return of work. A mechanism operated at each reverse of the table, reverses the tool-holder and the tool. The design is necessarily somewhat weak and it cannot be used successfully on heavy duty planers.

Another old established concern is Messrs. Smith & Coventry, Salford, near Manchester. This concern now employs about 500 men, and is principally pushing its lines of milling machines and drills, although also engaged in making boring and turning mills, ordinary engine lathes, gear-cutting machines, etc. In building sensitive drilling machines, careful attention is paid to the reducing of friction by means of ball bearings and anti-friction devices. Much attention is also paid to the rigidity of construction and with their heavy-duty drills a rate of drilling speed of 12 inches a minute has been obtained when drilling 1-inch holes.

Regarding the system of manufacture, all standard parts such as screws, studs and small parts that can be used for

several sizes of machines, are made in quantities sufficient to last six months or more. When the store for a certain size of stud is exhausted, an order for new studs is placed, sufficient to last another six months, and so on. As a rule large machine parts are not made for the store, but only to order.

Regarding the use of automatic labor-saving machinery in the machine tool works, it can be said that not so much automatic machinery is used in England as in America. Many English manufacturers claim that they can do better with less automatic machinery. For example, take the case of a machine tool manufacturer making his own supply of studs. The Englishman's view of the situation is that a cheap man, or even a boy can easily be put on this work on a hand-operated turret lathe, and will soon acquire skill in the particular operations involved, and consequently will soon reach high efficiency. There is no expensive machinery and no large capital invested. On the other hand, with automatic machinery, a high-priced man has to be employed for running it, and, in addition, there is a higher rate of interest on the capital invested. In a middle-sized machine tool shop which does not specialize, there is not sufficient work to be done on automatic machinery to keep the highest number of automatics that one man can manage efficiently, running all the time. When there is not sufficient number of automatics employed, and not sufficient work obtainable to keep the machines running but a small part of the time, the cost of labor becomes higher than with hand-operated machinery.

In the works of Messrs. Mather & Platt, Ltd., Salford, near Manchester, where gas engines, steam turbines, pumping machinery, textile machinery, electric motors, etc., are built, an interesting kink for cutting long screws was noted. An ordinary lathe is used for the purpose, the carriage being operated by a feed-screw as in ordinary thread-cutting practice. In addition to the common mechanism of all thread-cutting lathes, there is a device on the carriage which automatically reverses the traverse of the carriage, and at the same time operates the tool slide at the end of the screw, moving the threading tool backward to clear on the return, and advancing it into the work at the beginning of the cut. The depth of the cut can be regulated by hand when desired. The feed is automatic and at the back of the lathe a reversing bar is provided carrying two adjustable stops by which the reversing mechanism and tool slide are operated. Provisions are made for quick return of carriage. There is no automatic stop to stop the tool slide when it has reached the correct depth, the workman having to watch the work and stop the machine by hand when a screw is finished. With the exception of this omission, the machine works automatically. One man can operate three machines when cutting screws. [These lathes are evidently adapted to cut screws automatically in about the same manner as performed by the automatic threading lathe built by the Automatic Machine Co., Bridgeport, Conn.] —Editor.

Messrs. Hulse & Co., Ltd., Salford, near Manchester, a middle-sized concern, is putting its efforts into building large heavy machine tools for ordnance work, turbine shops, shipbuilding shops, etc., its works being equipped for just this kind of machine tool building. At the present time it is, to a large extent, engaged in machinery for the ordnance trade.

Another concern engaged in the same line of machine tool building is Messrs. Craven Bros., Manchester, but this concern is also building a few smaller sizes of machine tools. At the present time it is principally engaged on a large number of heavy machine tools for ordnance work, thus to some extent indicating the activity of Great Britain in her defensive and offensive preparations for war.

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MISCELLANEOUS FOREIGN NOTES.

German Locomotive Exports.—Last year Germany exported 552 railway locomotives, and 395 smaller locomotives for industrial purposes, up to 10 tons each, together with 3,605 tons of locomotive parts. Italy was the principal customer for German locomotives, but large shipments were also made to France, Chili, Argentina, and Brazil.

German Ship Building Profits.—While the English ship building yards have experienced considerable difficulty during the last part of the last year and during the first part of the present year, one of the chief German ship building yards, the Vulcan, of Stettin, does not seem to be financially embarrassed by the present depression, a dividend of 14 per cent having been declared for the last year. The company has reduced the working hours from 10 to 9½ hours a day.

Russian Steel Trust.—Rumors have long been circulated about the plans for the formation of a Russian steel trust. This trust or union has now become an established fact. The syndicate comprises the works in Southern Russia, and will control about 65 per cent of the aggregate steel production of the country; it will also be the owner of important ore deposits and coal mines. The working capital comprises about $75,000,000, and the trust is financed by Belgian and French financiers.

Electrical Industries in Germany.—Messrs. Felten and Guilleaume-Lahmeyer, of Mülheim-on-Rhine, Germany, one of the most important of the German electrical companies, state in their annual report, that the past year was one of exceptional activity. During the year the company obtained orders for dynamos amounting to total capacity of 500,000 horsepower. The capital of the company is nearly $14,000,000, and the dividend declared was 10 per cent. It is mentioned that the new patent law in England is likely to influence the German electrical trade.

British Trade Conditions.—The British machine tool trade is likely to be seriously affected for some time to come by the conflict in the ship-building trades between employers and employes, on account of which some works have closed. The difficulty is caused by the resistance of the employes to a reduction in wages. Unless an early settlement of the differences can be arranged, between 50,000 and 60,000 men will be affected directly in the ship-building trades, and a great many more indirectly by the stagnation in other trades which will necessarily follow.

Shipbuilding in Great Britain.—The conditions in the British shipbuilding trades are rather discouraging. The tonnage of vessels launched in Scotland during the month of May was exceedingly small. On the Clyde 25 vessels of only 11,072 tons were launched, as compared with 30 vessels of 43,670 tons in April this year, and 40 vessels of 62,246 tons in May last year. The comparatively large number of vessels launched is accounted for by the number of barges, tugs, and other small craft included. For the first five months of the year the total tonnage launched was 114,826 tons, as compared with 242,392 tons for the same months last year, a decrease of considerably more than 50 per cent.

The German Iron Industry.—At a recent meeting of the Union of German Iron Masters it was stated that while there had been a falling off in the business since last December, the depression was less pronounced in Germany than in other countries. Rather than to dismiss a large number of men, the iron industry had disregarded the trade requirements of the moment, and had continued its production to a certain extent, and kept the surplus material in stock. The advantage of the quiet time now prevailing after the past period of high tension was appreciated, inasmuch as it gave many works an opportunity of completing and repairing their plants. The basis for future development is considered sound.

Trade Conditions in Sweden.—According to a report read at the last quarterly meeting of the Union of Swedish Iron Masters, the general business depression has made itself felt in the Swedish iron market, and the exports of bar iron show a decline of 25 per cent during the first three months of this year, as compared with the same period last year. Many of the works, however, have orders since last year which have not yet been filled, and these will keep them busy for several months. The number of blast furnaces going was 114 as against 120 for the same period last year. The machine tool and general machine building industries seem not to have been affected very much by the general depression. Several important firms are extending their works, and as soon as the present uncertainty in business becomes settled the demand for machine tools is likely to be considerable, as many extensions to shops now being built will then have to be equipped.

WORK OF THE U. S. GEOLOGICAL SURVEY IN CONSERVING NATURAL RESOURCES.

The United States Geological Survey has been an important factor in the movement for the conservation of our natural resources, for many years, and while its work has been to a certain extent altruistic in that the immense benefits will come to the generations of the future, it has already saved millions of dollars' worth of resources for the people of to-day. The Survey's geologic and topographic work have resulted in an inventory of the natural resources, a stock-taking such as a prudent manufacturer takes once a year. This has disclosed the waste that has been going on, and led directly to the conference of the governors of the States in Washington in May. The study and classification of the coal deposits of the United States and especially those on the public domain, have established the value of these coals and have prevented the thoughtless disposal of the 50,000,000 acres of government coal lands. The values of the mineral deposits on government land have been approximated to such an extent that it will now be impossible to dispose of them without getting a fair return.

While there have been many immediate benefits from the topographic work and a study of the water resources of the country, their value to the people will be many fold greater in the near future. Without an accurate topographic survey of the land and water, the contemplated improvement of the waterways, the drainage of swamps and the great irrigation projects would be impossible. The work already done along these lines will push these big improvements forward several years and result in the saving of much money.

In its endeavors to check the great waste of the natural resources, the Survey a few years ago extended its field by taking up the subject of the utilization of the fuels of the country and so fruitful have been these investigations that there is every promise of a saving of millions of dollars within a short period. These investigations appeal directly to the manufacturer, the business man and the consumer, for they show him how to realize immediate economies he never dreamed of before.

Authorized to test the fuels owned by or for the use of the government itself, the Survey has made a number of discoveries of the greatest importance to the entire people. At the government's fuel-testing plant, it has been shown that the gas engine is capable of generating from two-and-one-half to three times as much power, using a given amount of coal, as can be obtained from a steam engine. This means, it is declared, that a 600 horse-power gas engine will save $5,000 a year in its coal bill over the same power steam engine, and that the saving on a 6,000 horse-power gas engine ought to amount to $72,000 a year.

The gas engine has also opened the way for the use of millions of tons of low-grade fuel, much of which has heretofore been thrown away as useless. The tests have shown that coals, practically valueless under steam boilers because of their high percentages of impurities, have in a gas producer generated sufficient power for the gas engine to render them of high commercial value. Coals as high in ash as 45 per cent have been used successfully in the gas engine.

In the West, where the supply of high-grade coal is inadequate, the low-grade lignites (the poorest form of coal) of North Dakota developed as much power when converted into producer-gas as did the best West Virginia bituminous coals when used under the boiler of a steam engine.

To the West, this discovery of the government scientists is of the utmost importance. It makes possible the introduction of cheap power and therefore the establishment of an industrial empire of immense proportions. There are many million acres of lignites in the West, an almost inexhaustible supply for fuel that, so far, has been practically useless, the people being compelled to send a great distance for their coal and pay big freight charges on what they used.

In the average steam engine to-day but 5 per cent of the coal energy is transformed into work. In the gas engine, this percentage of efficiency is 12½ per cent. The coal used in generating power in the United States last year amounted to about 300,000,000 tons. With the universal use of the gas engine, it is estimated that at least 100,000,000 tons of this coal could be saved.

In testing the efficiency of coals under the boiler of a steam engine, the Survey engineers suggest still another way to save the fuel. Recent experiments indicate that boilers ought to perform two or three times the work they do now. In New York City, a certain large corporation has almost doubled the capacity of its power plant by placing furnaces in the rear of its boilers as well as the front. This was done at a saving of several hundred thousand dollars, as it would have been necessary to purchase additional land held at a high figure to carry on the work. The tests of different coals under the steam boiler at the government plant have also showed the possibility of increasing the general efficiency of hand-fired boilers 10 to 15 per cent over ordinary commercial results.

The Survey is also engaged in a general analysis of the coals of the country. These analyses have resulted in the government purchasing coal on definite specifications based upon its heating value. Under this system a better grade of coal and coal better adapted to the types of furnaces in the government buildings has been obtained without any increase in cost, which in itself is a saving to the government. These investigations, by suggesting changes in equipment and methods, are also indicating the practicability of the government's purcnasing cheaper fuels such as bituminous coal and the smaller sizes of anthracite, instead of the more expensive sizes. With new boilers in the heating plant of the State, War and Navy Building in Washington, $15,000 is now being saved each year in the coal bill for this building alone. Many power plants are now buying fuel on specifications and have obtained increased efficiency as a result of the government's investigations. These tests of the coal will aid manufacturers, wherever situated, to save money in the purchase of coal, for they will enable them to learn where they can buy coal that is best suited to their purpose.

The government has found still another way of conserving the fuel resources in the briquetting of coal. The investigations show that in the near future the great quantities of waste coal seen about every mine and the low grade coal that is now being left in the mines, will be utilized in the generating of power and for locomotive power and domestic heating. Successful tests of briquets were recently made on two railroads. The briquets, which were made from the slack of high-grade bituminous coal, showed an economy of 20 per cent over the same lump coal, not taking into consideraton the cost of making the briquets.

At the government fuel-testing plant at Denver, Colo., investigations into the washing and coking of coal have been carried on for a year with much success. In the washery plant, it has been shown that coals were greatly improved by washing, at the nominal cost of from three to ten cents a ton. In recent experiments, the experts have succeeded in making coke out of several coals that have been regarded as non-coking. Of thirty-seven samples tested from the Rocky Mountain region, all but three produced good coke, though a number of these were considered non-coking coals. When the metallurgical interests of the West are noted, the importance of these investigations will be realized.

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PERSONAL.

J. B. Doan, vice-president and general manager of the American Tool Works, Cincinnati, O., returned July 17 from a business trip in Europe.

S. E. Balcom has been appointed chief engineer of the power, light and heat service of the Worcester Polytechnic Institute, following the resignation of Noah Ashwood.

C. A. Parsons, the inventor of the Parsons steam turbine, received, on June 11, the honorary degree of doctor of engineering, at the Liverpool University.

Dyer Smith, formerly an associate editor of MACHINERY, and later an examiner in the Patent Office, Washington, D. C., has graduated in a course of patent law, and is now employed as a patent attorney by Mr. Thomas A. Edison, Orange, N. J.

Carleton A. Reed, recently professor of mechanical engineering at the New Hampshire State College, has been appointed to fill the position vacated by Prof. George I. Rockwood, as professor of steam engineering, at the Worcester Polytechnic Institute.

George I. Rockwood, who for the past two years has occupied the chair of professor of steam engineering, at the Worcester Polytechnic Institute, has resigned. It is Professor Rockwood's intention to take up his entire time with the Worcester Fire Extinguisher Co.'s business, with which he has been connected for some time.

J. W. Lutz, since 1880 assistant superintendent and general foreman of the O. S. Kelly Co., Springfield, Ohio, has resigned to become superintendent of the Duplex Mill and Mfg. Co., Springfield, Ohio. This concern has bought the grinding business of the O. S. Kelly Co. and will extend its business to include other products. Mr. Lutz is a stockholder in the new company.

Walter M. Nones is here from London, England, to get in touch with manufacturers of specialties in machinery, tools and allied lines, who care for European trade, either for the purpose of securing agencies or licenses of patents. Mr. Nones informs us that he has placed some important lines abroad and would like to hear from manufacturers who are interested.

L. Moulthrop, who has been connected for the past thirty years with the New Haven Mfg. Co., New Haven, Conn., manufacturer of machine tools, recently resigned as secretary and treasurer, still remaining as director. William H. Brown, who has been with the company a long time, succeeds Mr. Moulthrop as secretary and treasurer, and J. Judd continues as superintendent.

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OBITUARY.

Charles H. Dale, of New York, died at his summer home in Larchmont, N. Y., July 18, from heart disease, after a brief illness. Mr. Dale was born in 1852. He was prominent in the rubber manufacturing business, being president and director of the Peerless Rubber Manufacturing Company, the Mechanical Rubber Company, the Morgan & Wright Company of Detroit, the New York Belting & Packing Company, the Rubber Goods Manufacturing Company, the American Commerce Company, and director in other rubber companies.

George H. Daniels, for many years general passenger agent of the New York Central R. R., died at Lake Placid, New York, July 1. He was born in Hampshire, Ill., 1842, and was in railroad service one way or another since he was a young lad. He entered the service of the New York Central in 1886, and in 1889 became general passenger agent. He doubtless was the best-known passenger agent in the world. His advertising methods were unique, and the literature issued was the most interesting issued by any railway. Mr. Daniels retired from active service of the New York Central May 1, 1907.

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NEW BOOKS AND PAMPHLETS.

THE HEWITT CORRESPONDENCE SYSTEM. By W. C. Holman. 38 pages $4\frac{1}{2}$ x 6 inches. Published by W. C. Holman, Chicago, Ill.

This booklet describes a system of correspondence, devised by Mr. Frank L. Hewitt, of the National Cash Register Co. It outlines a method of formulating letters and numbering paragraphs by which the correspondent can indicate to a stenographer the letter to write for any given condition likely to recur in correspondence, thus saving much valuable time and securing the maximum beneficial results that can accrue from a well-conducted business correspondence system.

CURVES FOR CALCULATING BEAMS, CHANNELS AND REACTIONS. By Sidney Diamant. 38 pages, 7 x 10 inches. Published by the McGraw Publishing Co., New York. Price, $2.00.

As indicated by the title this book was prepared to save time in structural designing by using the graphical process. The graphic method greatly facilitates the economic design of steel floor beams for various intensities of loading, and twenty-five plates for loadings of 80 pounds per square foot, up to and including 500 pounds per square foot for various lengths of span, and widths, center to center of arches, are included, these being the principal part of the work.

DESIGNING METHODS; REINFORCED CONCRETE CONSTRUCTION. 76 pages $4\frac{1}{2}$ x $8\frac{1}{2}$ inches. Published by the Expanded Metal and Corrugated Bar Co., St. Louis, Mo.

This pamphlet is No. 2 of Volume 1 of a series designed to educate engineers and others on the qualities of reinforced concrete construction. This issue is devoted to detailed design of a typical building made of reinforced concrete, in which the reinforcement is rectangular and with T-shaped beams. The pamphlet is highly technical, and will be found a valuable contribution to engineering literature on reinforced concrete construction.

DRAWING INSTRUMENTS; THEIR USE AND ABUSE. By Walter G. Stephan. 108 pages, $4\frac{3}{4}$ x $7\frac{1}{4}$ inches. 74 illustrations. Published by the McGraw Publishing Co., New York. Price, $1.00.

This book is intended as a guide for students and young draftsmen in the purchasing of drawing instruments, drawing boards, paper, T-squares, triangles, protractors, etc. It lists a complete drafting equipment and describes the various instruments—triangles, scales, boards, T-squares, etc.—giving many valuable hints on the care and selection. It also touches on the slide rule, section liner, elliptograph, blue printing, drafting machine, planimeter, etc.

ORGANIZATION, EQUIPMENT AND OPERATION OF THE STRUCTURAL MATERIALS TESTING LABORATORIES AT ST. LOUIS, MO. By Richard L. Humphrey and Jos. A. Holmes. 84 pages, 6x9 inches. Illustrated. Published by the Department of the Interior, U. S. Geological Survey, Washington, D. C.

This account of the organization, equipment and operation of the structural materials testing laboratories, at St. Louis, Mo., is bulletin No. 329, and is intended to give a comprehensive account to the public of the various activities of this important part of the government's experimental work for the improvement of industrial conditions.

SOME THINGS MANUFACTURERS SHOULD KNOW ABOUT COAL. By E. G. Bailey. 10 pages, 6 x 9 inches. Published by Arthur D. Little, 93 Broad St., Boston, Mass.

This paper is No. 3 of a series of contributions to engineering chemistry made by the members of the staff of Arthur D. Little's laboratory, and was presented at the annual meeting of the National Association of Cotton Manufacturers, Boston, Mass., April 16-17, 1908. The object of the paper is to educate coal users in regard to the qualities of coal, what coal is most economical to burn, and how the highest percentage of the heat energy may be converted into useful work. No charge is made for individual copies for these pamphlets.

ADDRESSES DELIVERED AT THE INSTALLATION OF W. F. M. GOSS. 59 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This pamphlet is a program of the installation of W. F. M. Goss, Dean of Engineering, at the University of Illinois, February 5, 1908, and includes addresses on "Significant Events in the History of the College of Engineering," by Ira O. Baker; "Standing of the Technical Graduate in the Engineering Profession," by Wm. L. Abbott; "The Value of Engineering Research," by Robert W. Hunt; "The Need of Graduate Courses in Engineering," by Willard E. Smith, and "The State College of Engineering," by W. F. M. Goss.

PRACTICAL PERSPECTIVE. By Frank Richards and Fred H. Colvin. 56 pages, $5\frac{1}{2}$x8 inches. Published by Norman W. Henley & Son Publishing Co., 132 Nassau St., New York. Price 50 cents.

This little work on drawing, explaining the principles of isometric perspective and the use of isometric paper, has just been issued in the third edition. It illustrates how to make all kinds of mechanical drawings in perspective, so that any mechanic unfamiliar with reading ordinary drawings can understand the shape and purpose of the parts illustrated. It will be found useful to mechanical draftsmen otherwise, as it frequently is advantageous to make "pictures" of parts which will show in one view what ordinarily requires three or more views to show and then in a way intelligible only to those who have learned to read drawings.

SLOW BURNING OR MILL CONSTRUCTION. 28 pages, $9\frac{1}{4}$ x 11 inches, and 8 folding plates. Published under the direction of the Boston Manufacturers Mutual Fire Insurance Co., 31 Milk St., Boston, Mass. Price, 25 cents.

This pamphlet is report No. 5 and is of the third edition, having been revised in accordance with the accepted practice of to-day. The pamphlet will be found of great value to all contemplating the construction of new shops and factories, or the reconstruction of old buildings with a view to improving their fire-resisting qualities. The great loss annually sustained because of mill and factory fires makes the problem of reducing fire losses of the greatest importance to all, and this pamphlet is recommended to students of economics, as well as to manufacturers.

AIR BRAKE CATECHISM. By Robert H. Blackall. 380 pages, 5 x $7\frac{1}{4}$ inches. Illustrated. Published by Norman W. Henley, & Son, 132 Nassau St., New York. Price $2.00.

This work is recognized as a standard treatise on the air brake, and its large circulation is indicated by the fact that the book in review is of the twenty-third edition. It treats of the equipment manufactured by the Westinghouse Air Brake Co., including the No. 5 and No. 6 E. T. locomotive brake equipments, the K quick-service triple valve for freight service, the cross-compound air pump and the operation of all parts of the apparatus in detail. The subject is handled in the well-known catechism style; over 2,000 questions and answers are required for presentation. The illustrations include a number of large folding plates, which show clearly the details of the apparatus, and their relations to one another. The work is recommended to all interested in air brake theory and practice.

BOOK OF THE ECONOMIZER. 159 pages, 6 x 9 inches. Published by the Green Economizer Co., Matteawan, N. Y.

This book treats of the history and merits of the fuel economizer, taking up such topics as the absorption of heat by different parts of the boiler surfaces, the relative economy of boiler surface and economizer surface under various conditions, effects of oil fuel, high steam pressures and superheat on boiler economy, etc. One chapter is devoted to a novel explanation of the often observed fact that the economy from pre-heating boiler feed water is greater than would be found by calculating the ratio which the heat contributed by the feed water heater or economizer bears to the whole amount of heat required for evaporation. While primarily issued to advertise a proprietary apparatus, the subject is treated in a broad and comprehensive way, making a pamphlet of much interest and value to all interested in the economical production of power.

COMPARATIVE TESTS OF CARBON METALIZED AND TANTALUM AND FILAMENT LAMPS. By T. H. Amrie. 44 pages, 6x9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

This bulletin, which is No. 19 of the series issued by the Experiment Station, records the results of tests made upon metalized carbon, tantalum and filament lamps in the laboratory of the electrical engineering department, with a view of bringing out the good points of each lamp, together with their faults, and offers help in the selection of the proper type for any particular purpose. The conclusion is that the tantalum and filament lamps cover adequately all the phases of incandescent lighting now covered by the three types. For a low power cost and rough usage the carbon lamp is best. For high power cost upon poorly regulated circuits the tantalum lamp is best, provided it is carefully handled.

IRON AND STEEL WORKS DIRECTORY OF 1908. 500 pages, 6 x $8\frac{1}{2}$ inches Published by the American Iron and Steel Association, Philadelphia, Pa. Price, $12.00.

This directory gives a full list of the blast furnaces rolling mills steel works, bloomaries and tin and terne plate works in the United States; also classified lists of wire rope mills, rail mills, plate steel mills, bessemer, open hearth, crucible and steel casting works. The present edition is the seventeenth and is corrected to March 1, 1908 The general plan of compilation adopted in the preparation of recent editions of the directory has been followed in the present edition.

Whenever possible the history of each plant has been preserved, giving the date of its erection, with all subsequent additions to the plant, changes in ownership, if any, etc. In view of the tremendous changes in ownership caused by the consolidation of plants under the ownership of the United States Steel Corporation, the importance of preserving an individual history of the various plants is apparent. The directory is one that can be heartily recommended to all interested in the information contained therein.

VOIDS, SETTLEMENT AND WEIGHT OF CRUSHED STONE. By Ira O Baker. 29 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This bulletin, which is No. 23 of the series issued by the Engineering Experiment Station of the University of Illinois, records the results of experiments made to determine the proportion of voids in crushed stone, loaded by various methods in cars and in wagons; to find the amount of settlement during transportation; and to obtain the relation between the weight and the unit of volume of solid stone and of the same volume of crushed stone immediately after being loaded in various ways. All the results are summarized in a table which gives, for different sizes of crushed stone the coefficients by which to multiply either the weight of a cubic foot of solid stone or its specific gravity to get the weight of a cubic yard of crushed stone at the crusher and at the destination. This elaborate table is summarized in the following statement: The mean coefficient by which to multiply the weight of a cubic foot of solid lime stone to obtain the weight of a cubic yard of crushed lime stone, is as follows: For ½-inch screenings, 15.5; for ½-inch to 2-inch stone, 14.6; and for 2-inch to 3-inch stone, 15.2. For trap rock corresponding methods are as follows: For ½-inch screenings, 14.6; for ½-inch to 1½-inch stone, 13.5; and for ½-inch to 3-inch stone, 13.9.

CATALOGUES AND CIRCULARS.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4590, describing self-starting device for alternating current motors.

H. G. OSBORNE, 74 Cortlandt St., New York. Catalogue of Osborne's extension drills for drilling holes in brick walls.

PRATT & WHITNEY CO., Hartford, Conn. Catalogue illustrating and describing a spline milling machine, a machine for slot milling, cutting splines, key-ways, grooves, etc.

HARDINGE BROS., 1034 to 1040 Lincoln Ave., Chicago, Ill. Leaflet illustrating the Cataract precision bench lathe outfit No. 3, and catalogue illustrating the Beyer single record watchman's portable clock.

ESTEP & DOLAN, Sandwich, Ill. Catalogue of hand bending tools, for forming eyes, hooks, rings, hinges, staples, chain links and other parts made by the blacksmith.

BURKE MACHINERY CO., 1837 Thirty-fifth St., Cleveland, O. Leaflet illustrating and describing the Burke cold saw, and the Burke No. 3 and No. 4 bench milling machine.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 105, superseding Bulletin No. 88, illustrating and describing polyphase induction motors, made in sizes from 15 to 250 H.P.

SKINNER CHUCK CO., 94 N. Stanley St., New Britain, Conn. 1908 price-list of independent universal and combination lathe chucks; also drill chucks, planer chucks, face-plate jaws, drill press vises and reamer stands.

EXPANDED METAL & CORRUGATED BAR CO., of St. Louis, Mo. Catalogue illustrating use of corrugated bar for reinforced concrete construction in factories, machine shops and other buildings.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Record No. 65 of Mallet compound locomotive, being a paper read before the Engineers' Club of Philadelphia, March 12, 1908, by Mr. Grafton Greenough.

BROWN HOISTING MACHINERY CO., Cleveland, O. Catalogue of hoisting machinery adapted to the use of artificial gas, coke and electric light companies, for the rapid and economical handling of coal, coke and other materials.

BAUSH MACHINE TOOL CO., 200 Wason Ave., Springfield, Mass. Leaflet descriptive of the Bocorselski turret tool-holder for lathes. This tool-holder is made in three sizes, and two styles, and may be used with the turret in either a vertical or horizontal position.

LUCAS MACHINE TOOL CO., Cleveland, O. A set of four cards, distributed at the recent Atlantic City convention of the Master Car Builders' and Master Mechanics' Associations, descriptive of the Lucas power forcing presses.

WHITING FOUNDRY EQUIPMENT CO., Harvey, Ill. Catalogue of cupolas, charging machines, bottom door hoists, electric travelers, jib cranes, air hoists, foundry ladles, tumblers and other equipment for the foundry.

GISHOLT MACHINE CO., Madison, Wis. Small catalogue of Gisholt turret lathes, vertical boring mills, universal tool grinders, horizontal drilling machines, double emery grinders, worm hobbing machines, gear testing machines and chucks.

HESS-BRIGHT MFG. CO., 2111 Fairmount Ave., Philadelphia, Pa. Catalogue descriptive of the Hess-Bright radial and thrust ball bearings. The catalogue illustrates applications to line shafting, automobiles, motors and dynamos, and machinery in general.

BLACK DIAMOND BORING MACHINE CO., Monongahela, Pa. Catalogue descriptive of special boring machine for boring locomotive rod brasses and rolling and compressing the babbitt lining. The machine can also be used for other purposes, such as drilling, tapping, reaming, etc.

ROBBINS & MYERS CO., Springfield, O. Bulletin No. 67, descriptive of the "Standard" motor. The bulletin illustrates the various styles of motors built and applications to sewing machines, grinders, buffing and polishing wheels, speed lathes, drill presses, pumps, blowers, fans, punch presses, linotype machines, printing presses, etc.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., has issued a little booklet of twelve pages on brushes for generator and motor commutators. The booklet gives valuable hints on the care of commutators, and some conclusions drawn from the results of tests made by Professor Albert F. Ganz, at Stevens Institute, Hoboken.

BANTAM ANTI-FRICTION CO., Bantam, Conn. Issue No. 2 of the *Bantam Anti-Friction Booster*, containing items of local interest, "hot shots," humorous paragraphs, and advertising the line of ball and roller bearings made by the company. This issue is published on pink paper, and is a unique specimen of advertising.

UNITED STATES ELECTRICAL TOOL CO., Cincinnati, O. Catalogue illustrating a complete line of electric hand drills, breast drills, electric-driven radial drills, electric-driven center grinders, bench grinders and surface grinders. The catalogue also demonstrates a few of the many uses of portable electric tools.

GENERAL ELECTRIC CO., Schenectady, N. Y., has just issued a small circular, No. 3664, descriptive of its new locking socket. This socket prevents the removal of an incandescent lamp by an unauthorized person. The peculiarity of this socket lies in the fact that the lamp is safe when the socket is unlocked. The socket and key are clearly illustrated in the circular.

WALKER GRINDER CO., Worcester, Mass. Circular descriptive of the Walker No. 3 plain surface grinder of the column and adjustable wheel head type. This machine has been specially designed to adapt it for finishing cast iron parts that are usually filed and polished, and in combination with the Walker magnetic chuck made by the same concern, it is exceptionally well suited for all kinds of surface grinding.

MARK FLATHER PLANER CO., Nashua, N. H. Bulletin No. 8, illustrating and describing 14, 16, 18, 20 and 24-inch Flather shapers, belt- and motor-driven. The bulletin also reproduces the analysis of the Flather shaper motion published in the March, 1907, issue of MACHINERY, in connection with the description of the shaper motion model built for the University of Michigan.

R. D. WOOD & CO., Philadelphia, Pa. Catalogue of hydraulic tools and machinery for steel works, boiler shops, bridge works and other plants requiring heavy bar shears, splitting shears, angle shears, punches, riveters, flanging presses, die presses, upsetting presses and other machinery required in the construction of boilers, bridges, cranes, etc.

AMERICAN BLOWER CO., Detroit, Mich. Illustrated sectional catalogue, No. 232, of "A B C" self-oiling steam engines, types A and E. This catalogue supersedes Bulletins 171, 181, 193, 194 and 206. It illustrates in detail the construction of the engine, showing the self-oiling features by which lubrication is assured to all working parts without the attention of the engineer, other than renewing the lubricant about once in three months, and filling the sight-feed cylinder lubricator.

LANDIS MACHINE CO., Waynesboro, Pa. Catalogue of pipe threading and nut tapping machinery and special threading machines. The Landis all-steel die-head, using a special form of chasers made from flat pieces of steel with threads milled their entire length on the flat side and adapted to cut either right or left-hand threads, is illustrated and described in detail. High speed steel dies are supplied for these die-heads to order. The high speed dies have the advantage of never needing to be re-hobbed or re-tempered.

GENERAL ELECTRIC CO., Schenectady, N. Y., has just issued a new bulletin on Thomson astatic instruments for continuous current switch-boards. These instruments are extensively used, and have a reputation for reliability and accuracy regardless of external influence. They have no controlling springs, and their accuracy is not affected by changes in magnet strength. The damping effect in these instruments is produced by an aluminum disk moving in a magnet field, and the indications are dead beat. The bulletin describes voltmeters and ammeters of the feeder board and illuminated dial types, and gives complete dimension diagrams.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Catalogue of push-button switch mechanism and push-button specialties. This electric push-button switch is of particular interest, on account of the simplicity and ingenuity of the design. Disregarding the casing, the switch mechanism consists practically of only three parts; first, a push bar extending clear through the switch, having its largest diameter in the center and having a conical shape from the center for some distance towards each end; second, a coil spring, which encircles the bar previously mentioned in such a manner that the axis of the spring forms a circle around the bar; third, a moving contact piece encasing the spring. The action of the device is simply this: when the bar is pushed, the coil spring rides up on the conical surface until it reaches the center, all the time preventing the contact piece from releasing until the spring has reached the central and highest part of the bar; then it suddenly contracts and moves swiftly along the conical shape on the other side of the highest point of the bar, carrying with it the moving contact piece. It is not possible to move the contact piece part way and let it slip back again, thereby drawing an arc which burns the contacts and eventually destroys them. The contact piece is either positively in contact or out of contact.

MANUFACTURERS NOTES.

WILLIAM HAHN, Chicago, Ill., maker of flexible shafts, etc., has changed his location from 220 Washington St., to his own building at 621-623 North Campbell Ave.

HOLBROOK-ARMSTRONG IRON CO., Racine, Wis., recently equipped its factory with three brass furnaces and an aluminum furnace at an outlay of $10,000. Crude oil is used for fuel.

GLOBE MACHINE & STAMPING CO., 974 Hamilton Ave., Cleveland, Ohio, has secured the shop rights from the United States Sherardizing Co., New Castle, Pa., for the dry galvanizing process, discovered by Sherard Cowper-Coles, London, England. Samples of articles to be sherardized may be sent to the company for an estimate as to the cost of the treatment.

CROCKER-WHEELER CO., Ampere, N. J. At a meeting of the directors, July 10, the following officers were elected: S. S. Wheeler, president; Gano Dunn, vice-president; A. L. Doremus, second vice-president; Gano Dunn, chief engineer; Rodman Gilder, secretary; W. L. Brownell, treasurer; J. B. Milliken, assistant secretary; G. W. Bower, assistant treasurer.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis., manufacturers of electric controlling devices, will be represented on the Pacific Coast by Otis & Squires, 111 New Montgomery St., San Francisco, Cal. Mr. A. W. Vinson, who for several years has been connected with the engineering department of the Cutler-Hammer Mfg. Co., has been transferred to the office of Otis & Squires, where his services will be available to those having problems in electric control to be solved.

HAYES FILE CO., Detroit, Mich., has just purchased the entire plant of the Peacock File Co., located at Buffalo, N. Y., which was formerly the Maisholf Bros. factory, and has removed the machinery to Detroit. The company has been unable for some time to accept orders from new trade as it has been running its plant to full capacity to supply old customers, but after installing the Buffalo machinery it will increase the output about one-third.

L. S. STARRETT CO., Athol, Mass., has opened a warehouse at 36-37 Upper Thames St., London, England, where a line of fine mechanical tools, hack saws, steel tapes, etc., will be kept in stock. The London store will be a great convenience to British and Continental customers. It will save three to four weeks in getting goods and all goods will be shipped from London. Bills will be rendered in pounds, shillings and pence, and payments will be made in London. The London branch will be in charge of Mr. E. P. Barrus.

BROWN & SHARPE MFG. CO., Providence, R. I., will close its works from August 1 to August 30, inclusive, for annual vacation and repairs. On account of the unusual length of the vacation, special provision will be made to fill the reasonable wants of customers for special cutters and gears that may be wanted quickly. During the vacation the office will be open as usual, and orders for machine tools, machinists' tools, and cutters will receive the same attention as at other periods of the year.

ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, Ohio, has changed its name to Electric Controller & Mfg. Co. The latter name more truly indicates the nature and scope of its business as evidenced by the following list of apparatus manufactured by the company: Controllers both manual and magnetic switch types for all purposes, lifting magnets, electric brakes, magnetic switches, solenoids, limit stops, arc welders, crane fittings, knife switches, flexible couplings, and the electric fault finder.

BECKER MILLING MACHINE CO., Hyde Park, Mass., has taken over the business of the Becker-Brainard Milling Machine Co. and will continue under the management of Mr. John Becker, whose practical experience in the design and development of the Becker Milling Machine has placed him among the foremost mechanics of the day. Many changes and improvements have been made in the plant, carrying out Mr. Becker's ideas and making it virtually the successor of the business which he started in Boston fifteen years ago and afterwards successfully built up in Fitchburg.

CONTENTS FOR AUGUST.

Electric Welding Products Co., Cleveland, Ohio, recently installed a grinding and finishing department equipped with Brown & Sharpe plain and universal grinders, special imported machines for spline milling or slot cutting and centering machines. This department will enable the company to turn out completely finished gas engine valves and valve stems and other similar work. It will finish gas engine valves made with nickel steel heads and carbon steel stems ground on both seat and stem and with slot, groove or thread cut or a hole drilled and the end hardened, thus making a product that is ready to be slipped into the engine in the assembling room.

Wilmarth & Morman Co., Grand Rapids, Mich., reports that the sales of "New Yankee" drill grinders for June, 1908, exceeded the volume of sales not only for June, 1907, but for every other month in the year 1907 with one exception. While the company appreciates this testimonial of recognition of the value of its machines, it is specially gratified by the fact that manufacturers are recognizing the need for mechanical appliances for grinding twist drills. It has taken many years of hard work to prove to mechanics the need of special machines for grinding drills and to demonstrate to them that machine-ground drills are far superior in efficiency to hand-ground drills, as usually done by the average workman.

COMING EVENTS.

August 18.—International Master Blacksmiths' Association Convention, at Cincinnati, Ohio. A. L. Woodworth, Lima, Ohio, secretary.

October 5-10.—First International Congress of Refrigerating Industries, Paris, France. J. F. Nickerson, 315 Dearborn St., Chicago, Ill., Secretary American Committee, will send circular and further information upon request.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

APPLICATIONS ARE DESIRED from shop men who believe that they would have ability as real estate salesmen, selling new farm lands. This is an exceptional opportunity to earn good money in your spare time and to work into a better paying line of business. Address Box 403, Madison, Wis.

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DRAFTSMEN cannot know too much about shop practice—many of them know too little and are handicapped thereby. Machinery's Shop Operation Sheets can help greatly. They are direct, definite and practical. The set now comprises 72 distinct operations. Write for pamphlet. Machinery, 49-55 Lafayette St., New York City.

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H. VOGEL, Room 823, 112 S. Clark St., Chicago, 'phone Main 3777. Designer of any kind of machinery.

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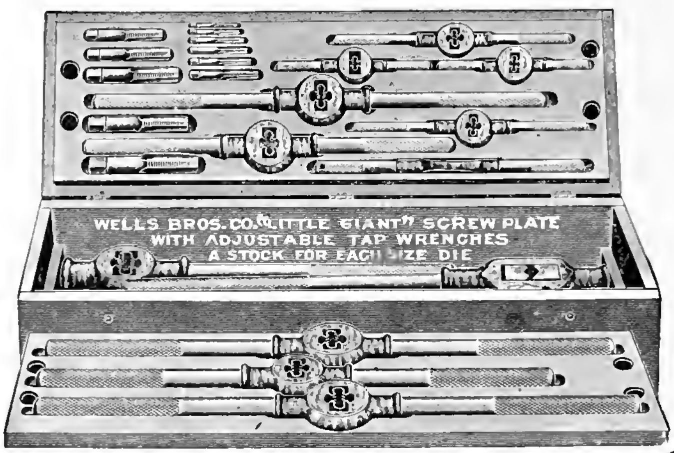
SCREW CUTTING TOOLS

You can't buy better tools than those bearing this stamp, and you can't do better work than they will produce.

They have strength, temper, accuracy, they are fast workers, are long lived and are adapted for every class of work.



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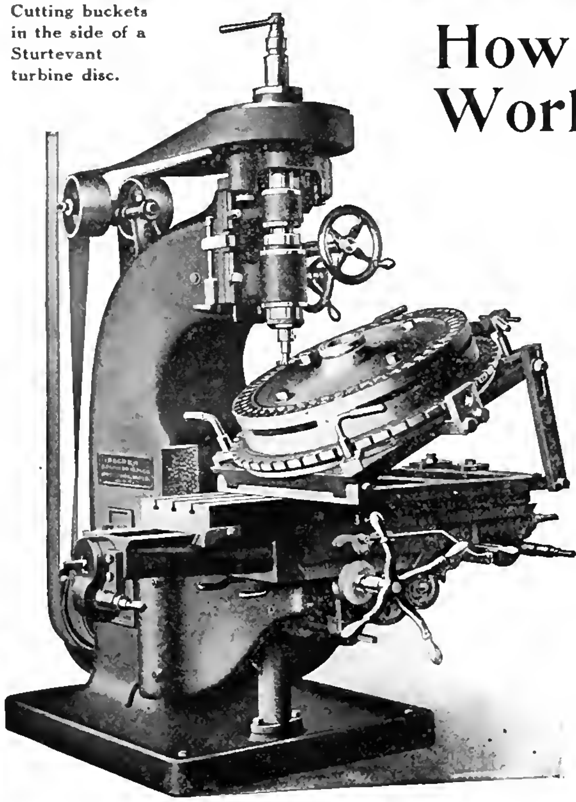


Cutting buckets in the side of a Sturtevant turbine disc.

How Else Could You Do This Work?

THE VERTICAL MILLER

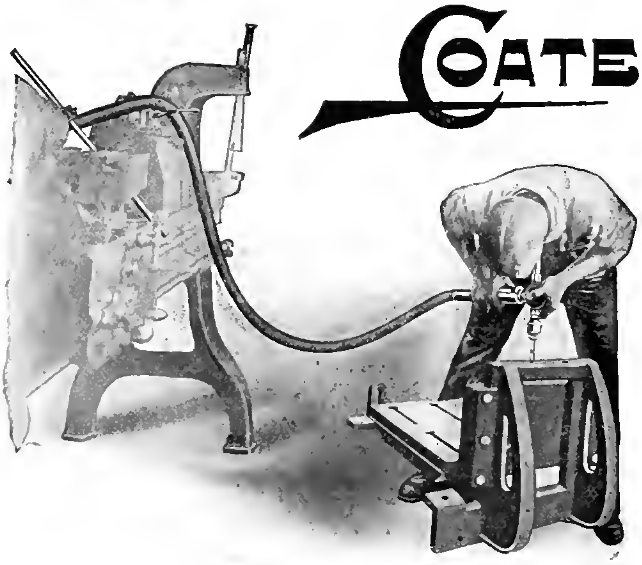
is the most adaptable tool to be found in the modern machine shop; it will do a larger variety of work, do it better and do it quicker than any other single machine. The new horizontal attachment adds to the **Becker-Brainard Vertical Miller** the essential features of the horizontal type, including the cutting of spirals. The permanency of alignment of the vertical spindle, the staunch design, the great depth of throat, the convenience of operation, all combine to make it an indispensable tool.

The Becker Milling Machine Co.

Hyde Park, Mass., U. S. A.

AGENTS:—McDowell, Stocker & Co., Chicago. L. H. Swind, Philadelphia, Pa. A. F. Kummel Hartford, Conn. Chas. G. Smith Co., Pittsburg, Pa. J. L. Osgood, Buffalo, N. Y. A. B. Bowman, St. Louis, Mo. A. R. Williams Machinery Co., Toronto, Ont. and Montreal, Winnipeg and Vancouver, Canada. Ludw. Loewe & Co., Berlin, Germany. Bevan & Edwards Propty. Ltd., Melbourne, Australia. Selig, Sonnenthal & Co., London, England. Schuchardt & Schutte, Berlin, Germany; Vienna, Austria; Stockholm, Sweden; St. Petersburg, Russia; Copenhagen, Denmark; Budapest, Hungary; Shanghai, China. A. H. Schutte, Cologne, Germany; Liege, Belgium; Milan, Italy; Barcelona, Spain; Brussels, Belgium; Paris, France; Bilbao, Spain.

COATES UNIT LINK FLEXIBLE SHAFT



Coates Flexible Shaft used in connection with breast drill.

For Drilling, Grinding, Polishing—for a hundred and one purposes of every day work—there is no device that equals the Coates Flexible Shaft. It will save an immense amount of time and labor; can be used anywhere and at any angle; the drive is steady throughout the entire length, running either backward or forward. It is perfectly flexible—bend it as much as you like; each link is a unit made of hardened steel and driven by by a square spheroid — the strongest drive possible. If a link breaks it is only a matter of a few minutes time and a few cents expense to replace it.

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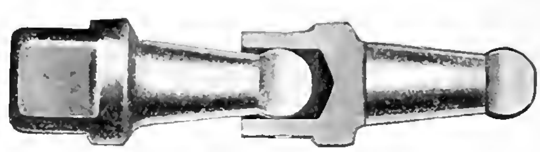
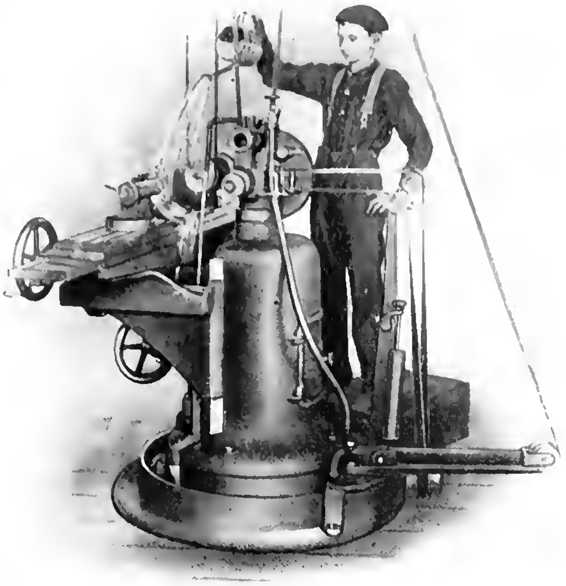


Section of the Unit Link Shaft.

COATES CLIPPER MFG. CO., Worcester, Mass.



This picture is shown for the purpose of emphasizing the fact that the

Thompson Universal Grinding Machine

is built with a perfect **water attachment.** Long open tank on base, easy to keep clean. Top of knee cast solid in the form of a basin, into which all water drains from above, and from which it is conducted through pipes to the tank.

This grinding machine is **convertable** into a **plain** grinder ; a **surface** grinder ; a **knife** grinder ; a **die** grinder ; a **cutter** grinder, or an **internal** grinder, and in each form it works to perfection.

Circulars and prices upon request.

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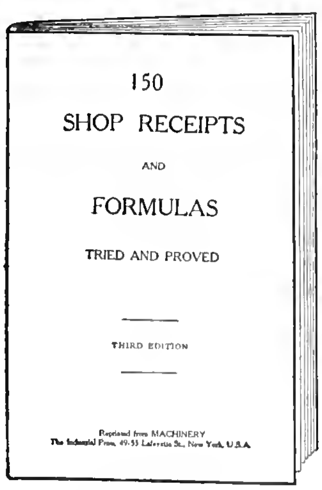
MACHINERY'S 132 Page Booklet



A collection of valuable Receipts and Formulas arranged for ready reference. The receipts in this Booklet are completely indexed and printed on one side of the paper only.

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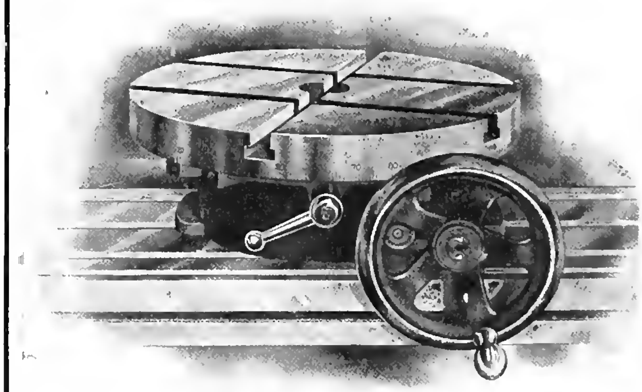
Our **Shop Equipment,** with which we build our **Milling Machines** is more than we can use. Just thought you might want to make use of it.
We make **Milling Cutters** and we do **Gear Cutting** as well.
Our Planers, Lathes, Shapers and Millers are all ready for your order, send it along.
We won't overcharge you, and we promise good work.
Now are you ready to talk it over?



Owen Circular Milling Attachment

For use on milling machines and of especial advantage in connection with the vertical attachment. Table is 15″ in diameter, with three T-slots, hand feed and entire circumference of circle graduated to degrees. Also made with automatic feed for both Plain and Universal Machines.

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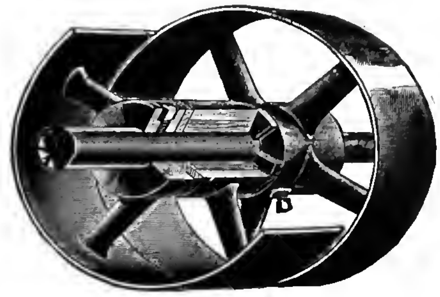
"Arguto" It is only a Question of Time

TRADE MARK

And a short time at that, before every loose pulley and friction clutch in *your* plant and in your neighbor's plant will be equipped with

ARGUTO OILLESS BEARINGS



Loose Pulley Equipment.

They are the bearings of the day and of the future. They solve the vexed question of lubricating rapid running loose pulleys; save labor, reduce fire risk, promote cleanliness and prolong the life of your belts.

They are adapted for all light, high speed machinery and were awarded the Gold Medal at the Jamestown Exposition because of their manifold advantages and their superiority over every other device of the kind.

A trial is all we ask—the bearing will do the rest.

HIGHEST AWARD
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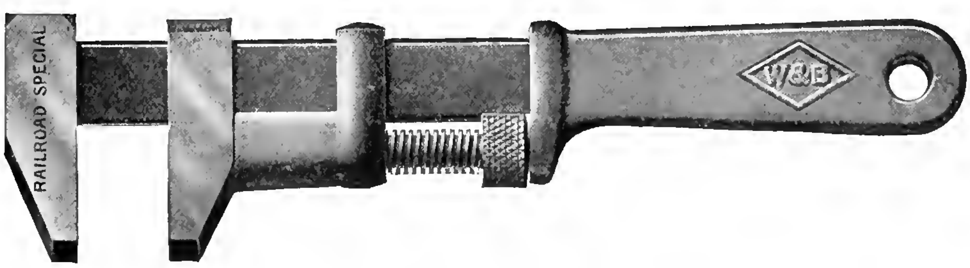
The Strongest Wrench Made, Barring None



BECAUSE:

W & B

The Head and Bar are Drop Forged **in one piece from open hearth steel.**
The Screw and Jaw have a deeply milled thread.
The Handle is our "W & B" Indestructible Iron Handle, and it fits the hand.
The Jaws are case hardened, the entire Wrench ground and polished and highly finished.
It is the most economical Wrench on the market and is used by the largest Railroads and Manufacturers in the world because it saves them money.

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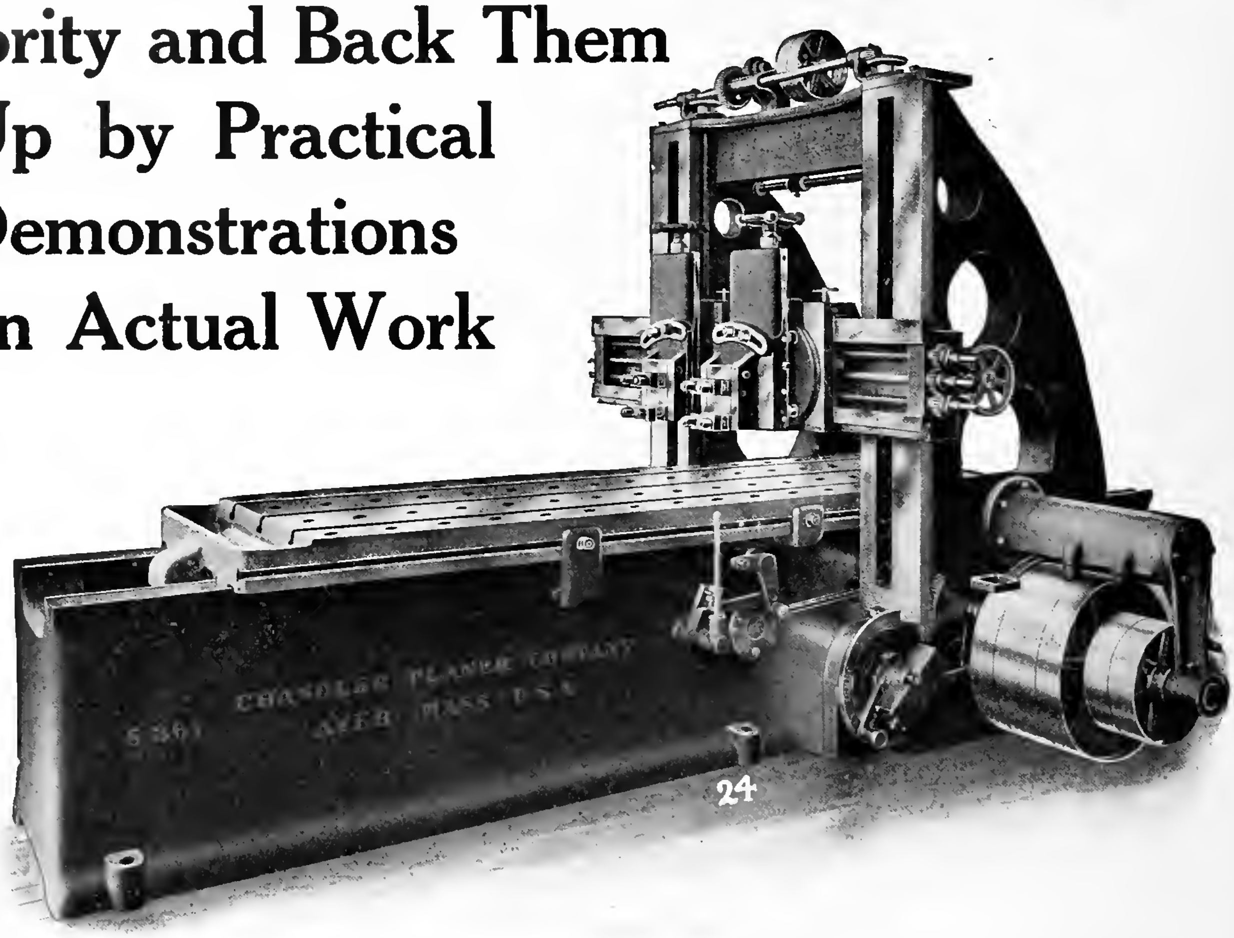

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1. They cut more linear feet per minute by running faster in each direction and reversing more promptly at each end.
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3. They secure an accurate surface in less chips.
4. They do the same amount of work in fewer strokes, thus economizing power. Reversing and returning represent wasted energy.
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7. Every adjustment is instantly made without the necessity of stopping the planer. This not only saves time but insures the best operating conditions on all classes of work.
8. They can be operated more hours per year. No planer requires so few repairs and has so few breakdowns.

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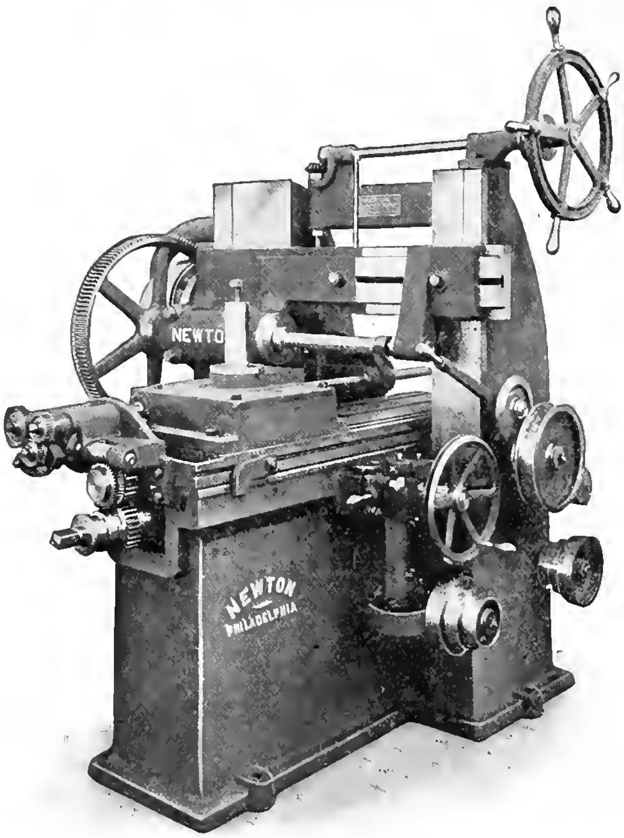

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Eleven sizes from 26″ to 100″ diameter of head.

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For Bars, Billets, Cranks, Steel Castings and Shapes.

Immediate Delivery.

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Stock Shipment.

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Crank, Geared and Portable.

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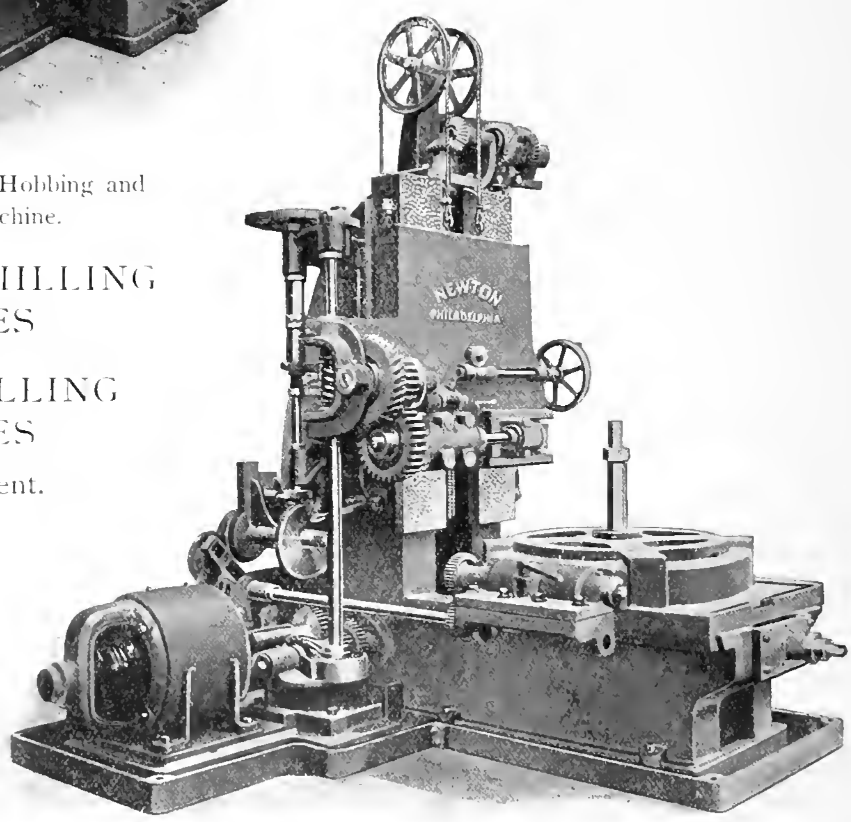

84″ High Duty Gear Cutter.

Newton Machine Tool Works, Inc.

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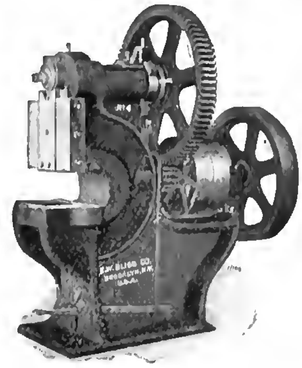
"Bliss"
Incilnable Power Press.



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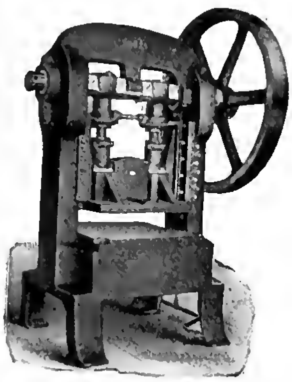
SHEET METAL WORKING MACHINERY

The "BEST PRESSES" are the only kind we know how to build; that is why "BLISS" presses are recognized as standard the world over. They are LABOR SAVERS and MONEY SAVERS.

We build every kind of press for sheet metal work. Special machines for unusual requirements. Our line includes Automatic Drop Hammers, Punching, Slitting, Shearing, Seaming Machines, etc., etc.



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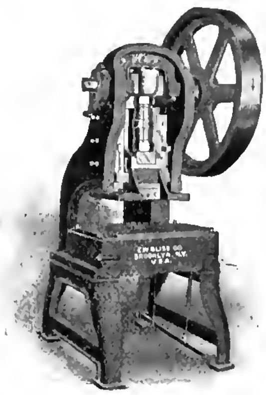

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"PRESSES FOR EVERY PURPOSE."

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An improved type of press with four rods—two at top and two at bottom—an arrangement which permits handling larger work than is practicable with the two rod type, and overcomes the eccentric strains that would otherwise result when work is not trued up. Three speeds can be obtained from the pump which is of the plunger type, and the Press is provided with all necessary valves, gauges, etc.

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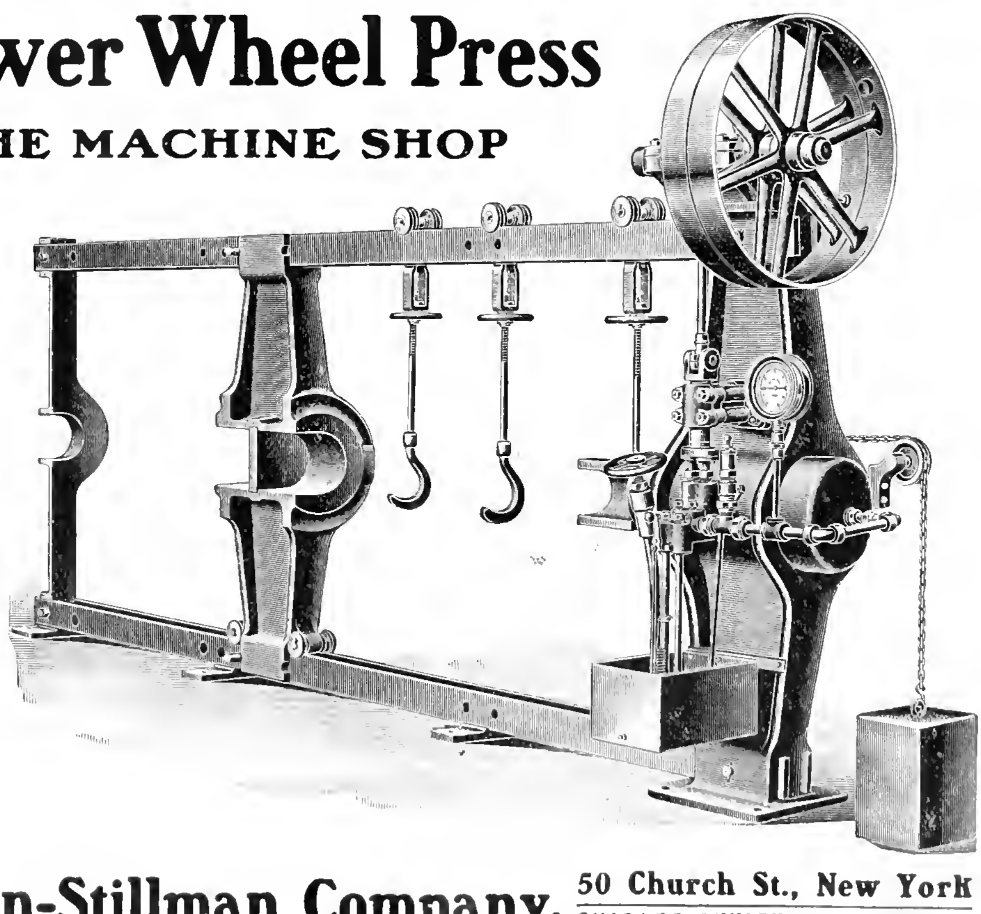

The Watson-Stillman Company, 50 Church St., New York
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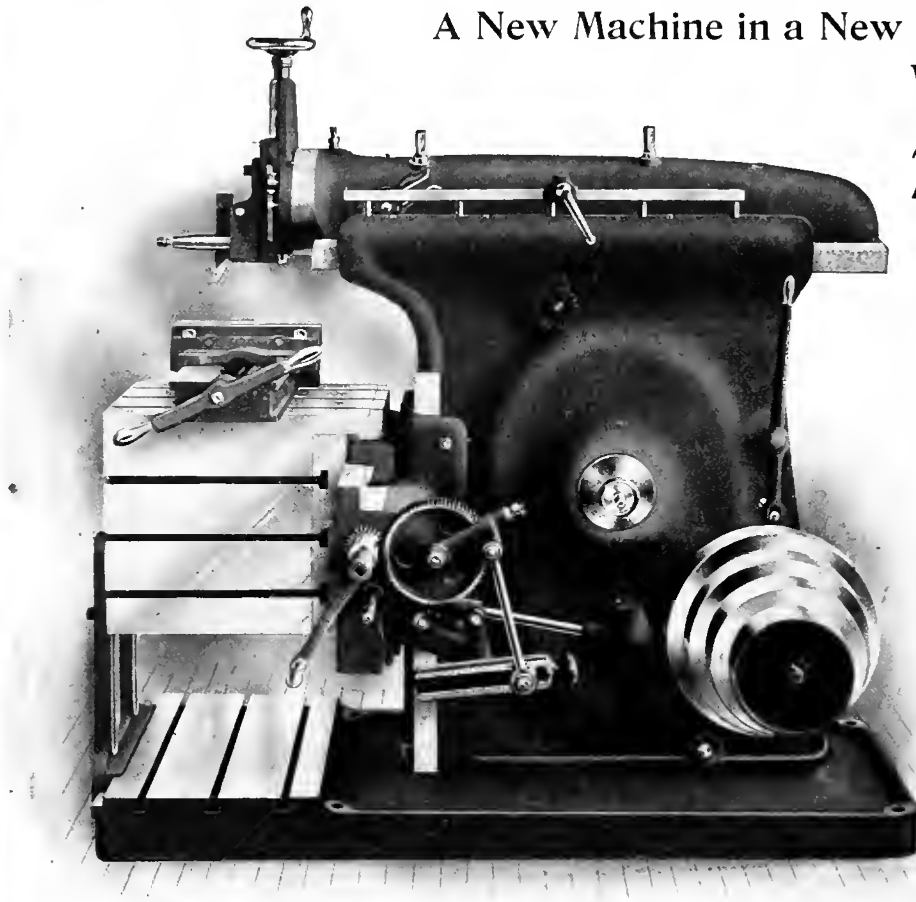
A New Machine in a New Line of Shapers



Walcott & Wood 20" Crank Shaper

In the design of this tool special attention has been given to increased strength and stiffness, and to correction of weak points common to this class of machine. The ram is of improved construction, insuring maintained alignment. Driving gear unusually strong. Ratio of back gearing very large. Quick return of ram is obtained through elliptical gears, providing greater power during the cut and giving a smooth, powerful drive with 8 cutting speeds for each length of stroke.

A 16" and 24" size in this style ready shortly.

Walcott & Wood Machine Tool Co.

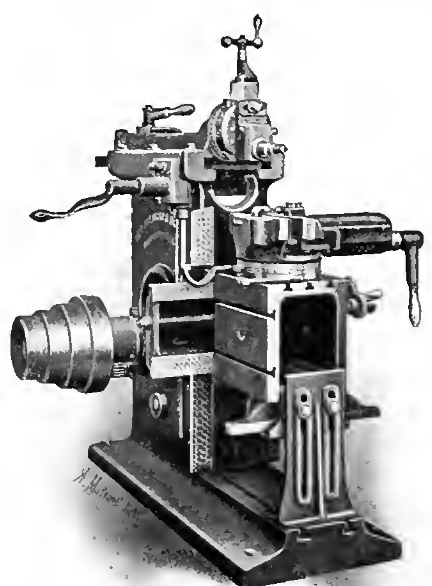
Jackson, Mich., U.S.A.

Succeeding GEORGE D. WALCOTT & SON

AGENTS—Frevert Mchy. Co., New York. Chandler & Farquhar Co., Boston. Chas. G. Smith Co., Pittsburg. Strong, Carlisle & Hammond Co., Cleveland. H. A. Stocker Mchy. Co., Chicago.

FOREIGN AGENTS—Fenwick Freres & Co., Paris. Buck & Hickman, Ltd., London. Heinrich Dryer, Berlin, Germany.

Improved Crank Shaper



THE TIME SAVING FEATURES

of this improved machine are worth investigation. All adjustments can be quickly made, the adjusting mechanism saving fully 15% in time over other methods. It is easily operated, rigid under heaviest cuts, has square bearings and a very simple method of feed regulation.

16", 21" and 26" stroke. Ask for Circular.

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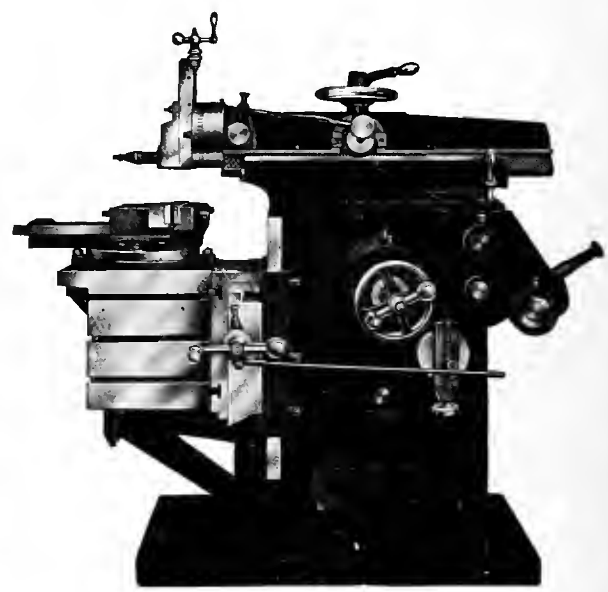
SHAPERS



New 16-inch Shaper

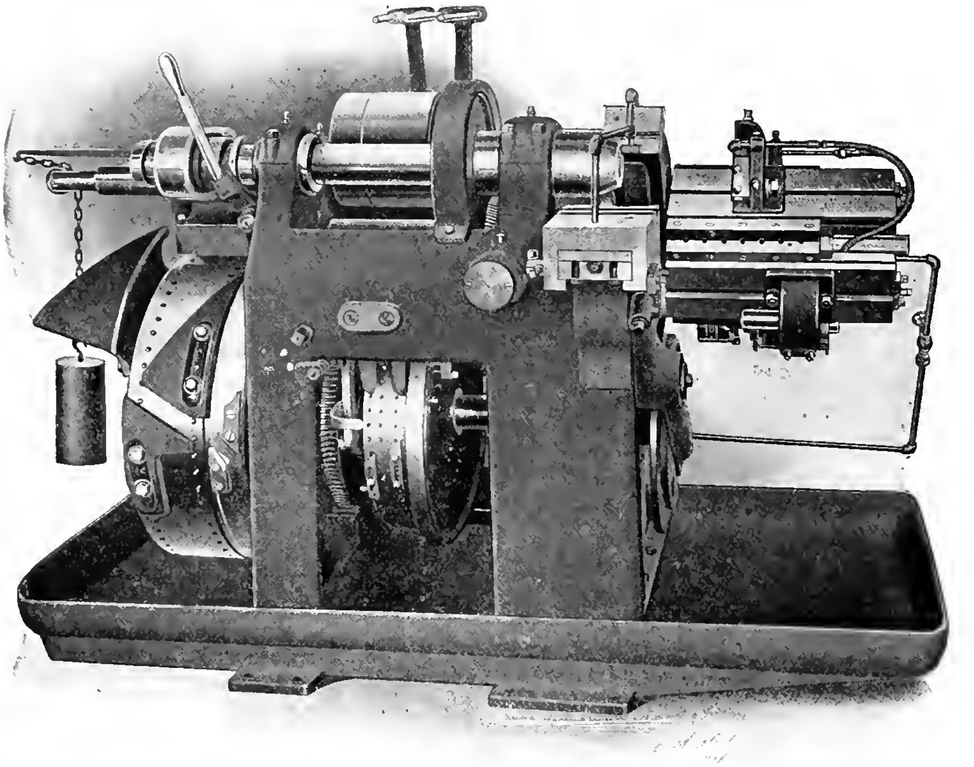
This improved machine has down feed, which will feed either up or down, and needs no adjustment when length of stroke is changed; an absolutely uniform stroke, gear box giving ten different speeds, extra large bearing surface, requires no gibs and no countershaft and is altogether one of the most convenient and powerful shapers yet built.

Write for particulars.

THE MARK FLATHER PLANER CO.

NASHUA, N. H.

THE GRIDLEY AUTOMATIC TURRET LATHE



Has peculiar advantages that save time, increase output, permit high speeds, coarse feeds and heavy cuts, and over and above all make accurate product a certainty.

The widest range of work of any Automatic Turret Machine, and capacity for handling pieces of far greater length than any other.

Low labor cost—one man can operate several machines.

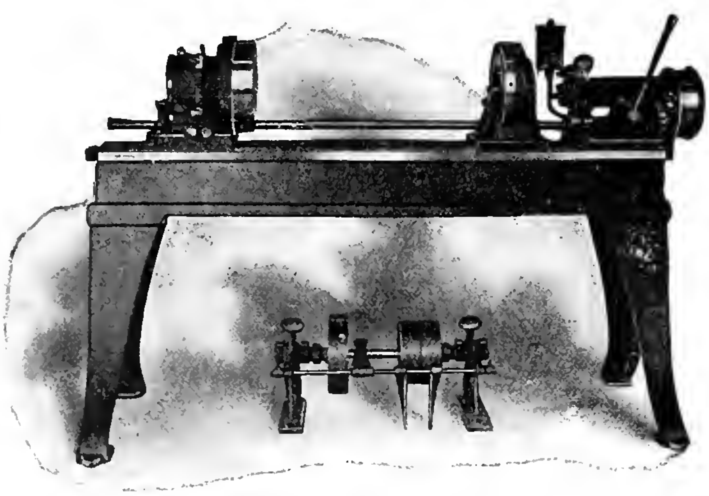
Windsor Machine Company, Windsor, Vt.

Manning, Maxwell & Moore, Inc., Sales Agents, New York, Boston, Syracuse, Pittsburgh, Philadelphia, Cleveland, St. Louis, Milwaukee, Chicago and Birmingham.

THE WHITON

Revolving Centering Machine

For Accurately Centering Finished Shafts



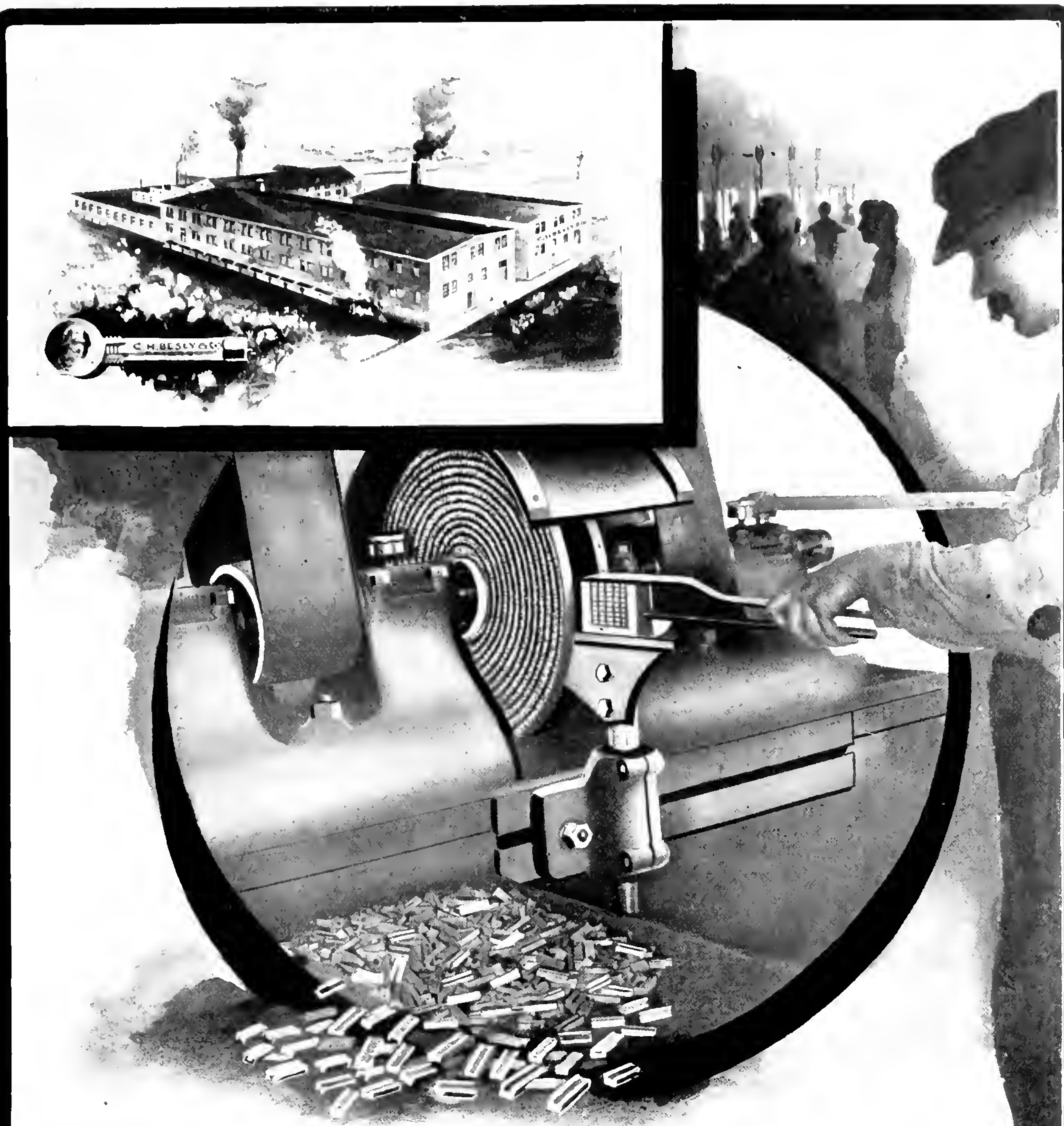
The cut shows new REVOLVING CENTERING MACHINE—a large size of the well known machine of this type. It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

Constructed same as the smaller machine and embodies all the special features.

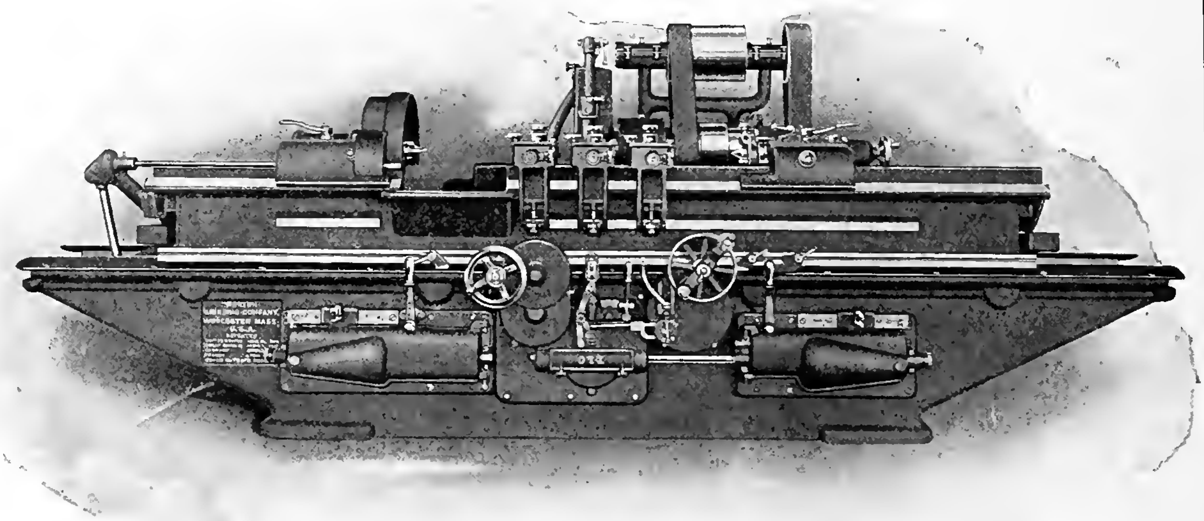
Circulars and prices sent upon application.

The D. E. Whiton Machine Company

New London, Connecticut

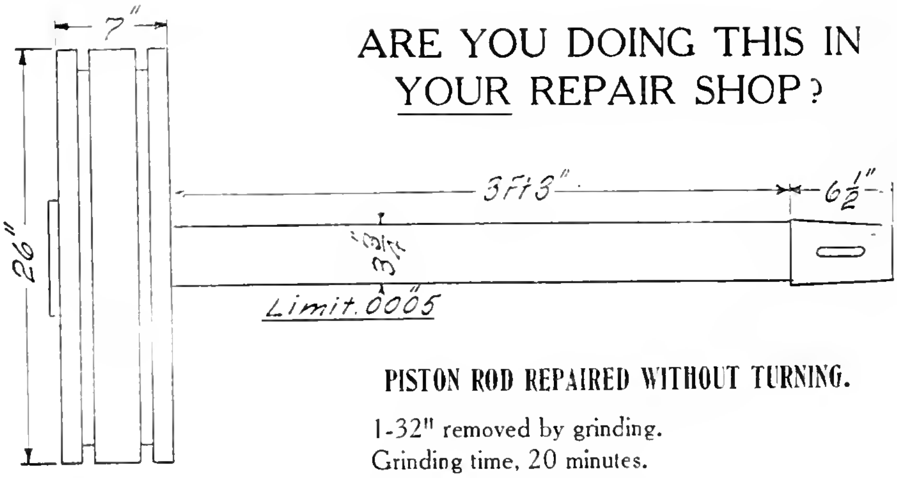


Railroad Repair Shops Find NORTON GAP GRINDERS Profitable



18 and 30 x 96 Norton Gap Grinder.

ARE YOU DOING THIS IN YOUR REPAIR SHOP?



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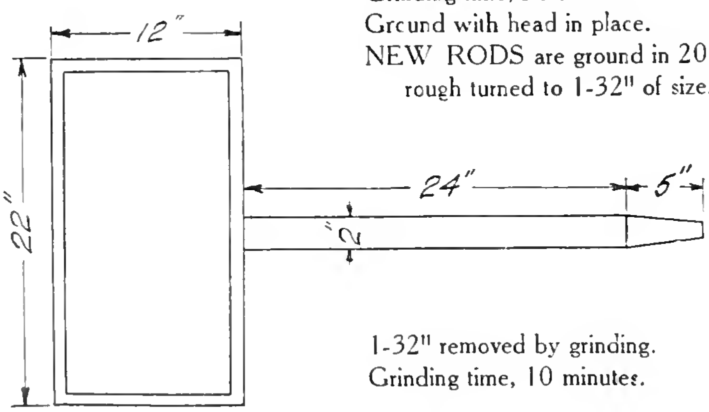
1-32" removed by grinding.
Grinding time, 20 minutes.
Ground with head in place.
NEW RODS are ground in 20 minutes, when rough turned to 1-32" of size.



1-32" removed by grinding.
Grinding time, 10 minutes.

Similar savings are made in grinding axles, crank pins, valve stems, etc.

Let us hear from you and we will show you how it is done.

Write for Catalogue N-7.

NORTON GRINDING CO., Worcester, Mass.

CHICAGO STORE: 48 South Canal Street.

EUROPEAN AGENTS: Ludw. Loewe & Co., Ltd., London, Berlin. F. W. Horne, Yokohama, Japan.

TRADEMARK NORTON REGISTERED

Norton Grinding Wheels are made of Alundum.

Grinding Information reprinted from booklet entitled "Helps-Don'ts"

To increase the speed of a grinding wheel gives the effect of a harder wheel; decreasing the speed gives the effect of a softer wheel.

For surface grinding, it is customary to run wheels at a somewhat slower rate of speed than for general grinding. A speed of 4,000 to 5,000 surface feet is usually employed.

Wheels are run in actual practice from 4,000 to 6,000 feet per minute.

Speed up the spindle as the diameter of the wheel is decreased. Approximately the same periphery rate should be maintained as the wheel wears down.

Transferring a wheel after worn down to a small diameter, from a large machine to a small one, is a good plan.

—*From Booklet: "Helps-Don'ts."*

"Helps-Don'ts" is a booklet full of valuable points on Grinding; information on the selection of the right grinding wheels for the work, mounting and truing wheels, operating speed, care of wheel, etc.

Grinding Points Ground Down for the benefit of all who grind—for foremen, for superintendents. It contains information based on many years of "Norton Experience" in the manufacture and use of grinding wheels and grinding machinery.

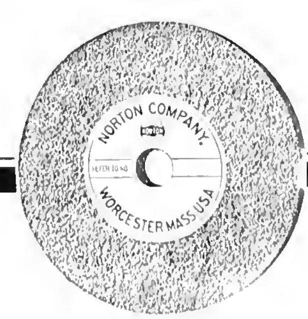
It will be sent without charge to anybody. Send a postal now.

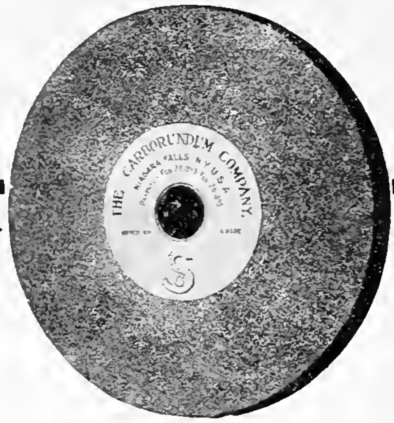
Norton Company

Grinding Wheel Works, Worcester, Mass.

NEW YORK OFFICE: 26 Cortlandt Street, Havemeyer Bldg.
CHICAGO STORE: 48 South Canal Street.
ALUNDUM PLANT: Niagara Falls, N. Y.

F 50

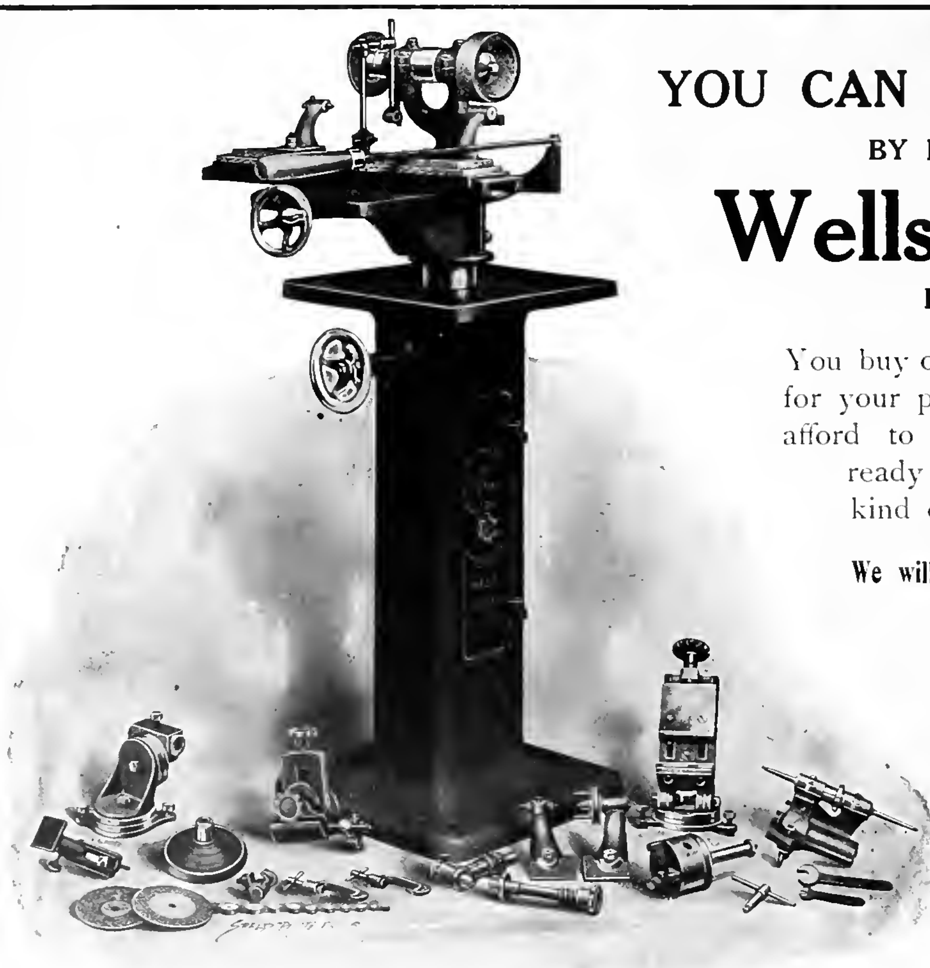




The Man is Worth More than the Machine

That's why Carborundum Grinding Wheels save money in every shop into which they are introduced. They increase the efficiency of the man—enable him to do more work and better work in a day—hence decrease the cost of production. There's a Carborundum Wheel to meet every grinding requirement.

THE CARBORUNDUM COMPANY
NIAGARA FALLS, N. Y.



YOU CAN SAVE MONEY

BY BUYING A

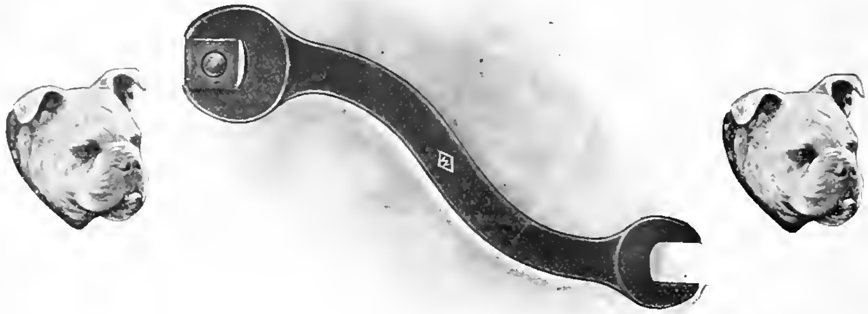
Wells Grinder

BECAUSE

You buy only the equipment wanted for your particular work. You can afford to keep a machine always ready for grinding all or any kind of tools.

We will gladly tell you more about it.

F.E. WELLS & SON COMPANY
Wells
GREENFIELD MASS. U.S.A.



Aug. the hot.

Dear Sir:

If now you are selling cast wrenches with otherwise high class machinery product we can, in many cases, give you tools that will match your machines—high class drop-forged wrenches—and probably save you money besides. We are making more than 32 classes covering entire range of uses. Oblige us and help yourselves by sending list of sizes and quantities used and we will hustle to place satisfactory reply in your hands. Catalogue "B" free.

Mr. Buyer

(The dogs are after you.)

J. H. WILLIAMS & CO.
SUPERIOR DROP-FORGINGS
BROOKLYN, N. Y. CITY

"At the Sign of the Lion."

MONARCH GRINDING WHEELS

Are so bonded that they combine the greatest degree of porosity with the greatest strength of texture—

Excel in cutting properties because of even temper secured by merging of proper abrasives under proper heat—

Are graded to suit every need requiring rapid and effective work—

Are free cutting, dependable and and durable.

May be used wet or dry—odorless, dustless, and never heat when properly graded.

Made in all sizes and in all face shapes.

We have a catalogue for you.

Monarch Emery and Corundum Wheel Co.

CAMDEN, N. J., U. S. A.

STERLING

Emery and Corundum

WHEELS

Write us your requirements in this line. Our wheels are graded to suit every kind of work. They are fast cutting, non-glazing, and equally effective on wet or dry grinding.

Sterling Emery Wheel Mfg. Company

Factory and Offices: TIFFIN, OHIO

BRANCHES: New York House, 45 Vesey St. Chicago House, 6 W. Washington St. San Francisco House, 461 Market St.

It Is Shop Economy

to have a **Cut-Meter** for every machine tool. With this device at hand there is no excuse for speeds below the standard. It is simple, requires no timing or calculation; adaptable, can be used on any machine; convenient, can be held in any position—and shows the operator instantly and exactly, the cutting speed in feet per minute at which his machine is running.

Built for hard service and will save its cost a hundred times over in a year.

Send for catalogue.

Warner Instrument Company

56-59 Roosevelt Avenue, BELOIT, WIS.

1691 Broadway, New York. 153 Federal St., Boston.

The King Machine Tool Company.

CINCINNATI OHIO U. S. A.

VERTICAL TURRET BORING AND TURNING MACHINES

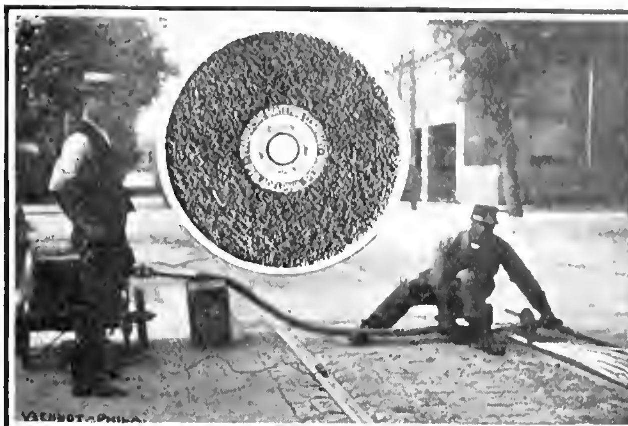
VITRIFIED CORUNDUM WHEELS

THE COOLEST CUTTING WHEELS

on the market and the most satisfactory on every other count. Made from almost pure corundum, by the vitrified process, they are 50 per cent. more efficient than other abrasive wheels, cut faster and cleaner, will not glaze and never draw the temper of the tool being ground.

Sent on trial when desired.

Vitrified Wheel Company
WESTFIELD, MASS.



ABRASIVE

Grinding Wheels Work Fast

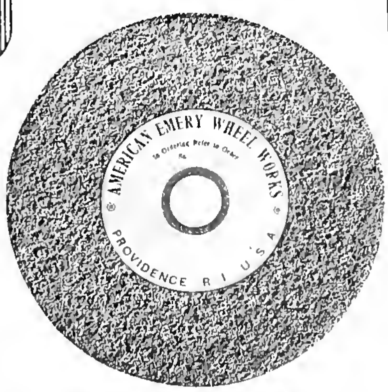
That's why they are preferred for grinding car tracks where as much work as possible must be done between cars.
For the same reason they are time and money savers wherever used; also, **they cut cool,** and there is little chance to spoil the work. Equally adapted and designed for the heaviest or the finest and most exact service.

Illustrated catalog and individual grinding advice free on request.

ABRASIVE MATERIAL CO.
PHILADELPHIA, PA.

AGENTS: H. A. Stocker Machinery Co., Chicago, Ill R. Sonnenthal, Jr., Berlin, Cologne and Vienna. Wilh. Sonesson & Co., Malmo and Copenhagen. Glaenzer Perreaud & Thomine, Paris, France. R. d'Aulignac, Barcelona, Spain.

AMERICAN



Corundum Wheels and Emery Wheels

Made in every grain, and grade of hardness, and by every process. Accurately tested, balanced and graded, and absolutely uniform, they represent

The Highest Possible Efficiency.

Every wheel that leaves our works carries with it our guarantee that it will be **entirely satisfactory** for the operation for which it is furnished.

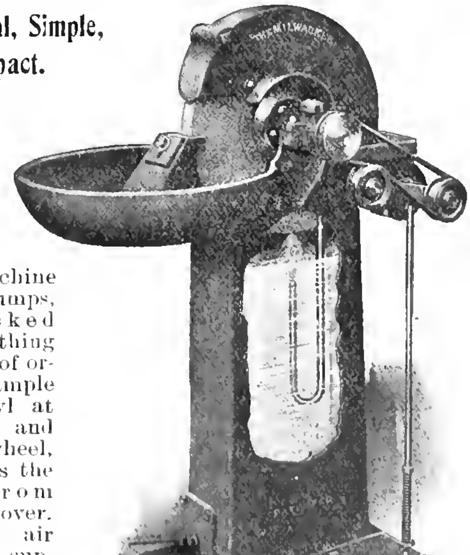
Write for copy of new Catalog.

American Emery Wheel Works
Providence, R. I., U. S. A.

"Milwaukee" Wet Tool Grinders

Substantial, Simple, Compact.

Ready, Reliable, Efficient.



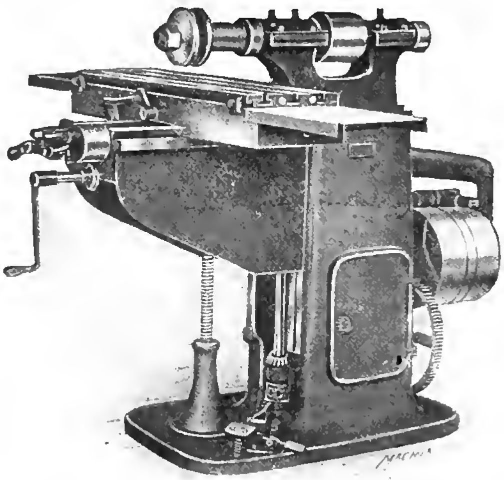
This machine has no pumps, no packed joints, nothing to get out of order. An ample sized bowl at the front and sides of wheel, prevents the water from slopping over. A patent air jet device supplies the wheel with clean water at all times, and the supply of water is regulated and controlled by a convenient foot treadle.

It will pay you to investigate.

Lutter & Gies, Milwaukee, Wis.

AGENTS—E. L. Essley Machine Co., Chicago. O. L. Packard Mchy. Co, Milwaukee. Vandyck, Churchill & Co., New York City. Chas A. Strelinger, Detroit, Mich.

Saxon Surface Grinders



Produce accuracy on flat work AT A LOW COST.

This is due to their strength and durability.

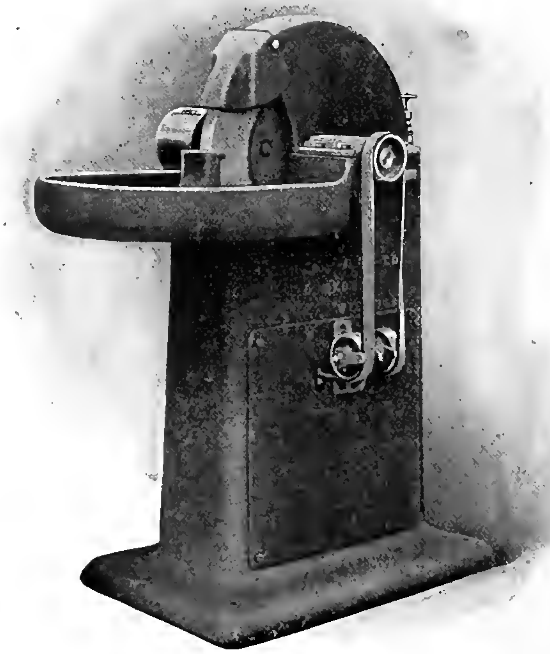
They will also finish work from the rough material where a small amount is to be removed, and do it economically.

They save money in the tool room and in the shop.

A better knowledge of what they will do, put into use, will help your bank account very materially.

Your request secures the information.

SAXON MACHINE COMPANY
HOLYOKE, MASS.

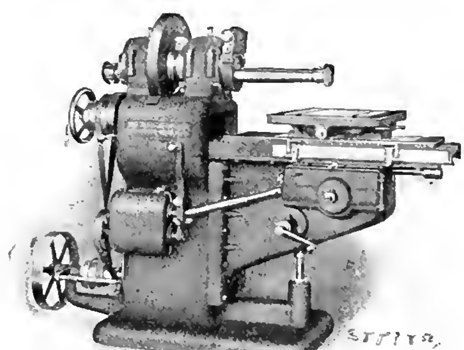


Has all self oiling boxes. Countershaft has half turn rod for shifting belt.

No spattering. Water control is perfect.

Ransom Mfg. Co., Oshkosh, Wis., U. S. A.

European Agents: Ludw. Loewe & Co., Berlin, Germany.



COMMERCIALLY

There is but one way to obtain Round Holes, Straight Holes, and Holes of uniform diameter. That is by GRINDING.
For this work, the **HEALD CYLINDER GRINDER** is especially designed and altogether satisfactory, rapid in operation and accurate to within .00025″ limit. It leaves a smooth, hard surface unapproached by any other method.

GAS ENGINE MANUFACTURERS

You will find this machine the solution of the problem "How to Obtain a Round and Straight and Smooth bore to your cylinders, at a minimum cost." Can we post you further?

THE HEALD MACHINE CO.
Station D-2, Worcester, Mass.

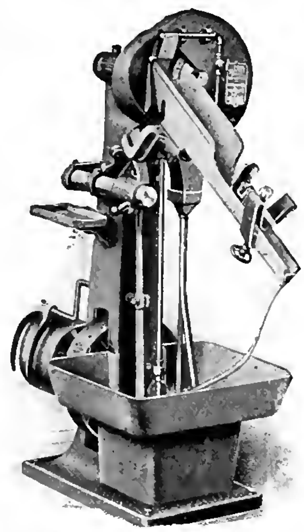
Two New Yankees

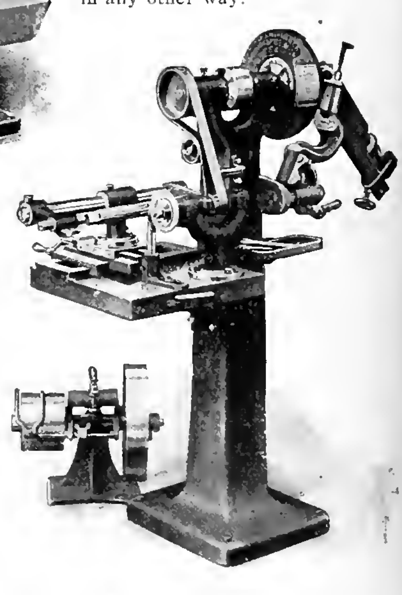
Wet drill grinder with capacity up to 3½″ drills. We make both smaller and larger sizes; also dry grinders of all sizes and types.

The **New Yankee** Line covers every shop condition—50 styles.

You can't grind drills by hand and do it perfectly.

A bright boy can do a perfect job with a **New Yankee** Drill Grinder and do it quicker than your best mechanic could do any kind of a job in any other way.





Style "F" Wet Drill Grinder and Combination Cutter, Reamer and Drill Grinder style "BX."

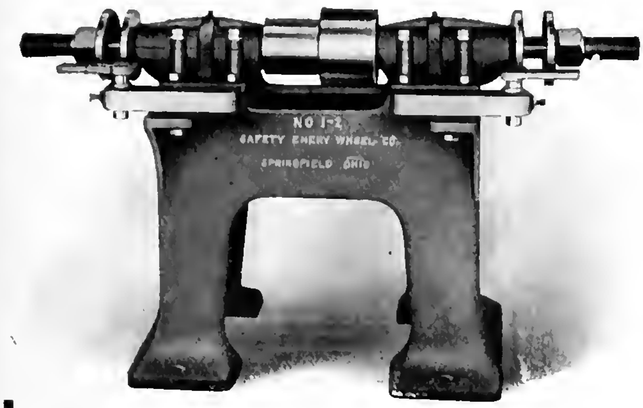
An ideal tool grinder for the small shop and department tool room in a large shop.

It has a range which compares favorably with machines costing $300.00 to $500.00 and does its work just as well and conveniently. It grinds drills in the **New Yankee** way too.

The cost is a trifle.

Wilmarth & Morman Co.
580 Canal St.,
Grand Rapids, Mich.

Yours for General Grinding



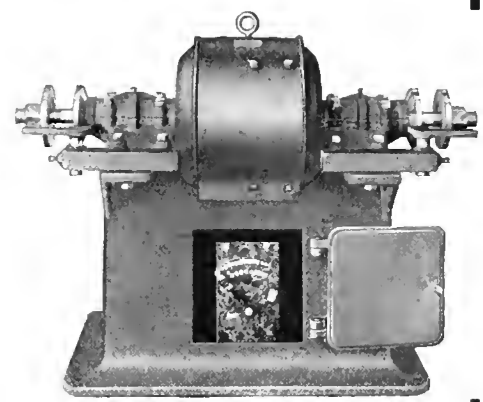
Belt-Driven Floor Grinder

Specially designed for general grinding. Built solid and substantial. Extra long self-oiling, dust-proof bearings, but FREE FROM LOOSE OILER RINGS TO WEAR SPINDLE. Abundant space between wheels. Rests easily adjusted. Countershaft provided with self-oiling boxes.

Motor-Driven Floor Grinder

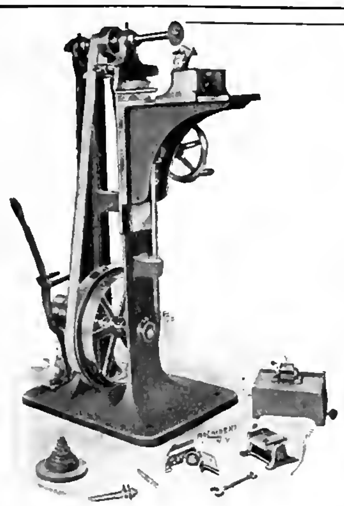
Compact and efficient. Constructed upon lines of greatest rigidity and adapted to the modern methods of electric drive. Motor armature is mounted upon wheel spindle which runs in extra long ring oil, dust-proof bearings. Motor is fully enclosed and receives proper ventilation from large base beneath, in which is located starting box and speed regulator. Our motors are built specially for this type and are equal in every respect to any on the market.

Our New Catalog No. 6-M gives details.



The Safety Emery Wheel Company, COLUMBUS AVENUE, SPRINGFIELD, OHIO.

J. R. Baxter & Co., Montreal, Canada. Pfeil & Co., London. V. Lowener, Copenhagen. Adler & Eisenschnitz, Milan. De Fries & Co., Akt. Ges., Dusseldorf, Berlin, Wein and Paris.



Perfectly Accurate Threads

can never be obtained with hand-ground chasers, because it is impossible to give each one the same angle. For good results it is necessary that all the chasers in a set be ground exactly alike, and the

Wallace Chaser Grinder

accomplishes this to perfection. Being accurately ground, each chaser does its proper share of work, does it well and wears five times as long as if ground by hand. The grinder is simple in construction, easy to operate and a time and money saver. For full details write

MODERN TOOL COMPANY, ERIE, PA.

Also manufacturers of Self-Opening Die Heads, Solid Dies, Tap and Die Holders, and Tapping Attachments for Drill Presses.

AGENTS—Tha Prentiss Tool and Supply Co., 115 Liberty St., New York. Frank H. Czarniecki Co., 335 Fifth Ave., Pittsburg, Pa. O. L. Packard Machinery Co. 34 S. Canal St., Chicago, Ill., Milwaukee, Wis. C. W. Burton, Griffiths & Co., London, Eng. Chandler & Farquhar, 34 Federal St., Boston, Mass. J. Lambercier & Co., Geneva, Switzerland.

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Complete line carried in stock for immediate delivery.
Write to nearest office for catalogs and prices.

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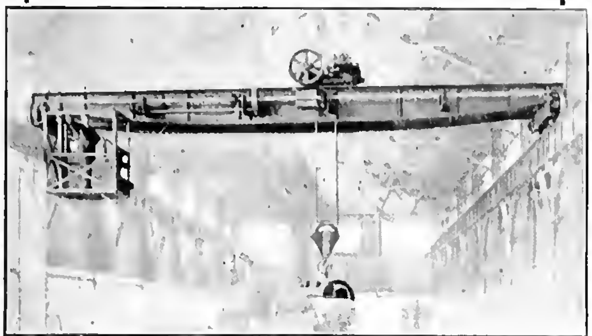


YOUR MONEY

In the selection of any piece of machinery it is highly essential that a maximum of reliable power be secured at a minimum cost.

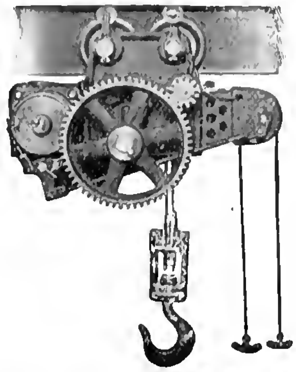
The experience, material and workmanship put into Cleveland Cranes make them the most durable and efficient cranes on the market today.

Your money in "Cleveland Cranes" will purchase lasting, A1 crane service.

Write for estimates.

The Cleveland Crane & Car Company
WICKLIFFE, OHIO

ELECTRIC HOISTS



NORTHERN CRANES

Traveling, Locomotive, Jib and other varieties
Electric, Hand or Steam

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26 Chene St., DETROIT, MICH., U.S.A.

NEW YORK: 120 Liberty St. PHILADELPHIA: Land Title Bldg.
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New Machine Tools

TAKE a look over your machine tools. You will soon have to make some replacements—some additions. You *need* new tools.

How about your engine lathes? Have you been using them for a class of work you should have done on Gisholt Lathes? One Gisholt, you know, will do as much chucked work as two to four engine lathes. There's twenty years of successful experience in "making good" behind that statement.

Why not ask what we can do for you?

Ask about Gisholt Lathes, Boring Mills and Tool Grinders. A new booklet we have issued recently will interest you. Write for it.

Gisholt Machine Company

Works: MADISON, WIS. and WARREN, PA.

General Offices: 1316 Washington Ave., Madison, Wis.

FOREIGN AGENTS: Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Vienna, St. Petersburg, Stockholm, Berlin. C. W. Burton, Griffiths & Co., London, England.

The Peerless Hoist

The latest type of spur geared hoist embodying special features that make it the most efficient device of its class.

Safety, Durability Speed and Power

are prominent characteristics of the "Peerless"—all qualities that go to make up the perfect hoist. The single load chain tends to light weight and compact form; all working parts are protected by dust proof cases; the hoisting mechanism—a train of compound balanced steel gears—insures smooth action and reduces wear to the minimum; and all danger of the load slipping is eliminated by a chain guide and stripper.

We shall be glad to furnish full particulars on request.

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DATA SHEET BINDERS
New Binders for MACHINERY Data Sheets, adapted to hold any number. Red cloth, black lettering. Price 35 cents, post paid.
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"BROWNHOIST"

10 - ton Standard Locomotive Crane in the yards of the American Steel Foundries at Pittsburg, Pennsylvania.

WRITE US FOR CIRCULAR "I."

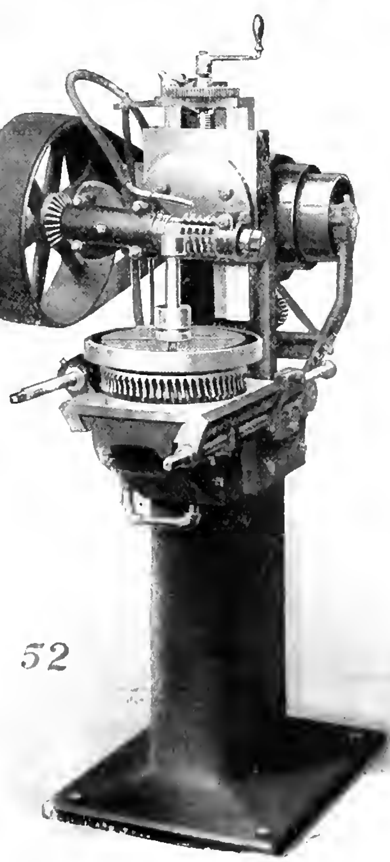
THE BROWN HOISTING MACHINERY CO.

Engineers, Designers and Manufacturers of Hoisting Machinery of all descriptions

BRANCH OFFICES:
Pittsburg and New York

Main Office and Works: CLEVELAND, OHIO

Automatic Gear Hobbing Machine



The Farwell Gear Hobbing Machine
requires no attention besides the setting of the blanks and removing the finished gears.

The Feed Stops Automatically
at the end of the cut.

And Best of All
the teeth are formed theoretically correct.

SEND FOR LITERATURE

The Adams Company

DUBUQUE, IOWA, U. S. A.

AGENTS: De Fries & Co., Dusseldorf, Germany. G. Koeppen & Co., Moscow, Russia. J. Lambercier & Co., Geneva, Switzerland. V. Lowener, Copenhagen, Denmark. Aktiebolaget V. Lowener, Stockholm, Sweden. Glaenzer, Perreaud & Thomine, Paris, France.

THE NEW POWELL HIGH SPEED ACCELERATING CUT PLANER

WILL INCREASE YOUR PLANER OUTPUT

The Acme of Perfection in Planer Design and Construction.

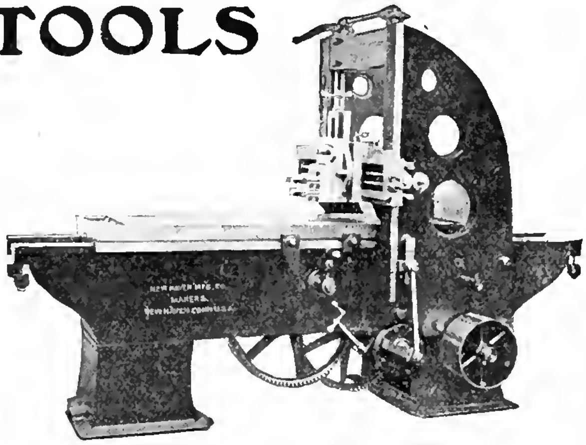
The result of thirty years experience in designing and building Planers.

Built like a watch. Interchangeable parts. Handiness in manipulation. Ease in operation. Increase in output.

Sizes: 16″-20″-22″-24″-28″-30″. Any length. Prompt deliveries.

POWELL TOOL COMPANY, WORCESTER, MASS.

"NEW HAVEN" TOOLS



Improved 24-inch Planer

Strong and rigid, driven by two belts, giving a very steady motion. Head provided with automatic power feeds in all directions. Every convenience for rapid operation. Planes 5 and 6 feet (inside the pockets) 24 inches wide and 24 inches high.

Manufactured by

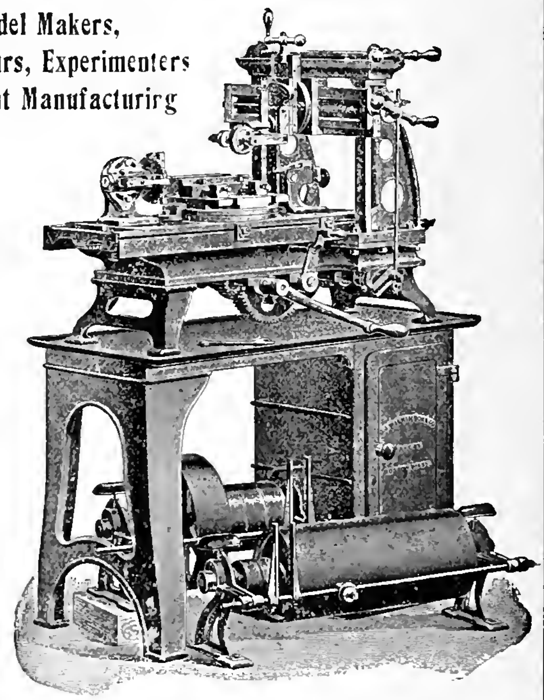
NEW HAVEN MANUFACTURING CO.

New Haven, Conn.

Improved Power or Hand Planer

For Model Makers, Amateurs, Experimenters or Light Manufacturing

Mounted on Heavy Cabinet Base

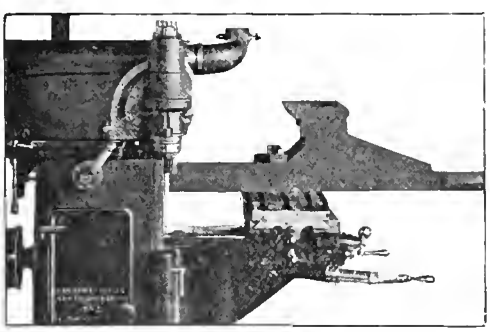


A small planer built from heavy, well proportioned patterns. Double Lifting Screws. Quickly adjusted round planer chuck with graduated base and 7″ planer centers. Efficient, durable and easily changed from power to hand crank.

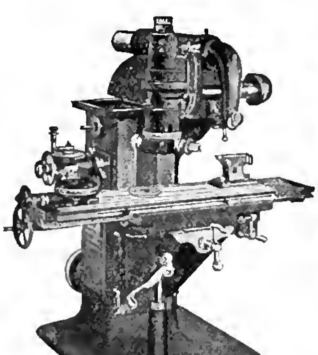
Write for full description.

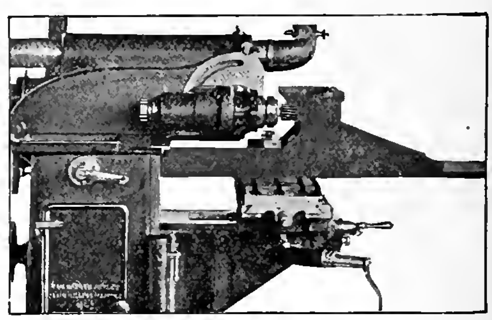
A. J. WILKINSON & CO.,

180 Washington Street, BOSTON, MASS.



No. 2 Van Norman "Duplex" with Head set Vertical and Ram drawn back, cutter operating close to the column of the machine





No. 2 Van Norman "Duplex" with Head set Horizontal and Ram thrown forward, cutting 17 inches away from the column.

Van Norman "Duplex" Milling Machine

Cutter spindle will operate in VERTICAL and HORIZONTAL positions and at ANY ANGLE. The most universal machine on the market, indispensable for Tool Room purposes, and an all-around manufacturing machine. We make 3 sizes. *Mention August MACHINERY.*

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Springfield, Mass., U. S. A.

Simple, convenient and efficient geared feed change.

Effective feed tripping mechanism.

Concentrated, convenient operation.

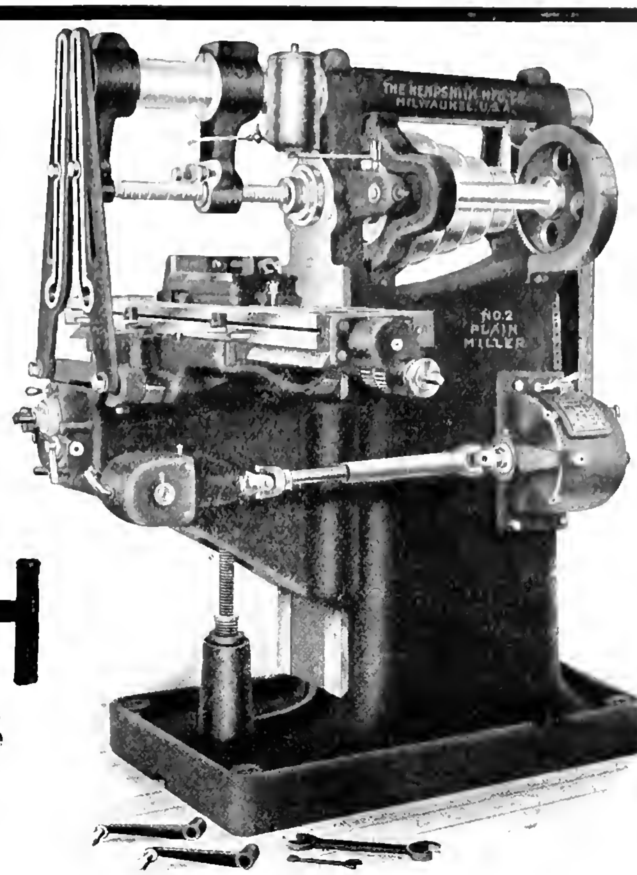
Wide range of automatic feeds.

Guaranteed accuracy of alignments.

Weight—power—stability.

These are all important points, and determine the real work-producing capacity of the machine.

In all of these



KEMPSMITH

MILLING MACHINES

have pronounced advantages, and warrant investigation and comparison.

THE KEMPSMITH MFG. CO., Milwaukee, Wis.

European Agents: Selig Sonnenthal & Co., London, E. C. Agents for Holland and Belgium: R. S. Stokvis & Zonen, Rotterdam.
Canadian Agents: London Machine Tool Co., Ltd., Hamilton, Ont.

LE BLOND

ECONOMICAL MILLING

LeBlond No. 3 Heavy Duty Miller

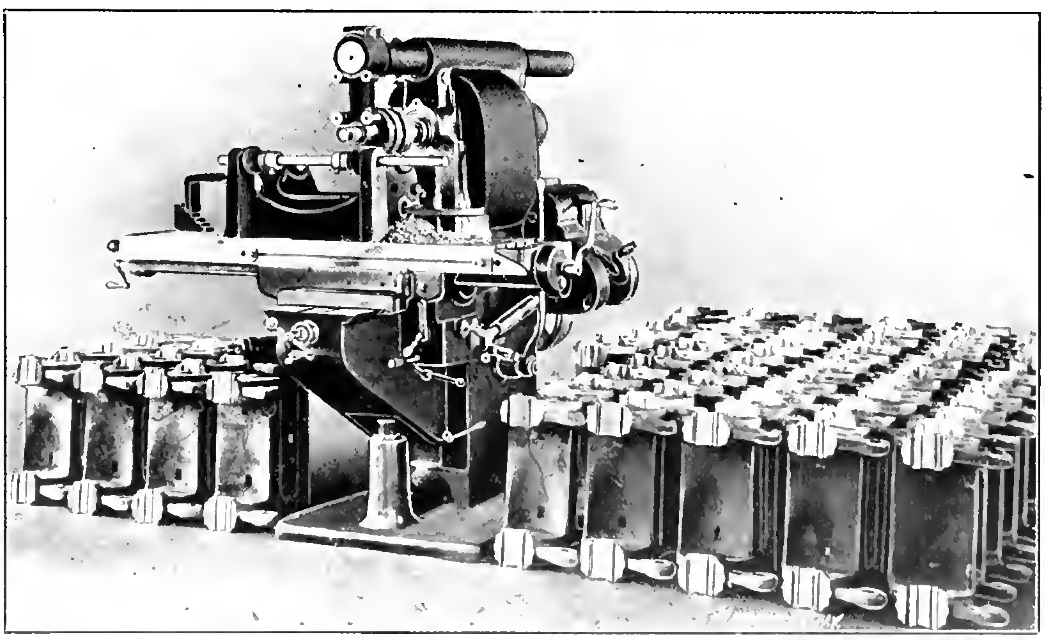
Machining Cap Seats in 14" Lathe Heads.

We find it profitable to mill all our heads to 24" swing. Heads are held in fixture and milled in correct relation to back gear arms. The cut is about 8" long, 4¾" wide and average depth 3-16".

Total Time:
75 Heads in 12 hours.

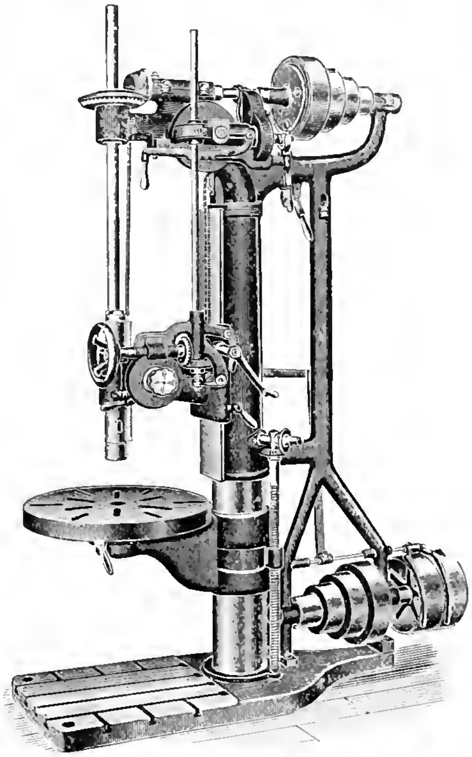
this is no exceptional time for this miller.

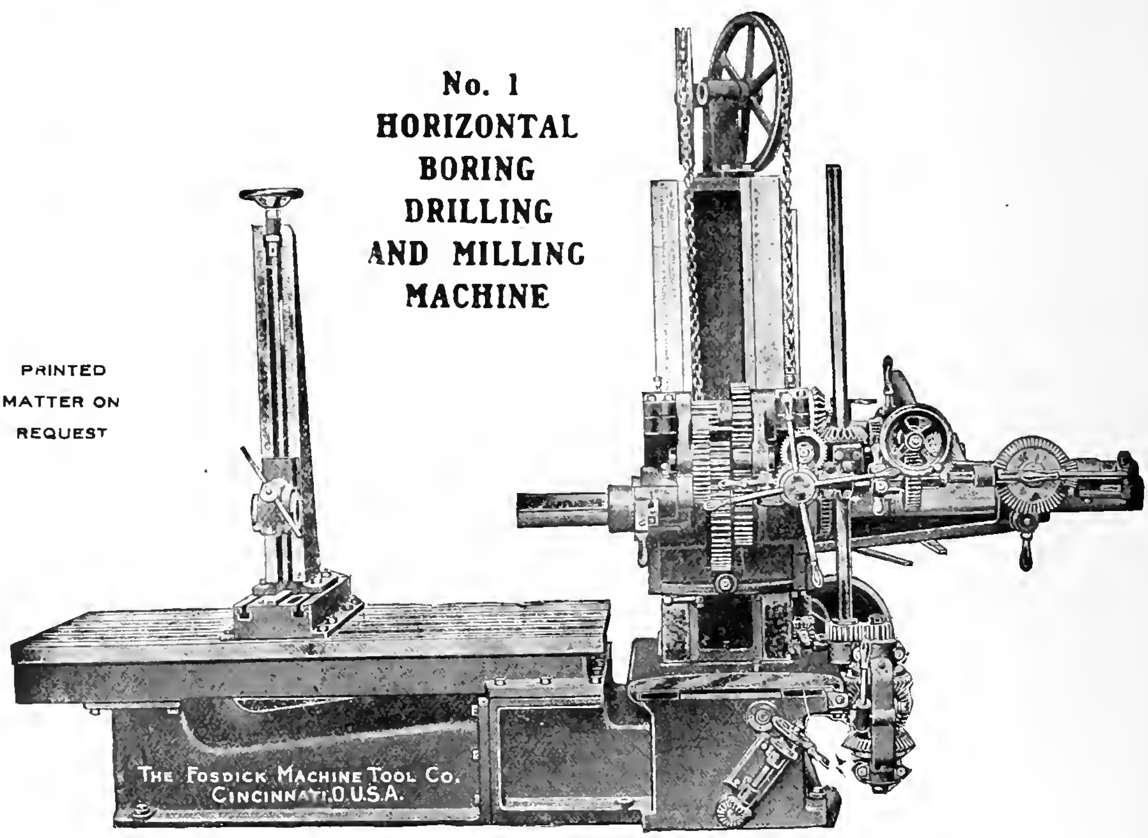
LeBlond tools are noted for ample reserve power in drive and feed.



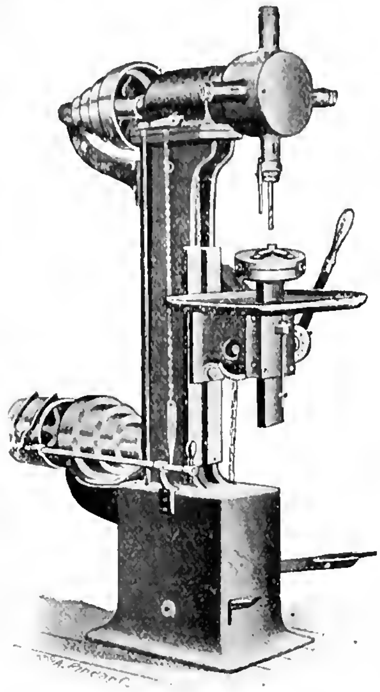
The R. K. LeBlond Machine Tool Company

4609 Eastern Avenue, CINCINNATI, OHIO




The Fosdick Machine Tool Co.
Cincinnati, O. U.S.A.

Quint's Vertical Turret Chucking Machine



A tool designed for light work and differing from all other chucking machines in the fact that the **cutting tool rotates**—not the work—thus obviating waste of time in stopping the machine to change the work. The chuck is balanced so when the feed is released the work drops with a quick return; a hole through the chuck and stand allows all chips to fall out of the way, leaving the work clear. Built with four or more spindles, positively driven with steel gears.

Write for details and price.

A. E. QUINT, Hartford, Conn.

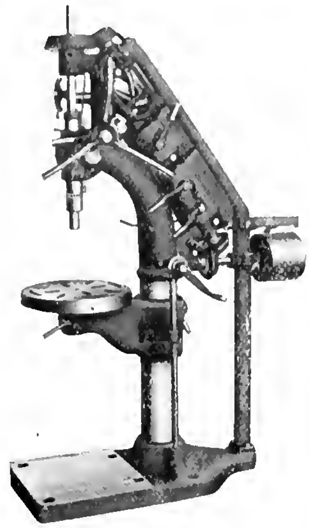
Our New 20-inch Drill

has

Geared Speeds

and

Positive Feeds



Showing Back Geared Style.

Mr. B. F. Barnes.

All changes of speeds and feeds are made instantly without stopping the Drill, and the operator doesn't have to move from his place in front of the machine.

This Drill has the capacity in power of the common 24″ belt driven drill.

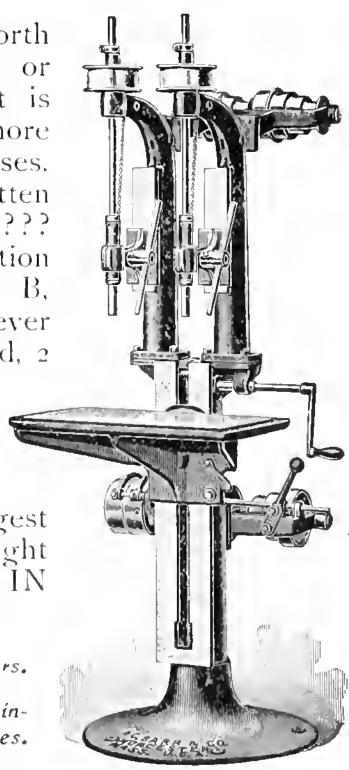
Meets requirements of modern shop practice in the use of High Speed Tools.

Descriptive catalogue tells more and it awaits your command.

BARNES DRILL CO., Inc. 1907

602 South Main St., ROCKFORD, ILL., U. S. A.

The Drills that Barr Builds



WHICH is worth MOST, Promises or Performances? It is easy to claim more than one possesses. Have you been bitten by the microbe????? Style A, (illustration 2-spindle), styles B, C, D, E, F, G, lever feed or power feed, 2 to 6-spindles, drill No. 60 to ¾″ holes and POWER TO SPARE.

THIS is the largest and best line of light Drilling Machines IN THE WORLD.

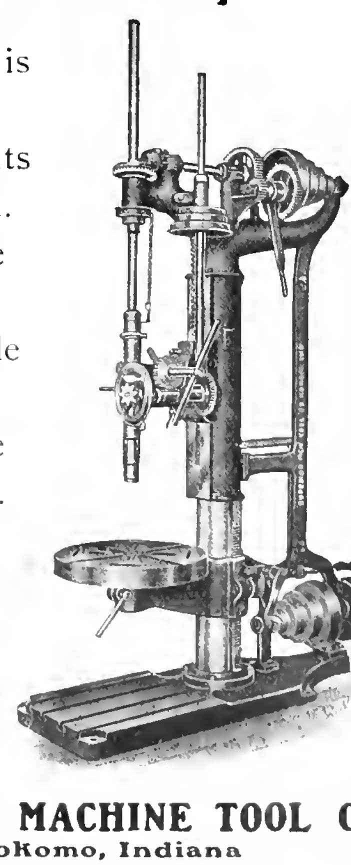
Write for special circulars.

Barr's line of Drills includes 60 styles and sizes.

H. G. BARR, Worcester, Mass.

AGENTS: De Fries & Co., Dusseldorf, Germany and Milan, Italy.

There's a Place for this Drill in your Shop



The design is new. All improvements incorporated. Drills to the center of a 25-inch circle and is quick and accurate in operation.

We shall be glad to send you a special circular of this 25-inch Back Gear Power Feed Drill if you will write us.

SUPERIOR MACHINE TOOL CO.

Kokomo, Indiana

We Manufacture

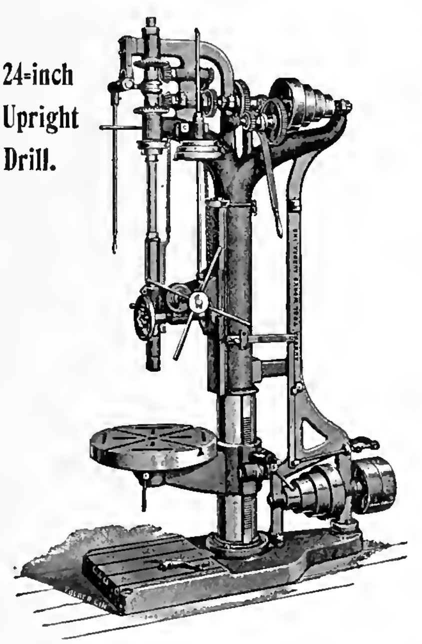
RADIAL DRILLS

Known all over the globe **by their merits.** All sizes and styles.
Cone, Speed Variator or Motor Driven.

DRESES MACHINE TOOL CO., Cincinnati, Ohio, U. S. A.

REPRESENTATIVES: Manning, Maxwell & Moore, Inc., New York, Philadelphia, Boston, Chicago and Birmingham. Carey Mchy. & Supply Co., Baltimore. Baird Mchy. Co., Pittsburg. Wm. C. Johnson & Sons Mchy. Co., St. Louis. The Strong, Carlisle & Hammond Co., Cleveland. Pacific Tool & Supply Co., San Francisco and Hawaiian Islands. Selig, Sonnenthal & Co., London. C. Schinz, St. Petersburg. G. Koeppen & Co., Moscow. V. Lowener, Copenhagen, Stockholm and Christiania. Van Rietschoten & Houwens, Rotterdam. Wilh. Sonesson & Co., Malmo, Sweden. Stussi & Zweifel, Milan, Italy. Alfred Herbert, Ltd., Paris, Belgium, Spain and Portugal. E. Sonnenthal, Jr., Berlin and Koln. White, Child & Beney, Vienna. Takata & Co., Tokio.

24-inch Upright Drill.



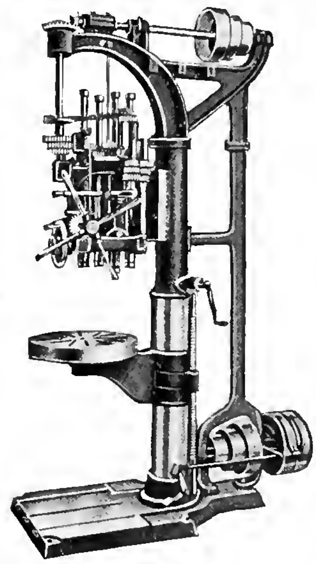
Ask the Price of AURORA DRILLS

It will surprise you to find how moderate is the cost of these up-to-date and efficient machines. They are built in sizes from 14" to 44", with back gears, power feed, automatic stop and geared tapping attachment; cover a very widerange of work, have the strength and rapidity for modern manufacturing and can be furnished with belt or motor drive.

We are ready for the question.

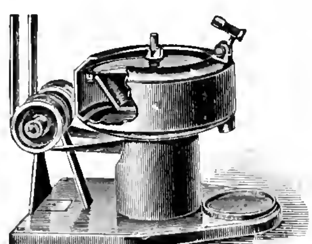
THE AURORA TOOL WORKS
AURORA, INDIANA

How do you do your Chucking and Jig Work?



Why not try out the **Cylinder-Turret Drill Press** on this class of product? It has no equal for work requiring different size holes in the same alignment. Will drill, ream, bore or tap on duplicate parts at proper feeds and speeds without necessity of changing the tools or work.

30 Days' Trial in your own shop.



Combined Oil Separator and Filter

A practical and economical device for the shop or factory. Can be operated by unskilled labor. Built in four sizes.

Write for particulars.

National Separator and Machine Co., BOSTON, MASS.

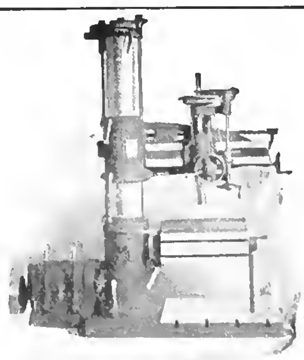
FOR YOUR HEAVY DRILLING

no tool of its class comes nearer perfection than the

Mueller Improved Radial Drill

Strength and rigidity to arm and work spindle are assured by the patented stationary column. 10 spindle speeds are instantly obtainable. One lever starts stops and reverses the spindle. Combination positive and friction feed facilitates handling many different kinds of work.

Catalogue on request.



The Mueller Machine Tool Co.
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SHOP ARITHMETIC FOR THE MACHINIST

No. 18 in MACHINERY'S Reference Series

makes the use of Formulas, and of tables of Sines and Tangents easily understood without a knowledge of Algebra or Trigonometry.

Price 25 Cents. Write for pamphlet.

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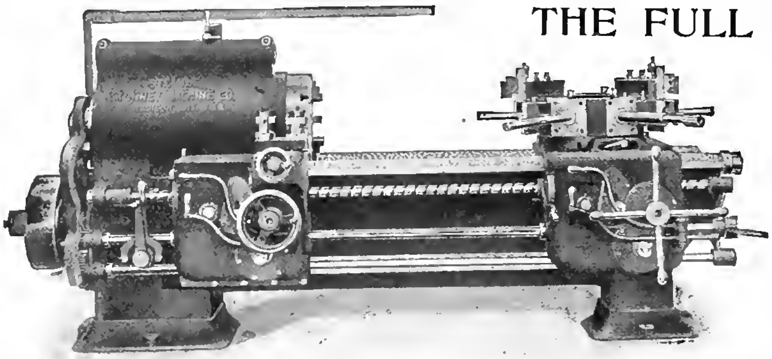


THE FULL SWING TURRET LATHE

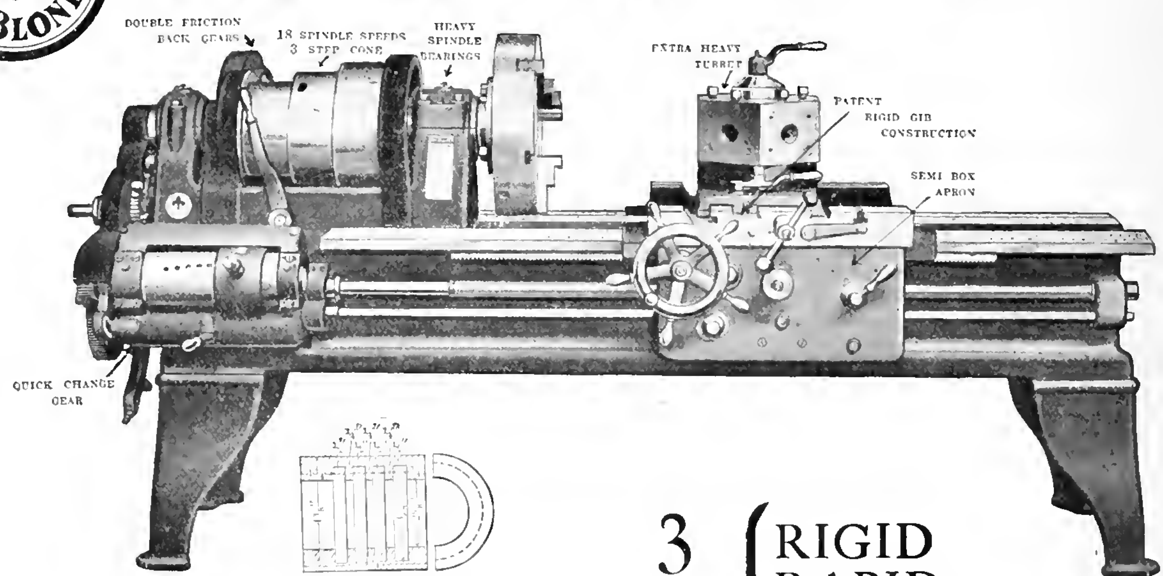
Increased Capacity
Short Turret Tools
Modern Construction

The requirements of modern manufacturing demand application of new principles. Our new tooling methods, the result of 16 years of experience in the evolution of Turret Lathe practice may prove of interest to **You.**

Send us drawings of your work, and we will tell **You** the time required to finish it.

STEINLE TURRET MACHINE COMPANY, Madison, Wisconsin, U. S. A.

LE BLOND 20" Special Turret Lathe



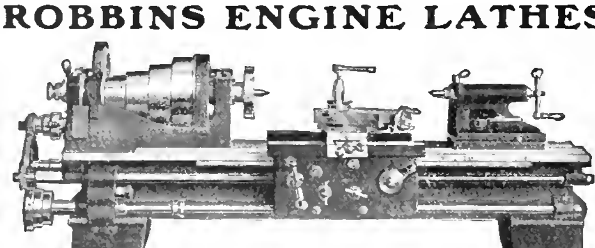
(PACKING CASING)

Bored, Faced and
Four Slots turned on inside
Time—15 Minutes

3 R's { RIGID, RAPID, RELIABLE

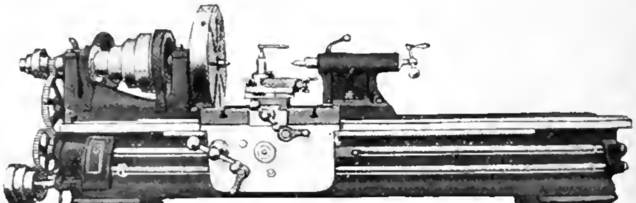
The R. K. LeBlond Machine Tool Co., 4609 Eastern Ave., CINCINNATI, OHIO.

ROBBINS ENGINE LATHES



Our 13, 15, 18 and 20" Engine Lathes are of massive and powerful design, are strongly back geared and furnished with compound rest and regular attachments. The range of feeds and speeds is ample, cone carries extra wide belt and operating convenience is a feature. We also make Pattern Makers' Lathes, 16, 20 and 24" sizes *Send for circulars*

THE ROBBINS MACHINE CO.
149 Lagrange Street Worcester, Mass., U. S. A.



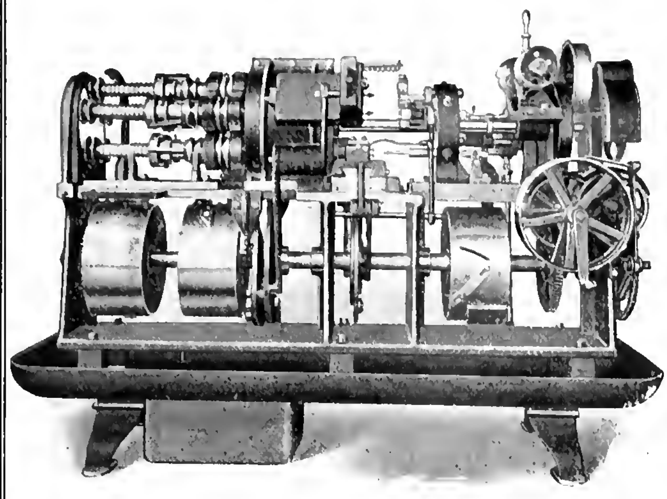
14" LATHES EXCLUSIVELY

A heavy, well built tool, with gear feed as well as belt feed. Just the lathe for the jobber and manufacturer.

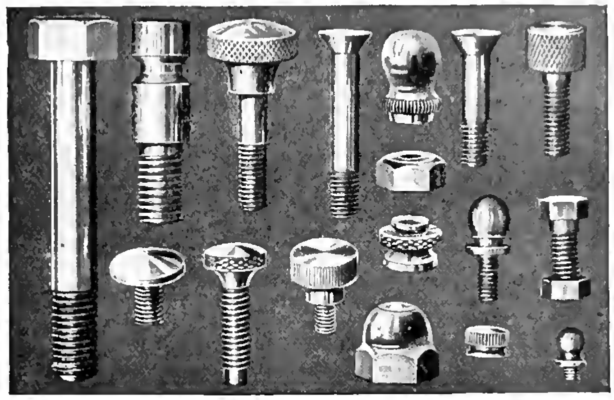
Send for circular.

Carroll-Jamieson Machine Tool Co.
BATAVIA, OHIO

10 Operations Simultaneously Performed—
One set of tools working on different bars of stock.



A time saving, cost saving, labor saving machine for screw work of every character – brass, iron, steel. Automatic in every move. Drive is by one straight belt from the countershaft. Threading mechanism positively driven from the spindles.



Samples of Work.

The Universal Multiple Spindle Automatic Screw Machine

Let us estimate on your work—the figures will surprise you.

The Universal Machine Screw Co., Hartford, Conn.

DOMESTIC AGENTS: Prentiss Tool & Supply Co., New York, Boston, Buffalo. Motch and Merryweather Machinery Co., Cleveland, Detroit, Cincinnati. Brown & Zortman Machinery Co., Pittsburg, Pa. Marshall & Huschart Machinery Co., Chicago, Ill.

WARNER & SWASEY TURRET LATHES

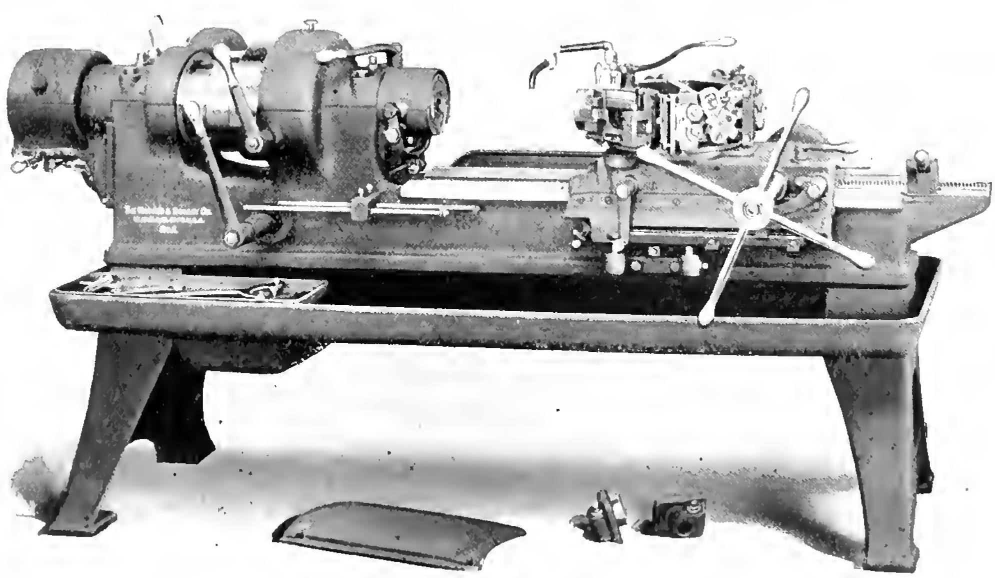
FOR EVERY REQUIREMENT — BAR OR CHUCK WORK

Hollow Hexagon Turret Lathes

Here Illustrated

Built in Four Sizes:

No. 1—1½ x 18 inches
No. 2—2¼ x 24 "
No. 3—3⅛ x 36 "
No. 4—4⅛ x 36 "



No. 2—2¼ x 24"—Hollow Hexagon Turret Lathe.

THE WARNER & SWASEY COMPANY, CLEVELAND, OHIO, U. S. A.

TURRET LATHES—SCREW MACHINES—BRASS-WORKING MACHINE TOOLS.

New York Office—Singer Building, 149 Broadway. **Chicago Office**—Commercial Bank Bldg.

Foreign Agents: Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Paris, Brussels, Liege, Milan, Madrid, Bilbao and Barcelona. A. R. Williams Co., Toronto. Williams & Wilson, Montreal.

Twelve to One in Favor of Novo Steel

NORTHERN MALLEABLE IRON COMPANY

RAILROAD AND AGRICULTURAL CASTINGS, CAR COUPLERS, CLEVISES, ETC.

ST. PAUL, MINN.

ALL AGREEMENTS CONTINGENT UPON STRIKES, ACCIDENTS, OR OTHER CAUSES BEYOND OUR CONTROL

April 10th, 1908.

Hermann Boker & Co., Chicago, Ill.

Dear Sirs:—We are pleased to report that Novo steel has gone beyond our expectation, in our factory. We have been able, by the use of Novo Steel, to reduce price of bolt cutting, 20%. We also feel that we have saved at least 50% of the first cost of Dies, because the Novo lasts so much longer.

Before using Novo, we found it necessary to re-cut the ordinary carbon steel die for about every 5000 threads, material cut being hard, and we now find it possible to cut as high as 50,000, or 60,000 with one re-cutting of the Novo Dies

We are now trying the 17/32 machine tap and as soon as we obtain some accurate figures, we will forward same to you.

Hoping you will call on us, whenever you are in the city, we are,

Yours truly,

NORTHERN MALLEABLE IRON CO.

S. Horsley

Asst. Superintendent.

INTRA STEEL

Between high speed and carbon tool steel.

Remarkable cutting qualities,
Extreme toughness,
Easy to handle,
Absolute uniformity in quality.
Water hardening.

Ask to have your tools made of Intra Steel.

Prices same as carbon tool steel.

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101-103 Duane Street, NEW YORK, N. Y.

WESTERN SALES OFFICE AND WAREHOUSE: 57-63 North Desplaines Street, Chicago, Ill.

Crescent Manufacturing Company

SCOTTDALE, PENNSYLVANIA

IMPROVED TOOLS

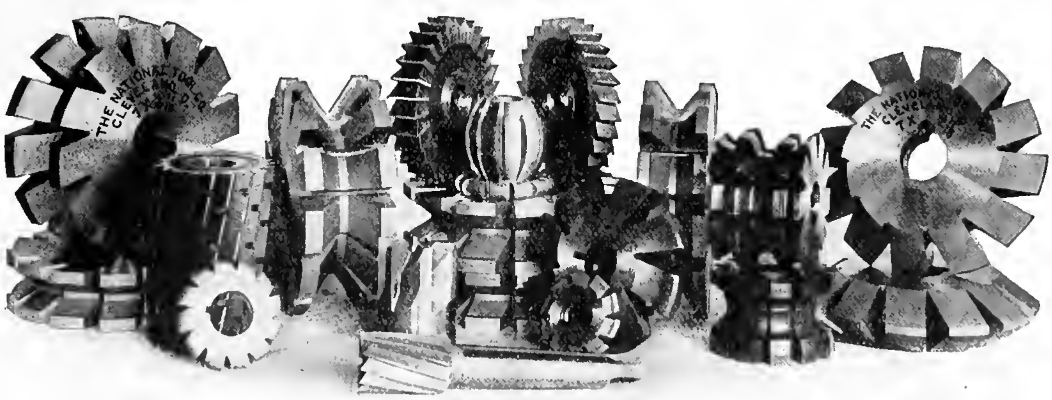
AND

SPECIAL MACHINE SHOP APPLIANCES

WRITE FOR ILLUSTRATED DESCRIPTIVE BULLETINS

NATIONAL CUTTERS WORK—

WORK FAST AND WORK LONG



Join the procession and send along your orders. **High Speed Steel Cutters** or **Carbon Steel** as desired—but every cutter the best that skill, good design and finest facilities for manufacture can produce.

Prompt delivery is another advantage.

The National Tool Company, Cleveland, Ohio

MILLING CUTTERS AND SPECIAL TOOLS

ROTHWEILER

THE WRENCH WITH A GRIP

A NEW WRENCH. Drop forged of the finest quality Tool Steel. For turning or holding pipe, pipe fittings, bolts, bars, shafts, etc. Simpler, stronger, lighter and more efficient than any other pipe wrench on the market. Designed on new lines. Upper jaw, shank and handle forged in one piece. No rivets, no loose parts to get out of order. The most satisfactory tool of its kind ever made.

Household size $2, express prepaid.

Write today for illustrated booklet.

CRESCENT FORGINGS COMPANY
1207 Railroad St., OAKMONT, PA.

Send Your Key Troubles To Us

INTRODUCE SCIENCE. ELIMINATE CHANCE.

NOTE SOME OF OUR CLAIMS:

We employ Skilled Workmen.
Use Special Machinery.
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You are to blame if your keys cost too much.

Our keys are MONEY SAVERS.

We want your business. You need our keys.

WRITE US TODAY for prices.
Valuable Catalog for the asking.

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Manchester, Eng.

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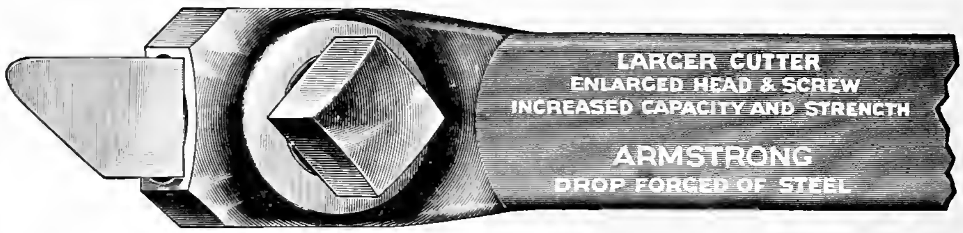
ARMSTRONG TOOL HOLDERS

THE WORLD'S STANDARD LATHE AND PLANER TOOLS

FIRST COST

is much lower than forged tools.

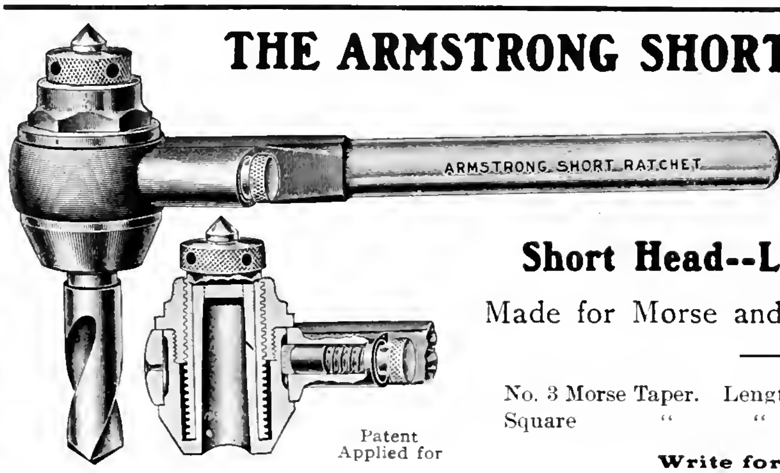


HERE'S ONE EXAMPLE

$\frac{5}{8}''$ x $1\frac{1}{4}''$ Tool Holder.		$\frac{5}{8}''$ x $1\frac{1}{4}''$ Forged Tool.	
One No. 2 S Straight Shank Tool Holder, equipped with two cutters. List Price	\$2.30	2 lbs. Steel at .60	\$1.20
Less 25%	.57	Forging, 8 dressings	1 00
		Grinding to shape, 8 times	.60
Net cost	\$1.73	Net cost	\$2.80

Showing First Cost of Forged Tools is 60% Higher than Armstrong Tool Holders.

THE ARMSTRONG SHORT RATCHET DRILL



Patent Applied for

SHORTEST and STRONGEST RATCHET made

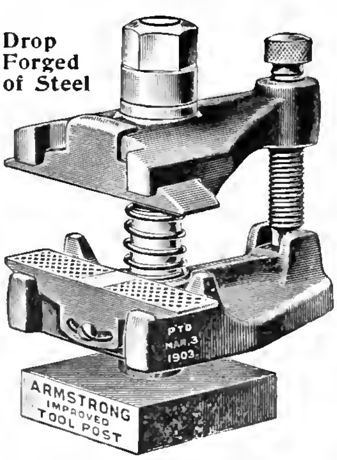
Short Head--Long Feed--Reversible

Made for Morse and Square Taper Shank Drills.

No. 3 Morse Taper. Length Head, $3\frac{3}{4}$ inches. Feed, $2\frac{3}{4}$ inches.
Square " " " $2\frac{3}{4}$ " " $1\frac{1}{2}$ "

Write for Special Circular.

Drop Forged of Steel



The Armstrong Improved Tool Post

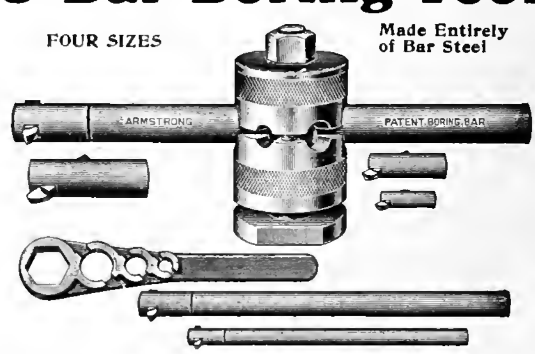
FOUR SIZES

OUR Improved Tool Post combines in itself the strength and holding power of the Strap and Stud Tool Clamp with the convenience of the "open side" and ordinary Set Screw Tool Post. Write for special circular.

3-Bar Boring Tool

FOUR SIZES

Made Entirely of Bar Steel



Increases production and reduces cost of tool maintenance. Cutters cannot jar loose. **High Speeds and Big Feeds** only set them tighter. Write for special circular.

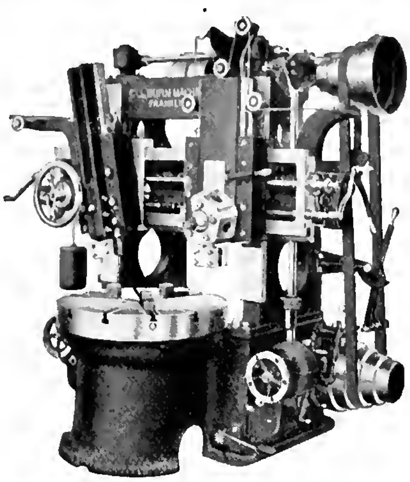
Do you want our New Catalog? It's a Tool Holder Encyclopedia.

Armstrong Bros. Tool Co.,

"The Tool Holder People" 113 N. Francisco Avenue, CHICAGO, U. S. A.

Imitations are Unsatisfactory ::: Infringements are Unlawful.

COLBURN BORING MILLS

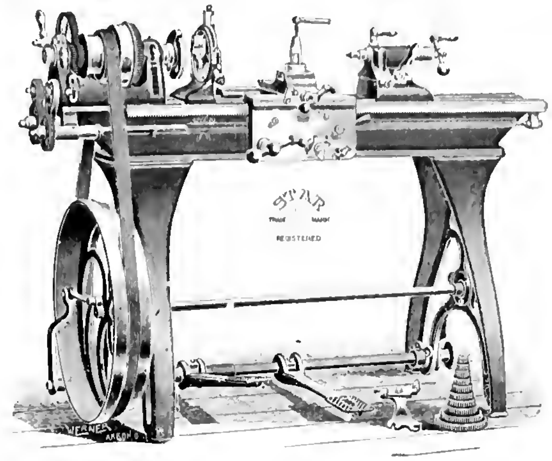


Do you want to run your boring mill department up to concert pitch day in and day out instead of getting a 50 or 75% output? Then bear in mind that COLBURN MILLS are built to do the hardest, fastest, stiffest jobs in the shop with accuracy and without jar or effort. They are the simplest and most easily operated mills on the market, correct in design and massive in construction. Write for bulletin of any size you are interested in. Sizes, 30", 34", 42", 48", 53", 60" and 72'.

Colburn Machine Tool Co.

Franklin, Pa., U. S. A.

Foreign Agents: Ludw. Loewe & Co., Berlin and London.



"STAR" Foot Power Lathes

are just what the name implies—Star lathes. They are built with the same careful attention to details and from the same high grade materials as the most expensive engine lathe on the market. Their work is as accurate as the production of precision machines, they have every feature for convenient operation and will "make good" in any tool room or light machine shop service.

9 and 11 inch Swing—Sent on Approval.

We guarantee satisfaction or no sale.
Write for catalogue "B."

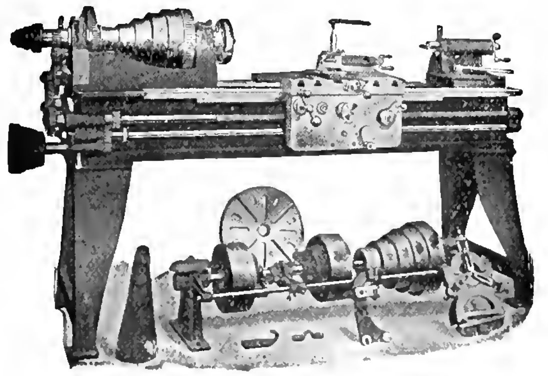
THE SENECA FALLS MFG. CO.,

330 Water Street, Seneca Falls, N. Y., U.S.A.

132A

Von Wyck 15-inch Engine Lathe

With Instantaneous Change Gear Device.



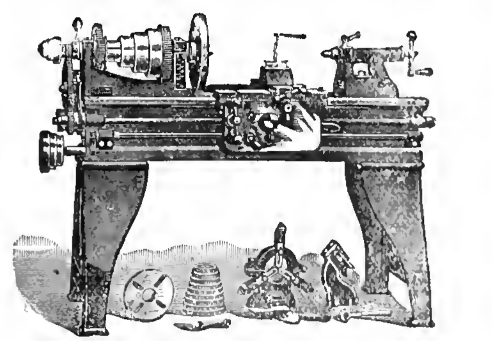
An especially well designed tool for its purpose. The quick change gear device for feeds and screw cutting permits 40 changes without duplication. Massive headstock prevents chatter even under the heaviest cut; every convenience for rapid handling.

Send for full description.

Von Wyck Machine Tool Co.

Cincinnati, Ohio, U. S. A.

Sebastian Lathes



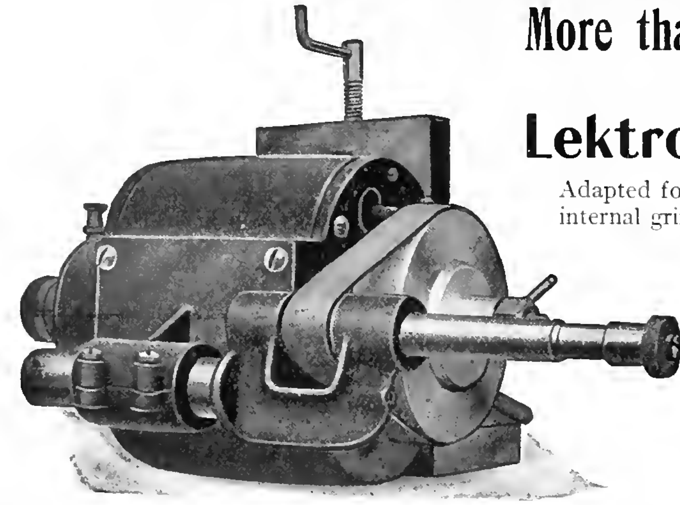
For modern manufacturing our line of 15-inch Engine Lathes fills every requirement

The design is new, all the latest time and labor saving improvements are incorporated and all parts are heavy and substantial. Our aim in putting this Lathe on the market is to furnish a thoroughly practical, high grade tool, suitable for present day work, at a moderate price. Even a hasty examination of its merits will convince you we have struck the bull's-eye.

Circular mailed on request.

Sebastian Lathe Company

129-131 Culvert St., Cincinnati, O.



More than 150 Different Grinding Operations

Can be performed on the new

Lektro Portable Universal Grinder

Adapted for cylindrical work, cutter and tool grinding, surface grinding, internal grinding—grinding of every description.

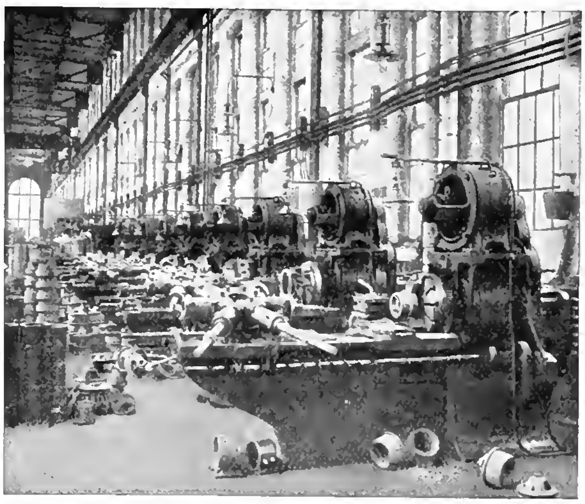
The machine is simple, has few parts, and used in connection with machine tools is full universal. It will grind anything that can be turned over a lathe carriage, can be set at any angle for cup wheel work and is an accurate, time and labor saving tool.

We can offer very attractive figures on a few of these machines—are you in line?

LEKTRO MANUFACTURING CO.
44 Walnut Street, CINCINNATI, OHIO

Efficient Machine Shops Use Western Electric Motors

Battery of Turret Lathes operated by Western Electric Motors.



Because—with individual variable speed motors, the maximum permissable speed is *quickly* attained and readily *maintained* for any and *all* operations and under any condition of operation.

Convenience of Control

enables workmen to work faster and turn out a better grade of work.

Thus you can get the maximum output and increase the productiveness of a plant at the same time decreasing the cost of operation.

Send for Booklet entitled "Increase Your Factory Productiveness" and Bulletin No. 505.

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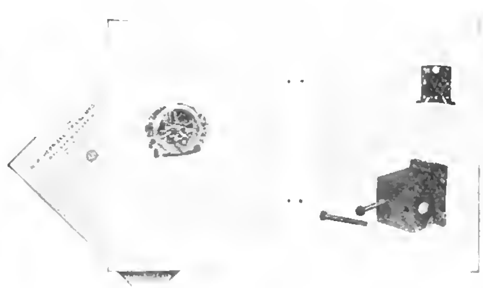


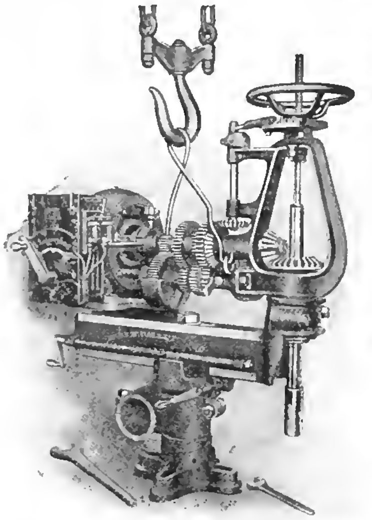
MAY WE SEND YOU A COPY?

991

Bulletin No. 2055 (just issued) is **different**—full of interesting facts and **worth reading.** It describes in detail the Best Engine Driven Generator ever offered—the new Northern **Type L.**

NORTHERN ELECTRICAL MFG. CO.
STANDARD AND SPECIAL ELECTRICAL MACHINERY
Madison, Wisconsin

"Dallett" Motor-Driven Portable Drills

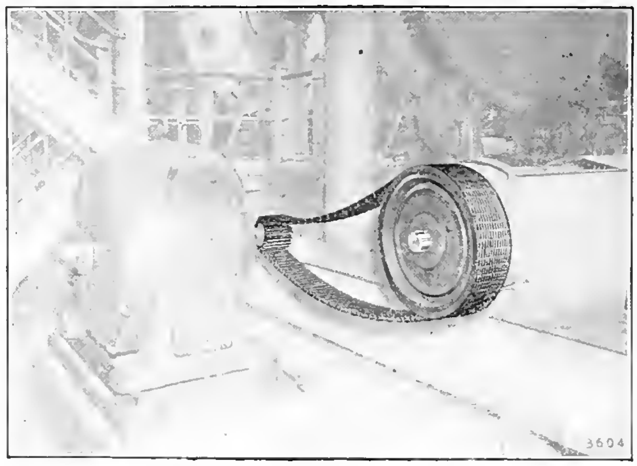


For Drilling in Every Position; a Portable, Standard and Radial Drill in one.

THREE SIZES:
No. 1—Weight 225 lbs
No. 4—Weight 720 lbs.
No. 5—Weight 1300 lbs

Write for Bulletins.

Thos. H. Dallett Co.
23d and York Sts., PHILADELPHIA, PA.



RENOLD SILENT CHAIN

is not affected by heat or dampness; its efficiency is always the same—**the highest in power-transmission.**

Write for Booklet "Y" and Bulletins 50-52-57 58.

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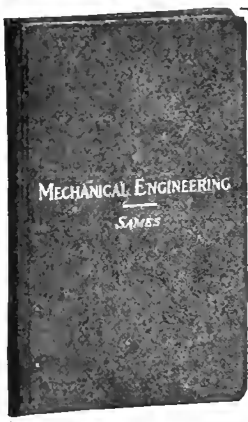
SEATTLE, 440 New York Block.



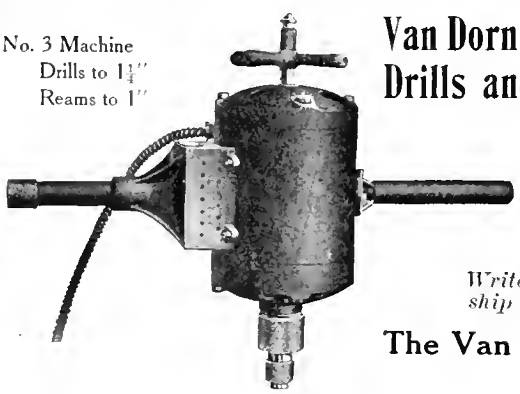
This Book ought to be in the Drafting Room

of every machine shop in the country. It *is* in many of the most progressive ones. You cannot afford to let the expenditure of $2.00 stand in the way of supplying your designers with the up-to-date reference matter it contains, which is not otherwise available in book form.

Descriptive folder on request.

C. M. SAMES, JERSEY CITY, N. J.
542 Bramhall Avenue.

No. 3 Machine
Drills to 1¼"
Reams to 1"



Van Dorn "Hard Service" Electric Drills and Reamers

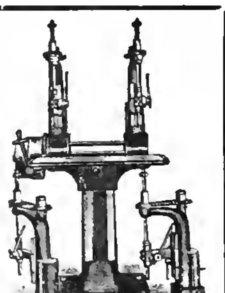
Especially designed for heavy drilling and reaming; rapid and simple in operation; convenient, durable, and operating expense far less than for air tools.

Write us for bulletins—or let us ship a VanDorn Drill on trial.

The Van Dorn Electric & Mfg. Co.
CLEVELAND, OHIO

Mighty handy for jig work

Our Manufacturers' Drill has adjustable top columns, three changes of speed for each spindle entirely independent of each other, lots of power, positive drive, quick changes of speed and plenty more good features which we can't tell about here. Get the catalog.



1 to 6 SPINDLES

THE TAYLOR & FENN CO.
Hartford, Conn., U. S. A.

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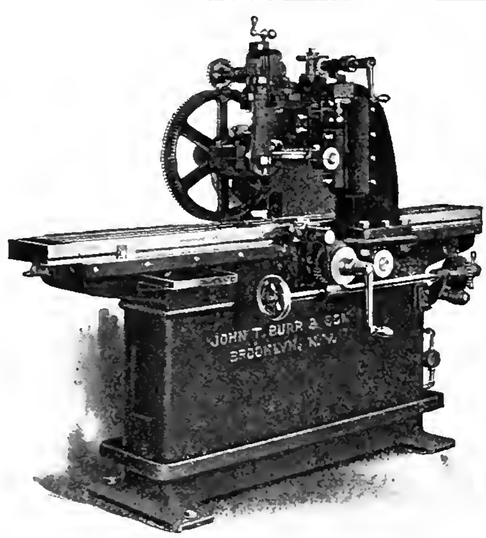
Machinery's Data Sheets
SENT ON REQUEST.

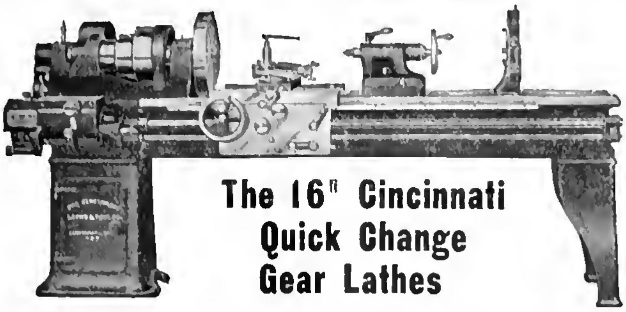


No. 5 Keyseat Milling Machine

Heavily built, powerful and adapted to a wide variety of milling other than keyseating. The construction of this tool represents the stiffest form for resisting strains incident to high speeds and fast feeds. Routing attachment has independent vertical and horizontal adjustment and when not in use can be raised so as not to interfere with the operation of the horizontal spindle.

A rapid producer of first-class work. Write for circular.

JOHN T. BURR & SONS
34 South Sixth St., Brooklyn, N. Y.
Portable Keyseaters, Broaching Machines, Cold Saws, Etc.



The 16" Cincinnati Quick Change Gear Lathes

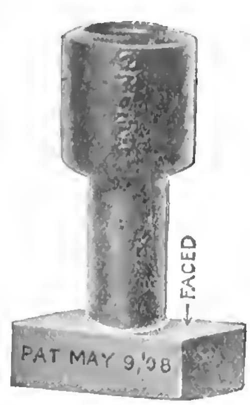
are well proportioned to take deep cuts rapidly. With their certain *desirable features* handle all work with extreme accuracy. Either five or three step cone and double back gear, also *another geared feed* for general manufacturing are furnished.

YOU better investigate now!

The Cincinnati Lathe & Tool Co.
Cincinnati, Ohio, U. S. A.

DON'T DELAY

using these "T" Heads too long or your planer slots will be *ruined*. Lang's "T" Heads save your "T" slots from breaking out but they won't mend them. Order now.

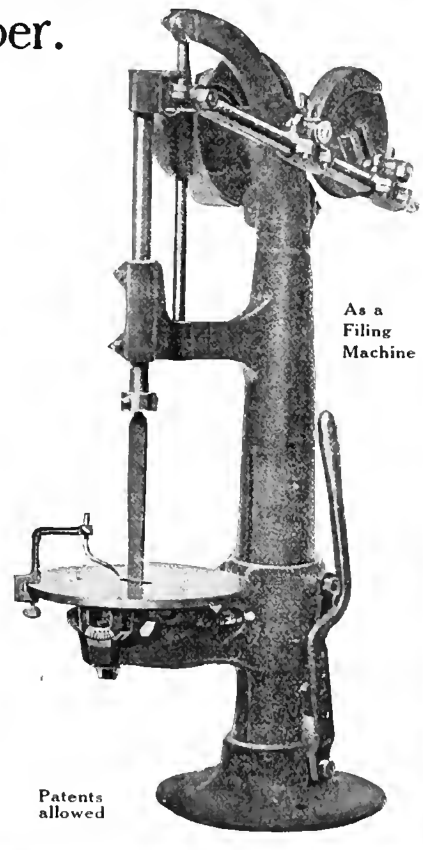


Drop Forged Steel

G. R. Lang Co.,
Meadville, Pa.

Manufacturers--Why not file those parts you are now milling? It can be done much cheaper.

All you need is a few special fixtures—more simple and less expensive than you now use on your miller.



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Patents allowed

The Simplex Combination Bench Filer and Metal Hack-Saw Machine

will lessen cost on a wide range of work including:

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Sewing Machines	House hardware
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Electrical Novelties	Rules
Silverware	Gas Meters
Gas Fixtures	Telephone Supplies
Surveyors' Instruments	Dental Instruments
Name Plates	Machinists' Tools

and can be used to advantage in the railway shop and jewelers' factory.

Ask for latest Catalogue.

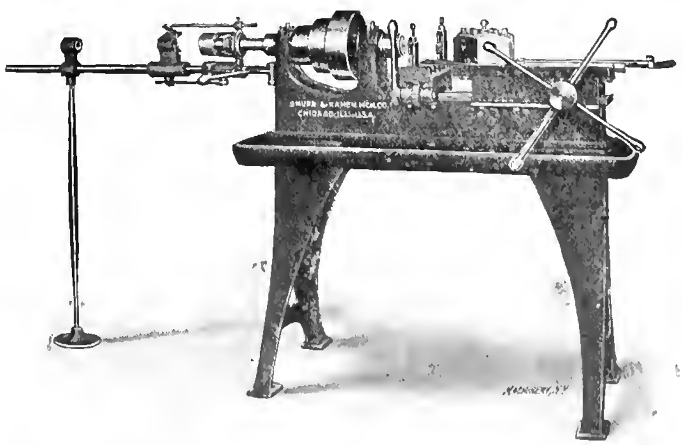
The Simplex Manufacturing Company
90 WEST STREET, NEW YORK CITY

New Wire Feed, Continuous in its Action

is one of the features of our improved

Plain Head Screw Machine

A tool that will prove an economy in any machine shop. Accurate alignment of the center of the spindle with the centre of the turret holes, and the permanent maintainance of same, is secured through the special manner in which the turret support is gibbed. The hexagonal shape of turret permits heavy tools to be fastened to the face when desired, there is positive stop for each tool, and other advantages fully described in the circular.



SMURR & KAMEN MACHINE CO.
97 S. Clinton Street, . . . Chicago, Ill.

BARGAINS NEW AND SECOND HAND MACHINERY TOOLS AND SUPPLIES

Second-Hand Machine Tools
in stock at Chicago, New York, Boston.

LATHES.

8" Rivett Precision, Screw Cutting.
13" x 5' Pratt & W., rise and fall and taper.
14" x 5' Putnam, compound.
14" x 6' Putnam, compound and taper.
14" x 6' Prentice, compound and taper.
16" x 6' Hendey, compound, taper and pan.
16" x 6' compound and taper toolmakers, Brown & Sharpe.
16" x 6' Fitchburg, compound and taper.
16" x 6' Bradford, compound and taper.
16" x 6' Putnam Motor Drive 110-V.
16" x 6' Putnam Motor Drive 220-V.
18" x 8" C. R. LeBlond.
18" x 8' Putnam Motor Drive 110-V.
18" x 8' Plain rest Wright & Powell.
18" x 10' Plain rest Wright & Powell.
20" x 12' Rise and fall Putnam.
24" x 12' Comp. Putnam Motor 110-V.
24" x 12' Compound American.
30" x 12' Comp. and taper Tri. Gd. Johnson.
36" x 16' Comp. and Taper Tri. Gd. Hamilton.
50" x 30' Pond Comp. Tri. Gd.
24" x 8' Pattern makers Fay & Scott.
36" Pulley lathe Putnam.
48" x 10' Face Plate Lathe.

RAILROAD MACHINERY

Bement Single Axle Lathes.
Bement Double Axle Lathes.
No. 2 Niles Double Axle Lathes.
No. 3 Putnam extra heavy double Axle Lathes.
36" Bement Car Wheel Borer.
36" Baker Bros. Car Wheel Borer.
300 tons 48" Niles Hydrostatic Wheel Press.
46" Bement Double Car Wheel Lathe.
90" Putnam Double Driving Wheel Lathe.

PLANERS AND SHAPERS.

12"x17"x17" Whitcomb Crank Planer.
16"x16"x4' Pratt & Whitney.
22"x22"x5' Putnam
22"x22"x6' Putnam.
24"x24"x6' Putnam 110-V Motor.
24"x24"x8' Old Style.
26"x26"x6' Pond.
26"x26"x16' 2 hds., Ferris & Miles.
30"x30"x6' Old Style.
30"x30"x12' 2 hds., Bement.
30"x30"x24' 2 hds., Sellers.
36"x36"x14' 1 hd., Sellers.
36"x36"x20' 1 hd., Sellers.
48"x48"x9' 1 hd., Hewes & Phillips.
60"x60"x10' 4 hds., Bement.
72"x72"x24' 3 hds. Bement.
72"x72"x24' 4 hds, Sellers.
84"x48"x20' 2 hds., Hewes & Phillips.
9"x23" Traverse Head Crank Shaper, Sellers.
9"x36" Traverse Head Crank Shaper, Sellers.
12"x45" Traverse Hd. Crank Shaper, Miles.
18"x9' Bed Double Head and Shaper, Cincinnati.
15" Pillar Shaper, Hendey.
16" B. G. Crank Niles
20" " " "
20" Pillar Shaper, Hendey.

MILLING MACHINES.

Kempsmith Hand Miller.
Brainard Index Miller.
No. 0 Plain Carter & Hakes.
No. 2 Plain Garvin.
No. 3 Plain Garvin.
No. 4 Plain B. & S. Old style.
No. 4½ Plain Becker Brainard.
No. 3 Universal. Brown & Sharpe.
No. 3 Universal New Model, Becker Brainard.
No. 5 Vertical, Becker Brainard.
No. 5 B., Becker Brainard, with rotary.
No. 2 Single Spindle Profiler, Garvin.
No. 13 New Model Profiler, P. & W.

BORING MILLS.

37" 2 hds. Vertical, Bullard.
37" 2 hds. Vertical, Niles.
72" 2 hds. Vertical, Niles.
21' 3 hds. Vertical Motor Drive, Pond.
36" Vertical Turret Borer, Brown & Sharpe.
2" Spindle Horizontal, Kelly.
2⅞" Spindle 6' Table No. 2, Bement.
3¾" Spindle 9' Table No. 4, Bement.
96" Swing Special Cylinder Borer.

TURRET MACHINERY.

¼" 00 Garvin Wire Feed.
½" No. 1 P. & W. Wire Feed.
⅝" No. 2 P. & W. Wire Feed.
1" No. 2 Warner & S. Wire Feed.
1¼" No. 3 B. & O. Wire Feed, geared head.
1½" No. 3 P. & W. Wire Feed, geared head.
2" No. 3 P. & W. Wire Feed.
2" x 24" Warner & S. hollow hex. Turret.
24" American Conradson Turret.
24" Gisholt Turret.

TURRET MACHINERY.

⅜" No. 0 Hartford Automatic Stud Machine.
⅜" Cleveland Automatic Stud Machine.
¼" 00 P. & W. Automatic Screw Machine.
5/16" No. 0 P. & W. 2 Spindle Automatic Screw Machine.
⅜" No. 00 Hartford Automatic Screw Machine.
⅜" No. 1 Acme Old Style for Spindle Automatic.
13/32 No. 1 B. & S. Old Style Automatic.
21/32 No. 2 Old Style B. & S. Automatic.
½" No. 1 P. & W. 2 Spindle Automatic.
½" No. 1 Spencer Single Turret.
½" No. 1 Spencer Double Turret.
¾" No. 2 P. & W. Automatic.
¾" No. 2 P. & W. 2 Spindle Automatic.
1" No. 2 Hartford Automatic.
1⅜" Hartford Automatic.
1¾" P. & W. Automatic.
2" x 24" J. & L. Flat Turret.

MISCELLANEOUS.

6" Crank Slotter, Bement.
3" Capacity No. 11 Higley Cold Saw.
16' Steam Driven Bending Rolls.
No. 3 Besly Disc Grinder.
No. 2 ¾" Splitting Shears, Long & A.
Single Spindle Sensitive Drills.
Multiple Spindle Sensitive Drills.
Upright Drills.
Radial Drills.
Adjustable Multiple Spindle Drills.

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84" x 40' Putnam.
36" x 12' Putnam, Rod Feed.
32"-58" x 16' Gap.
30" x 14' Fifield.
29" x 16' G. A. Ohl.
26" x 10' New Haven.
25" x 12' Fifield.
24" x 20' Fitchburg.
24" x 9' Pond, Rod Feed.
20" x 13' Betts.
20" x 10' Pond.
20" x 8' Betts.
20" x 8' Pond, Rod Feed.
20" x 7' 10" Pond.
19" x 6' Pond.
18" x 8' New Haven.

SHAPERS.

18" Hendey.
16" Steptoe.
13" x 22" English Traveling Head.
9" x 26" Sellers Traveling Head.
25" x 8' Pedrick & Ayer, Open Side.
20" x 30" Pedrick & Ayer, Open Side.

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1,000 lb. Chambersburg Steam Drop.
850 lb. Bell Steam.
800 lb. Pratt & Whitney Board Drop.
400 lb. Merrill, Board Drop.
400 lb. Bliss, Peck Lift.
200 lb. Morgan.
50 lb. Little Giant Trip.
50 lb. Justice.
Williams & White No. 4 Riveter.
No. 2 Hawkeye Trip.
No. 0 "Dupond," Power.

SLOTTERS.

10" New Haven.
10" Lowell.
6" Hawes & Phillips.

PLANERS.

84" x 84" x 24' Putnam.
37" x 33" x 10' Bement.
26" x 36" x 18' Niles, 4 heads.
33" x 30" x 8' New Haven.
30" x 30" x 12' Bement, 2 heads.
26" x 26' x 8' Niles.
20" x 20" x 5' Bement.
16" x 16" x 4' Hendey.

MISCELLANEOUS.

No. 3 LeBlond Unl. Miller, with Vertical Attachment.
No. 5 1-2 Bardons & Oliver Fox Monitor.
No. 3 Bardons & Oliver Fox Monitor.
No. 5 Cincinnati Double End Punch and Shear, 8" Throat.
10" x 30" Iroquois full Universal Grinder.
4 1-2" x 48" Burr Shaft Keyseater.
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60" Harrington Boring Mill for Pulleys.
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For Iron and Brass Castings. Various styles and sizes. For Machines, Bridges, Tablets, etc.
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All sizes in stock.
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What a chance!
Just when you can get them much less in price than they ought to be.

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17" x 6', Rahn.
20" x 8', Flather.
23" x 40" Swg. (gap), 18' bed.
24" x 12', Schumacher & Boye.
26" x 14', Porter.
26" x 18', Putnam.
28" x 16', Fay & Scott.
33" x 14', Triple grd. New Haven.
42" x 14', Triple grd, Quick change.
46" x 18', Triple grd. Lowell.
52" x 22', Triple grd. Putnam.
60" x 24', Triple grd. Fifield.
79" Double head Driving-wheel Lathe, "Niles."

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4½' Radial, with Tapping attachment.
3' Radial with Tapping attachment.
24" Upright, Back-grd., Sliding head.
21" Upright, Back-grd., Stationary head.

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Hyd. Riveting equipment, 96" gap, cap'y 1¼" Rivets, Accumulator, Pump, Crane, etc., Niles.
Punch & Shears 50", wt. 33,000 lbs.
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24" x 6' one-h'd Gray.
26" x 6' one-h'd Ohio.
27" x 7' one-h'd Gray.
30" x 8' one-h'd Niles.
30" x 10' two-head Bement.
30" x 12' one-head Newark.
36" x 10' two-head Putnam.
42" x 34" x 8' one-head Pease.
42" x 12', two heads, Whitcomb.
42" x 18', two heads, Miles.
54" x 16', one head, one on side, Bement.

SHAPERS

10" stroke, Crank, New Haven.
16" stroke, Friction, Prentiss.
24" stroke, Bk.-grd., Smith & Mills.
26" stroke, Triple-grd.

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Univ. No. 3, capacity 12" x 40", Brown & Sharpe.
Univ. Cutter and Tool Grinder, Oesterlein.
Cutter Grinder, Pratt & Whitney.
Car-wheel Grinder, double head, Springfield.

MISCELLANEOUS

Small and medium size Universal Millers, Oesterlein.
Plain Miller, 24" Table feed.
36" Automatic Gear Cutter, G. & E.
18" Automatic Gear Cutter, B. & S.
Slotter, 11" stroke, Lowell.
Upright Boring Mill, 72", Pond.
Upright Pulley Borer, 60", Niles.
Upright Power Hammer, 350 lb., Beaudry.
2" Wire Feed Screw Mch., P. & W.
20" x 7' Comb. Stud & Ckg. Lathe, Friction head, Bullard.
16" x 4½' Plain Turret Lathe, Back gears, Warner & Swasey.

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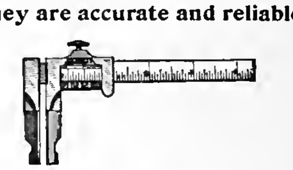
which save time
They are accurate and reliable.



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4" No. 1 with hardened jaws 1¼" long, by mail **$1.25**
6" No. 1 with hardened jaws 1¾" long, by mail **$1.85**

Graduated in 64ths and 16ths.

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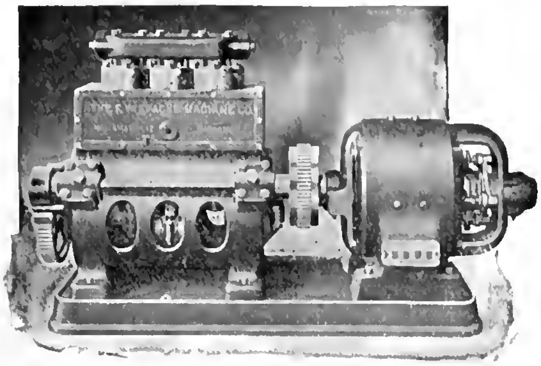
Columbia, Pa.
Caliper Catalog Free.



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Single or Three Cylinder Styles. Belt or Motor Driven

The Triplex and back-geared features of the Spacke Air Compressors make them compact and well-balanced. The variety of sizes is great, ranging in capacity from 1 to 100 cubic feet of free air per minute.

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GEAR CUTTING SPROCKET CUTTING

Special department for this division of our business. Estimates furnished.

NO MORE CUSS WORDS IN THE DARK

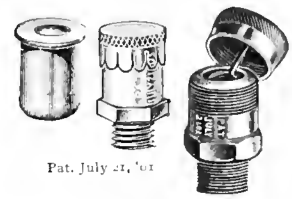
SKUNK UM UN D PL S

IF YOU CAN GET YOUR HAND ON IT YOU CAN PUT THE OIL IN

SEND FOR SAMPLES AND PRICES

European Agents, CHARLES CHURCHILL & CO., London, Eng.

BAY STATE STAMPING CO., WORCESTER, MASS.



Pat. July 21, '01

BENNETT HANDY OILERS

Twenty to Thirty Letters can be Engraved with the Gorton Engraving Machine at a Cost of One Cent.

This is a fact which should interest you and we would like an opportunity to prove that the machine will not only do better work than can be done by hand, but do it in a fraction of the time usually required. Engraving either in relief or sunken, on metal plates, seals, dies, patterns, etc.

Send samples of your requirements, we will then duplicate the same, stating the time required, quoting price with photo on suitable equipment.

GEORGE GORTON MACHINE CO., Racine, Wisconsin

Turret Tool Block

The advantages of this Carriage Turret will be readily appreciated in all modern, well equipped machine shops.

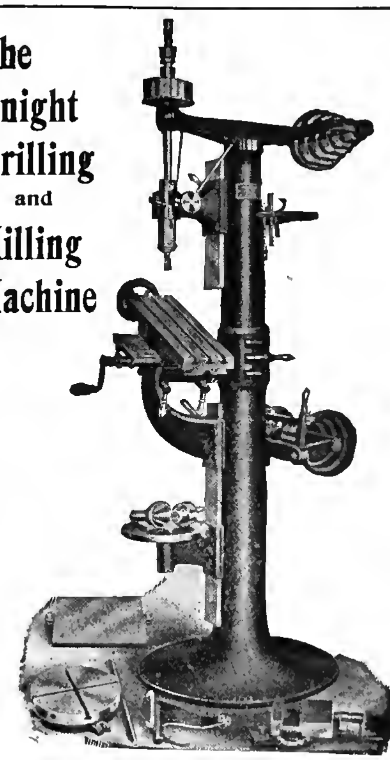
Attached to an ordinary engine lathe you secure a combination of Engine and Turret Lathe; the only difference being this Turret does not work automatically.

Of course the usual **FAY & SCOTT** excellence enters into the making of it.

Our booklet will tell you all you want to know.

Fay & Scott Dexter, Maine

The Knight Drilling and Milling Machine



Economy, Convenience and Efficency are the strong points of this machine. Handles a wide range of work and in many operations will save from 20 to 50 per cent. over other methods.

Write for circular showing samples of work.

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Precision Disk Grinders

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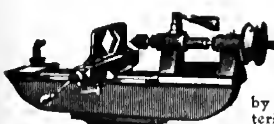
Steel Rules a Specialty.

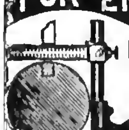


Save Money

by having one of our Centering Machines properly located. It has surprised many, why not you? Give it a little thought.

THE PHOENIX MFG. CO. 82 UNION PLACE, HARTFORD, CONN.

PAT. KEY-SEAT SETTING GAUGE FOR ENGINEERS & MACHINISTS



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SEND TO J. WYKE & CO.

E. BOSTON, MASS. U.S.A.

FOR LISTS OF THIS AND OTHER IMPROVED TOOLS

DRILL CHUCKS.

For sale by

De Fries & Co., Dusseldorf, Germany.

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Trump Bros. Machine Company,

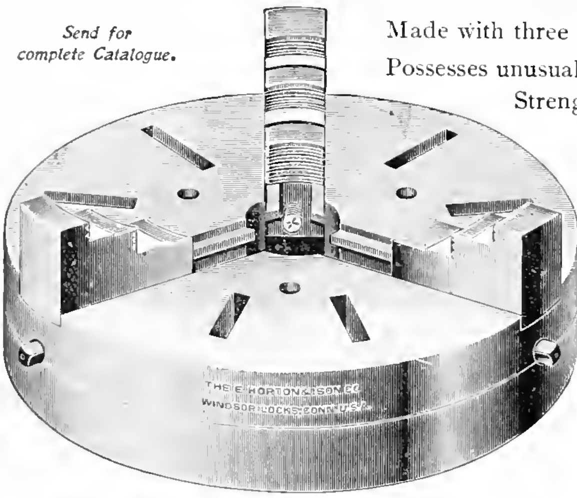
MANUFACTURERS

Wilmington, Del., U. S. A.

New Chuck. Heavy Universal, Three Jaws

18 INCH AND UPWARDS.

Send for complete Catalogue.



Made with three or four Jaws.

Possesses unusual Power, Rigidity, Weight and Strength.

Built to withstand the severest strains.

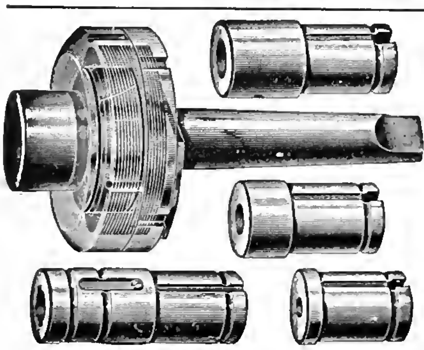
Corresponds with Modern Machine Tools.

We are specialists, and make nothing but Chucks.

The E. Horton & Son Company,
Windsor Locks, Conn., U.S.A.

THE

Safety Drill & Tap Holder



is the only attachment for the purpose that gives universal satisfaction, and is

UNEQUALLED in Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

Nothing to Break or get out of Order. Made in 4 sizes, covering from 0 to 2½ in. diameter.

The Beaman & Smith Co., Providence, R. I., U. S. A.

Almond Inclosed Pinion Drill Chuck

With pinion and gear teeth always in perfect mesh there is practically no opportunity for wear.

T. R. ALMOND MFG. CO.
ASHBURNHAM, MASS.
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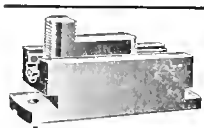
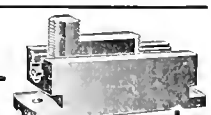


—UNION—



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MADE IN EIGHT STYLES WITH IRON OR STEEL SHELL

UNION MANUFACTURING COMPANY

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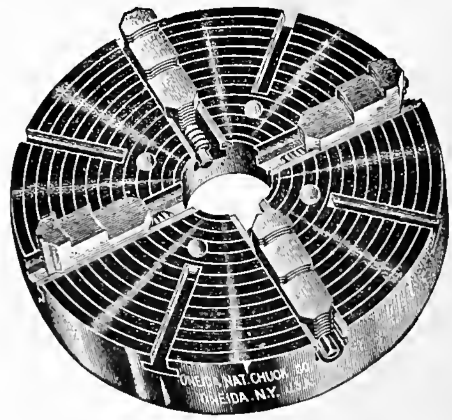
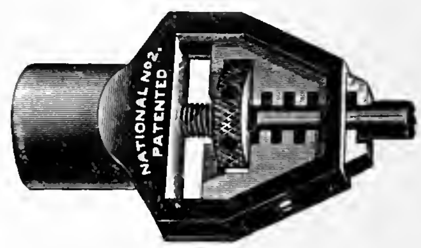
Oneida National Independent Chuck



National Drill Chuck

Made entirely of Steel.
Has no Equal.



Does not get Out of Order.

If you have a dirty job, try it. Money refunded if not satisfactory.

Oneida National Chuck Co.
ONEIDA, N. Y.

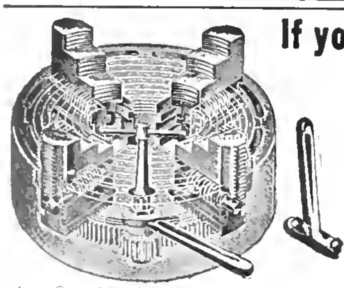
The Sweetland Geared Scroll Chuck

with SOLID REVERSIBLE JAWS.

No extra jaws to get mislaid or lost. Two styles of jaws in one, and those always where wanted, **in the chuck.**

THE HOGGSON & PETTIS MFG. CO.
NEW HAVEN, CONN., U.S.A.

If you want the best Lathe or Drill Chucks—buy Wescott's



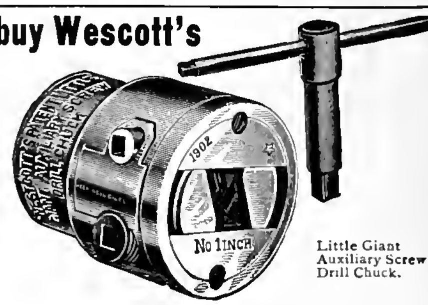
Spur Geared Scroll Combination Lathe Chuck.

Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Geared Combination Lathe Chucks, Geared Universal Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.

Strongest Grip, Greatest Capacity,
Great Durability, Accurate.

WESCOTT CHUCK CO., Oneida, N. Y., U.S.A.

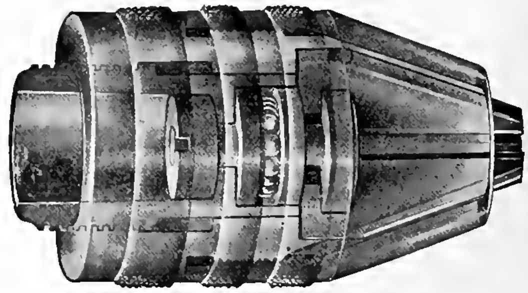
Ask for catalogue in English, French, Spanish or German.



Little Giant Auxiliary Screw Drill Chuck.

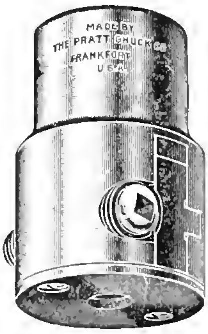
The Russell Anti-Friction Drill Chuck

Has the grip of a bull-dog—no slip, no wavering, no give up; is easily adjusted—operated entirely by hand, no key or spanner needed; saves time and drills.



The antifriction bearing is the special feature, overcomes all frictional resistance in tightening. Do you see the advantage? We'll tell you more about it if you will write us. Five sizes.

RUSSELL ANTI-FRICTION DRILL CHUCK CO., Elmira, New York, U. S. A.



A Securely Held Drill

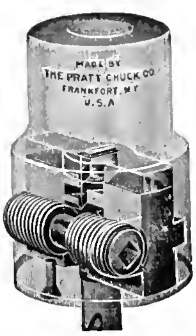
is half the battle. You can't do good work or do it quickly unless the drill, reamer—or whatever tool you are using —is held firmly.

The Pratt Chuck

is the ideal drill holder, because its construction makes slipping impossible. It not only holds the tool securely but it holds it without damage to the shank. The flattened end of the shank is passed through a little dog floating at the top of the chuck jaws, and which must turn as the chuck turns; the jaws are tightened just enough to keep the drill from falling out—and the shank is kept in good condition.

The simplest, most practical and most reliable Drill Chuck on the market.

Write for the book.



THE PRATT CHUCK CO.

Frankfort, N. Y.

European Agents—Selig, Sonnenthal & Co., 85 Queen Victoria Street, London, Eng.

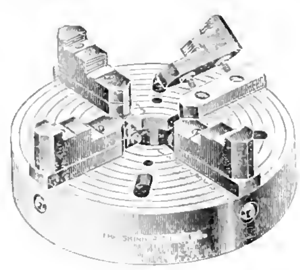
? ? ? CHUCK QUESTIONS ? ? ?

Are they accurate?

Are the Jaws and Adjusting Screws of such grade of steel, properly tempered, to withstand the wear and tear?

Are they so constructed that the operator has to go through only a few convenient motions, in adjusting them?

All **Skinner Chucks** are guaranteed for accuracy, the chuck jaws being ground true in the chuck body after hardening.



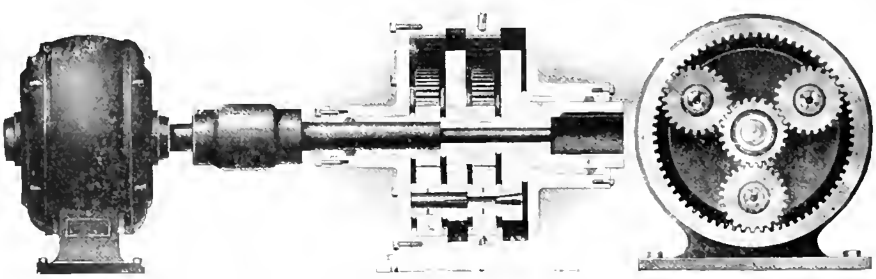
Convenience of operation was an important factor is designing each different style.

Write us in regard to your requirements for **Lathe, Drill** or **Planer Chucks,** and we will be pleased to recommend sizes and styles. You want our 1908 Price List at least.

THE SKINNER CHUCK CO.

94 N Stanley St., New Britain, Conn , U. S A.

94 Reade St., New York City.



O'Kelly Patent, June 27, 1905.

We use a Universal Coupling to Connect the Motor to the Reduction Gear Shaft, which Obviates the Necessity of Perfect Alignment.

The engraving illustrates a Speed Reducing Transmission for reducing the speed from a motor or driving shaft to any required speed of machine or driven shaft. It will be found efficient, strong and durable, being entirely incased and oil tight. It is absolutely safe and requires practically no attention. All the moving parts run in the same direction and you will note by taking power from three points of the pinions it gives a balanced drive with great emergency strength. The annular or internal gears are made of semi-steel; the idlers are made of steel, bushed with hard steel bushings. The idler pins are steel, case-hardened and keyed to the discs with a hard taper pin which can be quickly removed as shown in the cut. The bearings are bushed with Phosphor bronze. We make this device in a variety of sizes and speed reductions from ½ to 50 horse-power, either vertical or horizontal

D. O. JAMES MFG. COMPANY, - - 351-353 West Monroe Street, Chicago

The Jacobs Improved Drill Chuck

With Toothed Sleeve and Key

Chuck No. 3, cut actual size.

Capacity 0 to 17-32".

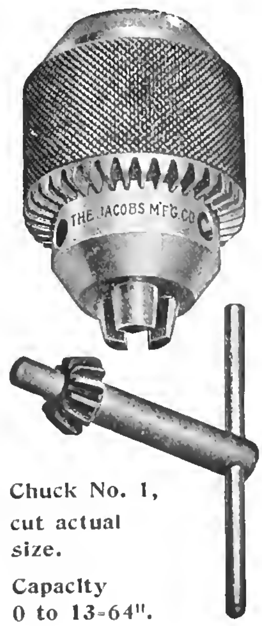
MADE IN FIVE SIZES

Largest with capacity up to 1" drills.

Patented Sept. 16, 1902.

Chuck No. 2, cut actual size.

Capacity 0 to 21-64".



Chuck No. 1, cut actual size.

Capacity 0 to 13-64".

"The Jacobs Improved Drill Chuck is not only the most convenient, but after two years of service, has proven to be the most durable Drill Chuck we have ever used."

Superintendent of a large Fire Arms Concern.

We offer you a chance to economize on your drill work—ask for the book and learn just how.

The Jacobs Manufacturing Company

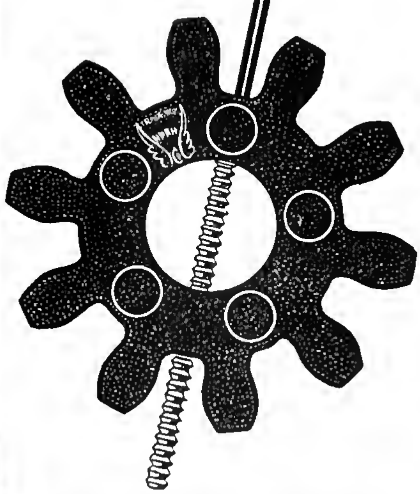
Hartford, Conn., U. S. A.

A timely hint

Write for Booklet telling all about New Process Raw Hide.

Now, while your shop isn't as busy as it has been, why not overhaul things? Substitute

New Process Noiseless Pinions



for those old grinding metal wheels and secure a quiet shop. They wear like iron, run quietly when meshed with your old iron gears.

The New Process Raw Hide Co.,
Syracuse, N. Y.

ELEC. WORLD

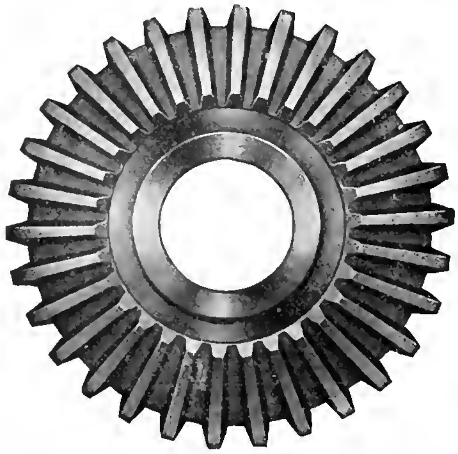
Grant Gear Works
6 Portland St., Boston, Mass.

Gear Wheels and Gear Cutting

of every size and kind on hand and to order. Facilities complete.

Grant's Treatise on Gears
One dollar—worth ten.

Grant's Gear Book
Full information. Free.



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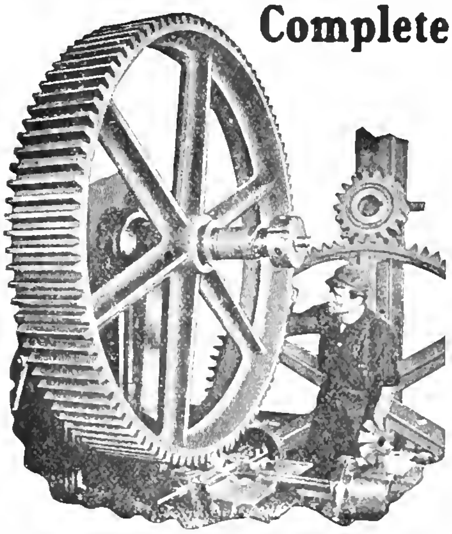
WM. GANSCHOW
S. W. cor. Washington Blvd. and Morgan St., Chicago

Our Line of Gears is Complete



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Successors to James & Foote,
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RAW HIDE GEARS

RAW HIDE bars, 2" to 12" diameter, 12" long carried in stock, therefore we are prepared to chop off the bar and ship your "**HURRY ORDERS AND BREAK-DOWN JOBS**" in 24 hours after we receive your order.

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LIGHT SPROCKETS and CHAINS.
SMALL and MEDIUM SIZED GEARS.
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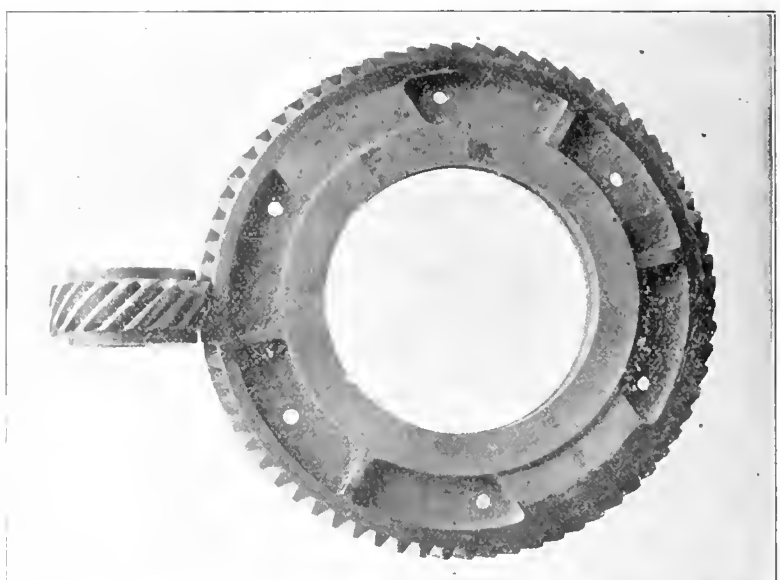

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are the newest creation in the art of making commercial gears. They drive forward or backwards with equal efficiency and smoothness of rotation.

Write for the Hindley Gear Book.

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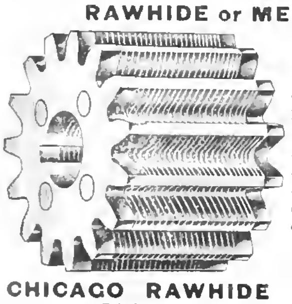
(Department of Otis Elevator Company)
Engineers PHILADELPHIA, PA.

GEARS and PINIONS
RAWHIDE or METAL



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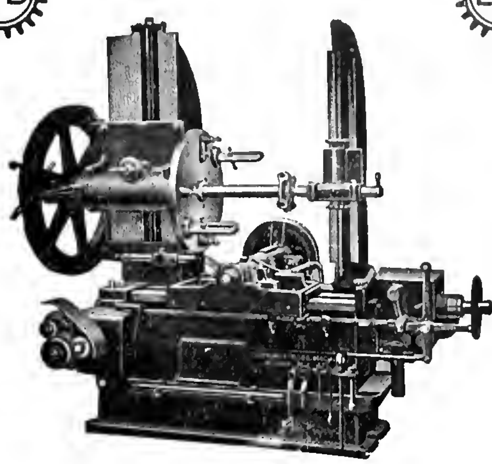
PEERLESS RAW HIDE PINIONS

Adapted for light or heavy service—noiseless, efficient, durable—the gears that are replacing metal gears in the best shops in the country.

These pinions mesh perfectly with metal gears and prolong their life; save power, run smoothly and in silence.

Our Blue Book on Gears gives details.

The Horsburgh & Scott Co., Cleveland, Ohio



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AUTOMATIC GEAR CUTTING MACHINES.

THEY CUT ACCURATE GEARS FASTER THAN ANY OTHER MACHINES. IMPROVED DESIGN IS THE REASON.

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BEVEL GEARS Cut Theoretically Correct

Facilities for cutting Spur, Worm, Spiral and Internal Gear Wheels.

Bevel Gear Generators and Special Machines

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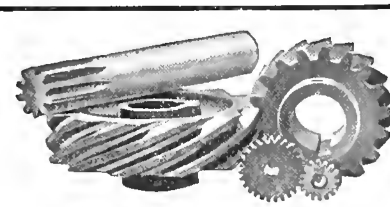

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WE GUARANTEE SATISFACTION.

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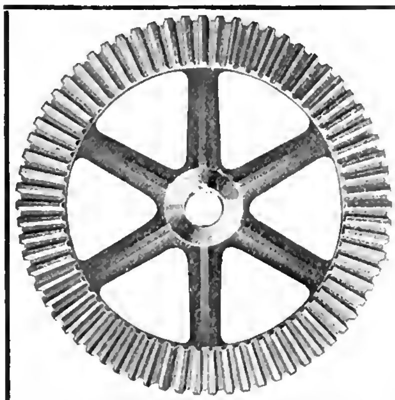

Spur, Bevel, Mitre Worm and Spiral

GEARS

Teeth planed in our Bevel Gears theoretically correct. Equipped for Gear Cutting and the manufacture of Gears of all kinds. Breakdown jobs handled promptly.

Send us your specifications.

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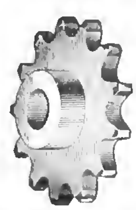

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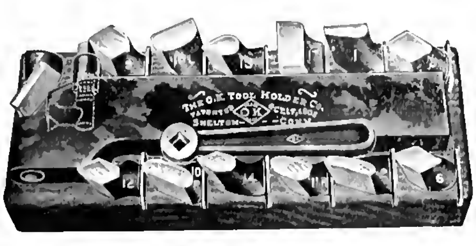

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The O.K. Tool Holder Co.
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And Machines Built on Contract.

Jigs and Fixtures, Punches, Dies, general machine work. Fifteen years experience on work of this character. Send blue prints and let me estimate on your work—it's money saved.

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MACHINERY FOR

Railroad Shops Structural Iron Works
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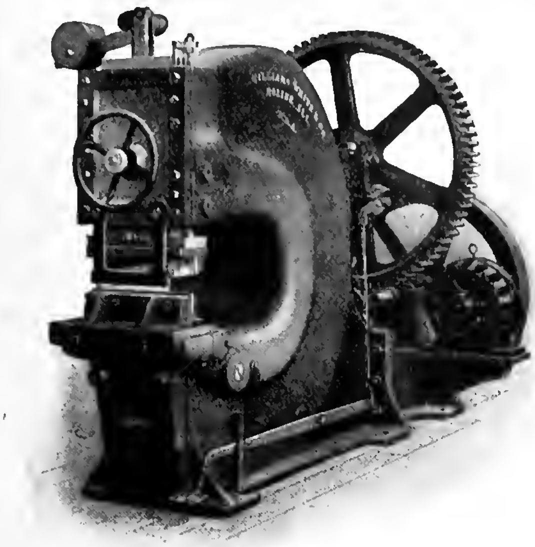

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Multiple Punches Upsetters and Taper Rolls
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WILLIAMS, WHITE & CO.

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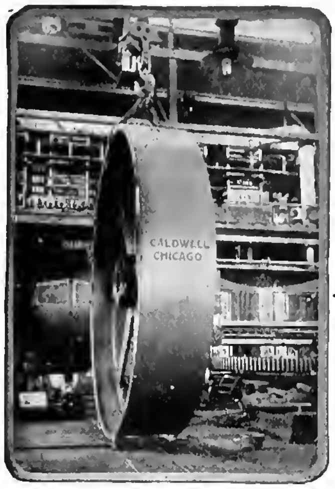

Reliable Band Wheels Fly Wheels etc.

No Walker band wheel or fly wheel has ever been known to burst. These wheels were designed expressly to replace other wheels that had burst. We have all the Walker data, standards, drawings, patterns and preparations, and are making Caldwell-Walker wheels along the old, time-tried lines. Our product is as good as past experience, modern skill and high-class equipment can make it. If you need a wheel now, write us; if not, better file this advertisement for future reference.

H. W. Caldwell & Son Co.

Chicago, Western Ave., 17th-18th St.

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Carpenter's Machine Screw Taps

OLDEST ON THE MARKET!

NONE SUPERIOR!

THAT'S ALL.

Made to A. S. M. E. Standard at regular price.

TRADE MARK

J. M. Carpenter Tap & Die Co.

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STEEL Shop Barrels and Boxes

Illustrating one of our Triple hem Shop Barrels fitted with a solid stamped steel bottom, allowing the barrel, when heavily loaded, to be easily rocked, or tipped over on to an ordinary barrel truck.

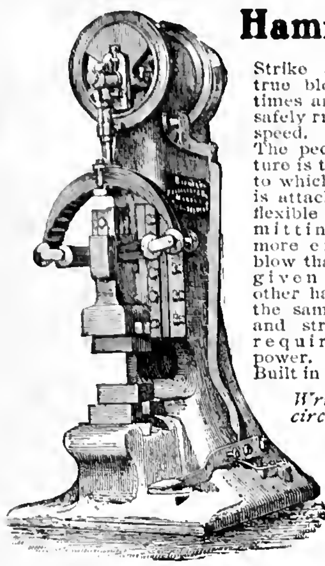
Factory Shelving and Adjustable Tool and Supply Racks.

Catalogue No 27.

The Cleveland Wire Spring Co.

Cleveland, Ohio.

"Dead Stroke" Power Hammers



Strike a square, true blow at all times and can be safely run at high speed.
The peculiar feature is the spring, to which the ram is attached by a flexible belt, permitting a far more effective blow than can be given by any other hammer of the same weight and stroke, and requiring less power.
Built in 7 sizes.

Write for circulars.

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Dienelt & Eisenhardt, Inc.
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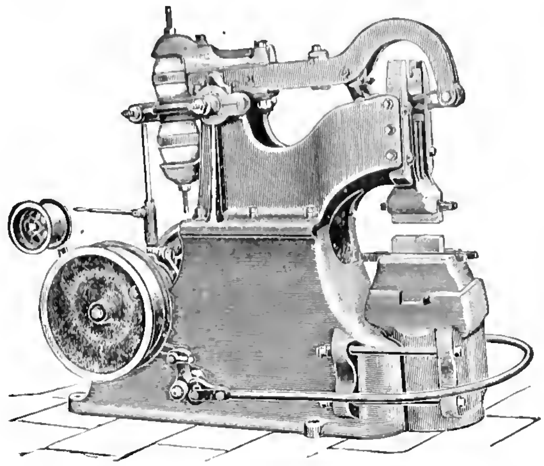


Bradley Upright Hammers

Are made with heads weighing 15 to 500 pounds. Each contains one-third to one-half more material than those of any other make of the same rating.

Their anvil blocks weigh nearly or quite double those of other hammers.

Their output is guaranteed 25 per cent. greater than is possible with other hammers of same rating or no sale.

More Bradley Hammers are sold each year than all other power hammers combined.

WE MAKE

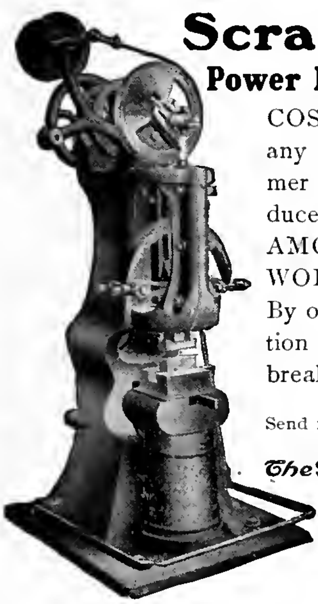
The Bradley Cushioned Helve Hammer. · The Bradley Upright Helve Hammer.
The Bradley Upright Strap Hammer. The Bradley Compact Hammer.
Forges for Hard Coal or Coke.

SEND FOR CIRCULARS.

C. C. Bradley & Son, Syracuse, N. Y., U.S.A.

FOREIGN AGENTS: Schuchardt & Schütte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schütte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. Buck & Hickman, Whitechapel Road, London.

Scranton Power Hammers



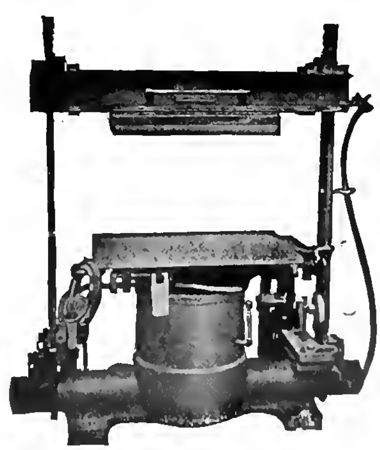
COST LESS than any other hammer that will produce an EQUAL AMOUNT OF WORK.
By our construction we avoid breakdowns.

Send for Circular 37.

The Scranton & Co.
New Haven, Conn.

PATTERNS of Every Description.
Penn Pattern Works, Chester, Pa.

Tabor Molding Machines.



Cut shows 13″ Cylinder Power Squeezer designed to squeeze the sand to the proper density instead of ramming by a blow.

Machine is adapted for use with Vibrator Frame, Paraffine Board or Plated Pattern.

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PHILADELPHIA, PENNSYLVANIA

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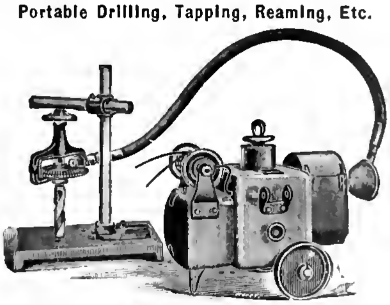
Stow Flexible Shaft
and
Multi-Speed Electric Motor.
Portable Drilling, Tapping, Reaming, Etc.



Stow Mfg. Company,
Binghamton, N. Y.
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THE SCHWERDTLE STAMP CO.
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its own story.

REED VISES

will grip and hold when the ordinary vise will slip and spoil the work.

The Reed Guarantee

is back of every one sold.

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REED MFG. CO., Erie, Pa.

The Service in Any Shop

will be quicker and better if this

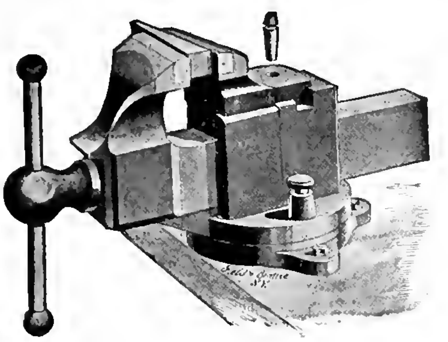
All Metal Truck

is part of its equipment. Holds tools or work as needed, is light running, can be quickly moved from place to place—never oil soaked or out of repair. One of the conveniences of the day, and one of the most durable devices in the market.

WRITE FOR OUR NEW BOOKLET OF SHOP FURNITURE.

New Britain Machine Co.

New Britain, Connecticut



Machinists' Swivel Vise

with self-adjusting jaw that is as strong and durable as any solid jaw, and a Swivel Bottom that gives any desired adjustment to right or left, and is solid and firm at any angle. We make all sorts of good vises, and have been leaders in this line for twenty years. Send for catalogue and price list.

Prentiss Vise Company,

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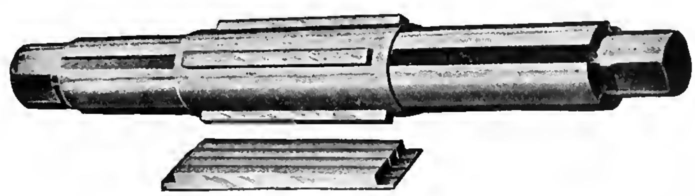
Agents for Great Britain, Chas. Neat & Co., 112 Queen Victoria St., London. E. C.

Still Sorting over those Solid Mandrels?

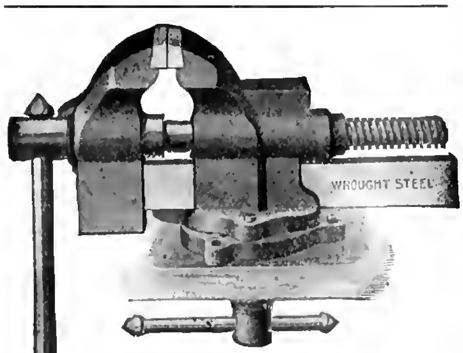
Better throw the whole lot into the scrap heap and get a set of NICHOLSON EXPANDING MANDRELS, they are what you want.



A set of nine of these will fit you out for work anywhere from one to seven inches in size, and you'll have the job done in the time it takes to look for an ordinary mandrel that's just the size required. Workmanship and material the best. Catalogue gives full description.

W. H. NICHOLSON & CO., Wilkes-Barre, Pa., U. S. A.

FOREIGN HOUSES: C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Stockholm and St. Petersburg.



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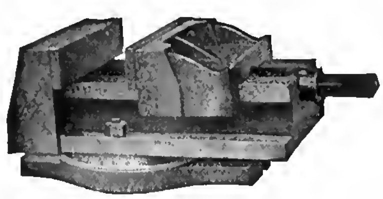

Plunket Improved Vises

Made with Plain or Swivel Base

Specially adapted for the hard service of the machine shop. Can be used with every style drill-press, shaper and milling machine. Strongest construction, steel screw, steel faces to jaw, cast steel handle. Write for further information.

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47-49 South Jefferson St.

——DRILL——

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CUT OUT AND FILE the three **Shop Operation Sheets** in this number. Your set **may be** worth a hundred dollars to you some day.

"TRIMO" PIPE WRENCH

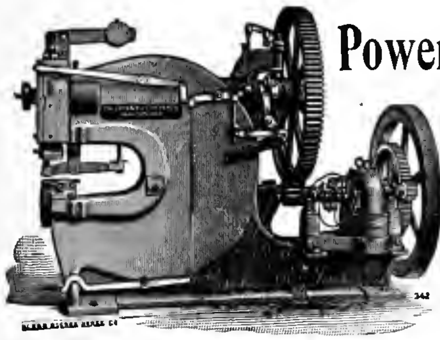
TRADE MARK

STRONGEST MADE. Less expense for broken parts replaced as well as time saved. Drop-forged from specially selected steel. Inserted jaw in handle easily and cheaply replaced when worn out, displacing the out-of-date and unsatisfactory method of drawing temper, filing and re-hardening when teeth are cut in the handle.

GOLD MEDAL
St. Louis, 1904.

Send for catalog No. 38 showing full line.

TRIMONT MFG. COMPANY, 55 to 71 Amory St., Roxbury, Mass.



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Belt, Steam and Electrically driven.

LONG & ALLSTATTER CO.

HAMILTON, OHIO, U. S. A.

Our machines are made in over 350 sizes and varieties.

SINGLE,
DOUBLE,
UPRIGHT,
HORIZONTAL,
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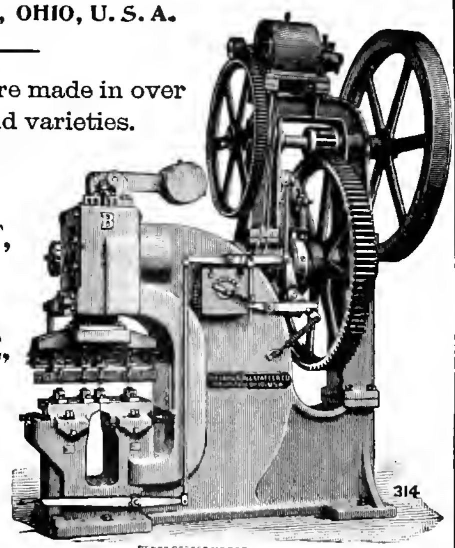
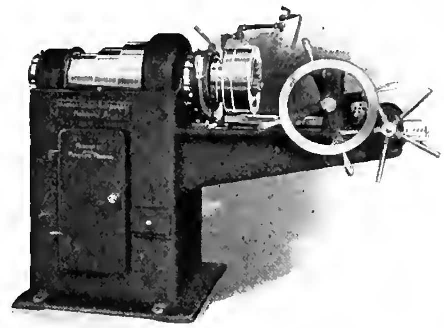
MULTIPLE,
FOR
Railroad Shops,
Locomotive Shops,
Bridge Works,
Etc.



"Plurality Die" Bolt Cutters



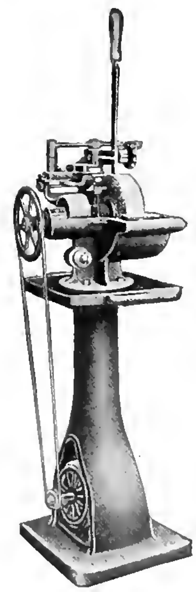
Simple, strong, compact, very few parts, no exposed gearing. Automatic throw-out opens the dies quickly with no jar to head.

THE "PLURALITY DIE" is the special feature of this machine, a single set doing the work of twelve of the ordinary kind. Will cut all commonly used threads from $\frac{1}{4}''$ to $1\frac{1}{2}''$. **Durability and Low Cost of Maintenance** strong points.

Keep your scrapers in good condition with the

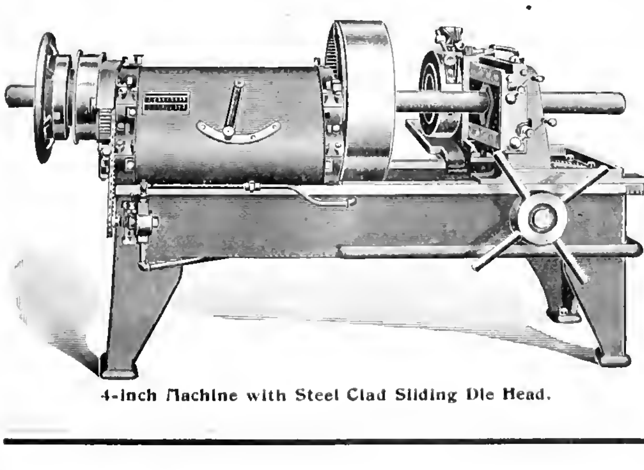
REVOLVING OILSTONE SHARPENER

This improved machine puts on a straight, keen edge that will stand much work without needing regrinding. Adapted for other work, easily portable and can be operated by unskilled labor. Ask for the catalogue.



Mummert, Wolf & Dixon Co.

HANOVER, PA.



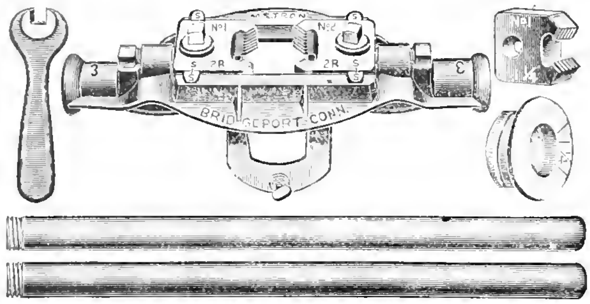
4-inch Machine with Steel Clad Sliding Die Head.

A SLIDING DIE HEAD ON A PIPE THREADING MACHINE

is absolutely necessary to get the most and best work out of it. Pipe does not come perfectly round, neither is it straight. If the head can move it will follow the pipe and you will get better work with less wear on the machine and dies. ¶ You can also put the pipe in and take it out thro the die stand **without dragging it across the dies and taking the edge off.** ¶ You can also cut off closer to the gripping chuck which saves time and makes money.

The Stoever Foundry & Manufacturing Co.

LEBANON, PA.



THE

Genuine Armstrong Stock and Dies

ARE

Unequaled in Efficiency, Accuracy and Simplicity

Are carried in stock by all Leading Jobbers in the country. Engineers and Steam Fitters require good tools. Go to your nearest dealer and get the **Genuine Armstrong Tools** which have stood the test for years. Manufactured by

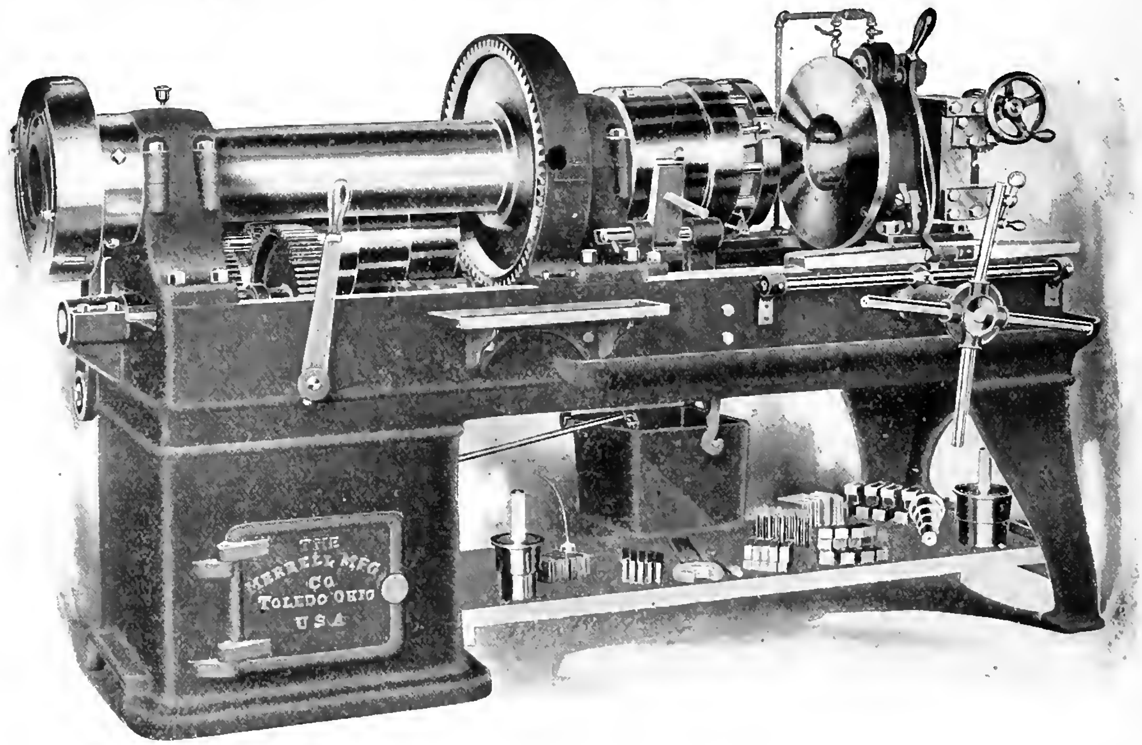
This Trade Mark on all our goods.

THE ARMSTRONG MFG. CO.

297 Knowlton Street, BRIDGEPORT, CONN.

WHAT THE MERRELL MACHINE MEANS TO YOU:

Merrell Pipe Threading and Cutting Machines mean *greater* work, and *better* work. Merrell Machines mean more *economical* work, and easier work for the operator. Merrell Machines mean greater efficiency and economy, and extreme simplicity and ease of operation.



This Merrell Apex Nos. 1 and 2 is designed and built for the man who has great quantities of pipe of one size to be cut. It has a special arrangement for cutting very short pieces of pipe. It has a special threading gauge that automatically cuts the pipe when the desired length has been threaded. It will cut steel or iron pipe *equally well*. It will cut nipples satisfactorily. Why not let us tell you further about this Machine? Why not get the Merrell catalogue?

30 DAYS FREE TRIAL

THE MERRELL MFG. CO., 15 Curtis St., Toledo, O.

Pipe Threaders and Cutters

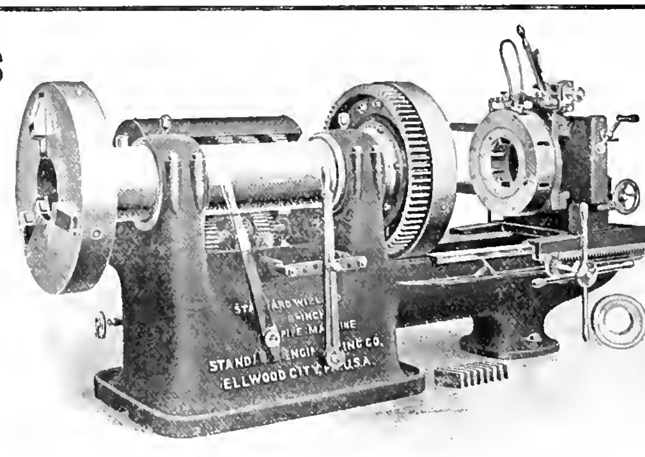
With efficiency as well as beauty.

Heavy—none more so; bed cast in one piece, no stands nor legs to work loose. No oil soaked floors; fire risk reduced.

Single speed pulley; all gear speed changes through semi-steel cut gears.

Deep chasers cutting long taper perfect threads in one cut as easily on steel as on iron pipe.

Let us prove to you that the higher cost of a modern tool is justified by the character and quantity of its product. Circulars for the asking.



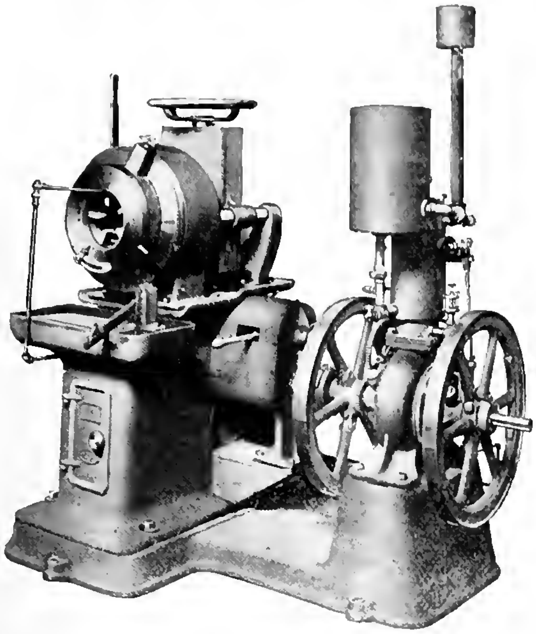
Standard Engineering Co.,

Ellwood City, Penna.

St. Louis Office: 1012 Chemical Bldg.

The LOEW VICTOR Gas Engine Driven Outfit

Newest and best thing in Pipe Machinery ever offered to the trade.

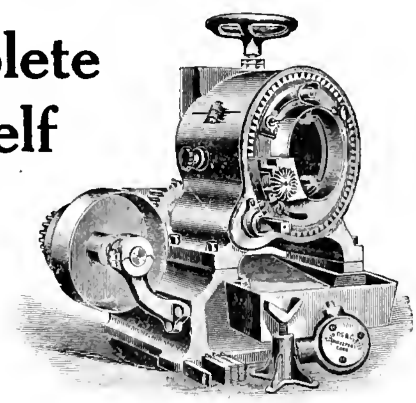


Self-contained—Will operate under any conditions—Neat—Compact—Fills a long-felt want.

Catalog on request.

THE LOEW MFG. CO., Cleveland, O.

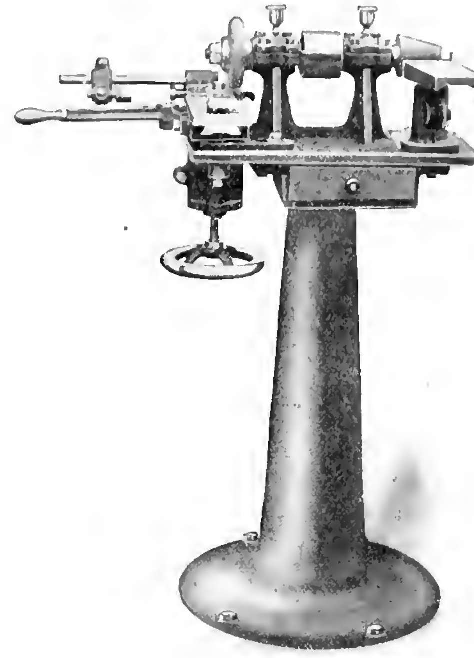
Complete in Itself



There are no vises or other accessories needed with the **Forbes Patent Die Stock**—it is a complete tool for cutting off and threading pipe, doing the work so easily that one man, unaided, can cut off and thread pipe up to 15 inches by hand. Machines are arranged for hand or power, are easily portable, especially convenient for use in cramped quarters and have all parts interchangeable.

Send for latest catalogue showing sizes, prices and capacities of our machines.

The Curtis & Curtis Company
8 Garden Street, Bridgeport, Conn.



DEBUT

It is needless to say that steel pipe requires a sharp, properly shaped die to cut a good thread. The little machine shown here is the

B. & K. Die Grinder

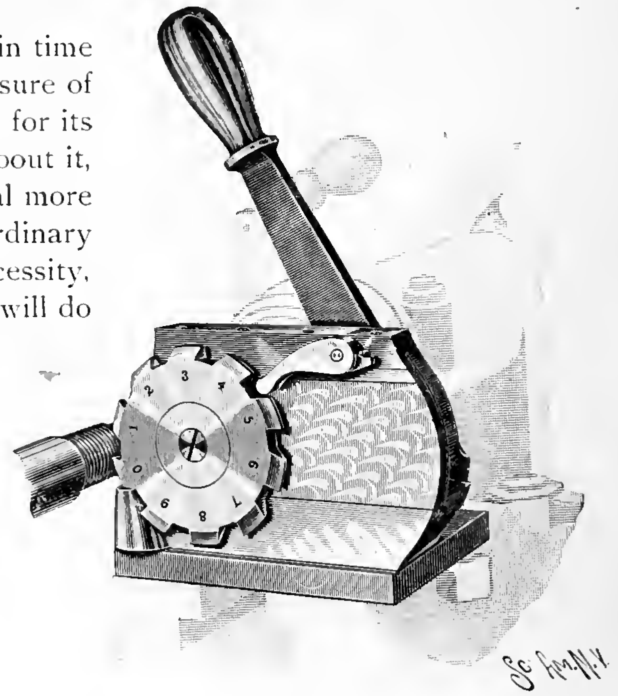
for the correct grinding of the dies. Simple to operate, moderate in price, and will save you dollars.

Get the folder.

Bignall & Keeler Mfg. Co.
EDWARDSVILLE, ILL.

THE RIVETT-DOCK THREADING TOOL

FOR ACCURATE THREADING AND DUPLICATE WORK



You not only save from 25 to 75 per cent. in time with this device, but you can be absolutely sure of exact results. Skilled labor is not required for its operation, there is nothing complicated about it, and a boy with this tool will do a great deal more and better work than an expert using the ordinary thread tool. Grinding is an infrequent necessity, with one sharpening the Rivett-Dock Tool will do as much work as a hundred of the single point variety. Practically a shop necessity and now in use in the best equipped plants in the country. As a labor saver it stands in the front rank and we shall be glad to send one on Thirty Days' Free Trial.

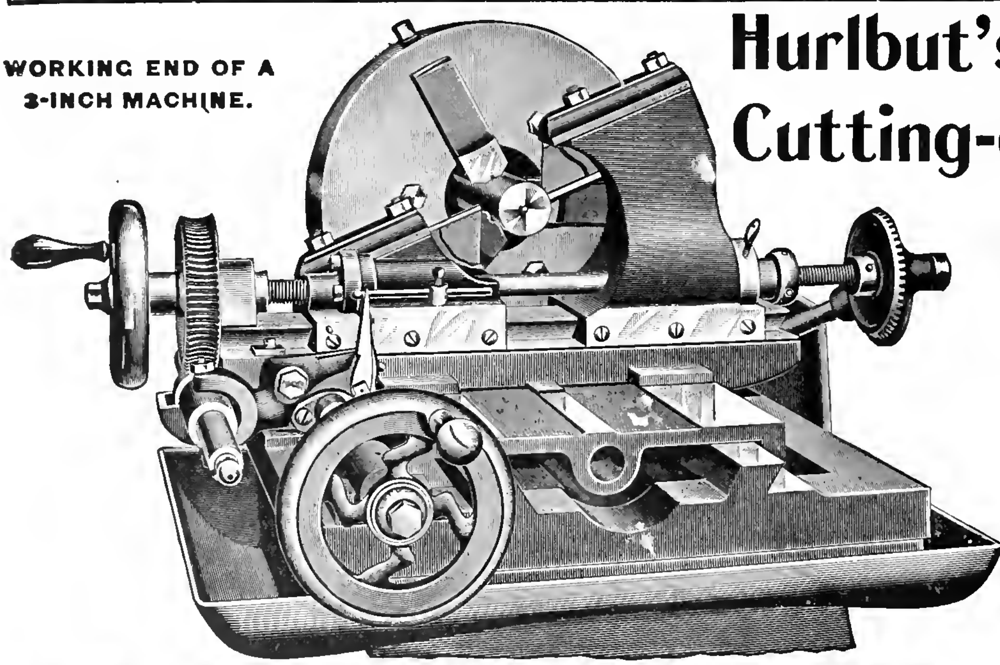
Ask for a Catalogue.

We manufacture the Rivett Precision Lathes and Internal Grinders.

RIVETT LATHE MFG. COMPANY,

Brighton District BOSTON, MASSACHUSETTS

WORKING END OF A 3-INCH MACHINE.



Hurlbut's Patent Cutting-off Machine

Made in 2-inch, 3-inch, 4-inch, 5-inch, 6-inch, 8-inch and 10-inch sizes.

Circulars on application.

HURLBUT-ROGERS MACHINE CO.

So. Sudbury, Mass.

No better Crucibles than ours can be made. The very best that skill, experience and finest quality of materials can produce.

McCULLOUGH-DALZELL CRUCIBLE CO., Pittsburgh, Pa.